

**FINANCIAL LENDING INNOVATION, OPERATIONAL EFFICIENCY AND
FINANCIAL SUSTAINABILITY AMONG COMMERCIAL BANKS IN KENYA**

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**A Thesis Submitted in Partial Fulfillment of the Requirement for the conferment of
Degree of Doctor of Philosophy in Business Administration (Finance) of Masinde
Muliro University of Science and Technology**

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DECLARATION

This research thesis is my original work prepared with no other than the indicated sources and support and has not been presented elsewhere for a degree or any other award.

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CERTIFICATION

The undersigned certify that he has read and hereby recommend for acceptance of Masinde Muliro University of Science and Technology a Research Thesis entitled, **“Financial Lending Innovation, Operational Efficiency and Financial Sustainability among Commercial Banks in Kenya”**

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ABSTRACT

The sustainability of commercial banks in Kenya is a major concern to various stakeholders as market volatility conditions are continuously shifting, stiff competition, and evolving customer demands all affecting banks business models. A critical issue confronting these banks is the limited understanding of how financial lending innovations such as digital lending, open banking, block chain-based lending and credit card lending affect their financial sustainability. Despite the significant investment in these innovations, the relationship between these lending practices and long-term financial sustainability remains unclear, particularly in the context of how operational efficiency mediates this relationship. The primary objective of this study was to examine the effect of financial lending innovations on the financial sustainability of commercial banks in Kenya and operational efficiency explored as a mediating factor. The study was guided by the following specific objectives: to assess the impact of digital lending, open banking, block chain-based lending, credit card lending on the financial sustainability of commercial banks and to test the mediating effect of operational efficiency on this relationship. A descriptive research design was employed to capture the current state of lending innovations and their impact on financial sustainability. The study targeted commercial banks in Kenya, categorized into Tier 1, Tier 2 and Tier 3 banks, with a total population comprising 7 Tier 1 banks, 19 Tier 2 banks, and the remaining Tier 3 banks. A stratified random sampling technique was used to select a representative sample, ensuring that insights are captured across different bank categories. Data was collected using a structured questionnaire, designed to gather information on respondents' perceptions of lending innovations, financial sustainability and operational efficiency. The reliability and validity of the instrument was tested through a pilot study, employing Cronbach's alpha to ensure internal consistency, Keiser- Meryer -Olkin (KMO) tested construct validity, current variance index (CVI) used to assess content validity and Brletts Test of Sphericity assessed null hypothesis. Data analysis involved testing the assumptions of the Sobel Test, Classical Linear Regression Model (CLRM), including linearity, normality, homoscedasticity, autocorrelation, and Multicollinearity. The main analysis was conducted using regression models to determine the direct and mediating effects. The results were presented using descriptive and inferential statistics, including regression coefficients, significance levels and graphical presentations to illustrate key findings. The findings of this study are expected to provide critical insights into the role of lending innovations in enhancing the financial sustainability of commercial banks. The results will inform stakeholders on the strategic value of operational efficiency as a mediator, offering recommendations for enhancing sustainable banking practices in Kenya.

LIST OF ABBREVIATIONS AND ACRONYMS

APIs	Application Programming Interfaces
BCBL	Block chain-based Lending
CBK	Central Bank of Kenya
CVI	Content Validity Index
CCL	Credit Card Lending
CLRM	Classical Linear Regression Model
DOI	Diffusion of innovation
DL	Digital Lending
FIN Tech	Fin Tech Firms
FS	Financial Sustainability
KMO	Keiser Meyer - Olkin
NPLS	Non-Performing Loans
OE	Operational Efficiency
OB	Open Banking
Q-Q	Quantile-Quantile
IT	Information Technology
TCT	Transaction Cost Theory
TU	Tolerance Value
NRF	National Research Fund
US	United States
VIF	Variance Inflation Factor
IT	Information Technology
DV	Dependent Variable
IV	Independent Variable

OPERATIONAL DEFINITION OF KEY TERMS

Block Chain-Based Lending: Block chain-based lending uses block chain technology to facilitate peer-to-peer lending, ensuring transparency, security, and efficiency in the lending process through decentralized ledgers.

Credit Card Lending: Credit card lending refers to the provision of revolving credit facilities via credit cards, allowing customers to borrow funds up to a pre-approved limit for transactions and payments, with interest applied on unpaid balances.

Digital Lending: Digital lending involves the use of digital platforms, such as mobile applications and online services, to provide loans to customers without the need for physical interaction. This innovation leverages data analytics, machine learning, and automation for quick loan approval and disbursement.

Financial Lending Innovation: Financial lending innovations refer to the adoption of new and advanced lending practices by commercial banks to improve service delivery, enhance customer experience, and drive financial sustainability. These

innovations include digital lending, open banking, block chain-based lending, and credit card lending.

Financial Sustainability:

Financial sustainability refers to the ability of commercial banks to maintain financial health, profitability, and operational viability over the long term while managing risks and adapting to market changes.

Open Banking:

Open banking is a system that allows third-party financial service provider's access to consumer banking, transaction, and other financial data through application programming interfaces (APIs), enhancing transparency and competition in the banking sector.

Operational Efficiency:

Operational efficiency in banks refers to the ability to deliver products and services in a cost-effective manner, minimizing waste while maximizing output and service quality.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Globally, leading authors such as Capgemini and Accenture highlighted the importance of innovation for the banking sector's sustainability. In their annual World Retail Banking Report, (2021) they argued that banks that failed to innovate struggle to remain competitive and sustainable. Lending has historically been at the heart of banking operations, serving as a primary income-generating activity.

Traditionally, banks relied on collateral-based lending whereby loan approval was dependent on the physical assets a borrower could offer as security (Berger and Udell, 2006). However, with changes in technology, customer needs and market dynamics, traditional lending practices had been insufficient in addressing emerging sustainability concerns. As global financial markets continued to evolve, lending innovations were becoming critical tools for addressing the sustainability challenges that banks faced. Innovations such as FinTech-driven lending, peer-to-peer lending and block chain enabled credit platforms had shown potential to transform the credit landscape (Gomber et al., 2017). These innovations allowed banks to offer faster, more accessible credit services to a larger customer base while minimizing operational costs (Kaffenberger and Totolo, 2018).

Over time, banks had gradually adopted risk-based lending, which incorporated credit scoring models and more sophisticated risk management techniques (Chironga et al., 2018). In the modern era, financial lending innovations such as digital lending, open

banking, block chain-based lending and credit card lending had emerged as key disruptors. They offered more scalable, efficient and customer-friendly approaches to credit (Diniz et al., 2011; Gomber et al., 2017). These innovations not only addressed inefficiencies inherent in traditional lending models but also offered ways to lower operational costs and reduced risks. This enhanced financial sustainability (Ngugi et al., 2017). For instance, digital lending through mobile apps and digital platforms had become ubiquitous in Kenya. This enabled banks to provide small, unsecured loans to previously underserved populations.

According to Kaffenberger and Totolo, (2018) digital lending services such as M-Shwari and Tala had revolutionized access to credit, especially among the lower-income population. This not only expanded banks' customer base but also enhanced their revenue streams which was an important driver of sustainability. However, concerns had emerged around the repayment behavior of digital borrowers. Most of them were accumulating multiple loans from different platforms leading to defaults and higher non-performing loan ratios (FSD Kenya, 2021).

In addition to digital lending, open banking had also gained momentum. It enabled secure sharing of financial data between institutions with customer consent. Open banking promoted transparency and financial inclusion by allowing third-party providers to offer tailored products to banking customers. This led to more personalized lending and potentially reducing credit risk (Accenture, 2020). Although open banking was still in its nascent stages in Kenya, there was potential to drive long-term financial sustainability by expanding product offerings and improving customer loyalty.

Block chain-based lending was also a promising innovation. It used distributed ledger technology to reduce fraud, ensured secure lending transactions and improved transparency. Globally, Deloitte, (2019) noted that block chain in lending would streamline operations and reduce transaction costs. This was vital for financial sustainability. Although still emerging in Kenya, block chain-based lending would address the inefficiencies in traditional lending and boost trust in the financial system.

Credit card lending remained conventional yet critical component of bank lending. It offers flexible short-term credit options and diversification of banks income streams. Studies by Muiruri and Ngari, (2014) showed that Kenyan banks had increasingly promoted credit card products particularly targeting the rising middle class. However, careful management of credit risk was essential to ensure that banks do not expose themselves to significant financial losses that would undermine their sustainability.

In an increasingly competitive and volatile market, the concept of financial sustainability had become central to the long-term viability of banks. Financial sustainability refers to the ability of banks to generate consistent income, manage costs efficiently and mitigate risks over time (Olson et al., 2014). Banks sustainability was not just about profitability in the short term but about creating value and stability over the long run. This required strategic adoption of innovations that could drive operational efficiency and mitigate risks (Chironga et al., 2018).

Financial sustainability was intertwined with banks' ability to innovate. Demirgüç-Kunt and Klapper, (2012) argued that banks that failed to embrace new technologies and

innovations risk becoming obsolete. Innovations such as digital lending, block chain and open banking allowed banks to lower transaction costs, expand market reach and offered more tailored products to a diverse customer base. All of these were critical in achieving long-term financial sustainability. Locally, Ngugi et al., (2017) found that over-reliance on traditional lending models had exacerbated financial risks in Kenyan banks. This had called for a shift toward innovative, tech-driven solutions to maintain their sustainability in a fast-evolving market.

The Kenyan banking sector is a cornerstone of the nation's economy. It accounts for a substantial portion of the financial system's assets and acts as a conduit for investment, credit and economic growth. However, in the recent years, concerns about the financial sustainability of banks had been growing, particularly as technological disruptions, regulatory pressures and shifting market dynamics converged. Kenya's banking sector had grown significantly in recent decades, becoming a leader in financial inclusion and innovation across Africa.

According to the Central Bank of Kenya, (2020) commercial banks had expanded services and broadened their customer bases through innovations like mobile money and digital banking platforms. However, through the growth, a series of financial sustainability challenges including rising levels of non-performing loans (NPLs), regulatory changes and heightened competition from fintech firms had been realized. (Muthiora, 2015; Muiruri and Ngari, 2014).

The financial sustainability of banks depends on the capacity to balance profitability with operational efficiency while managing external risks such as economic downturns and fluctuating market conditions. As competition increases, traditional banking models were under pressure. Rising operational costs, inefficiencies in credit assessment and challenges related to credit defaults had strained many banks' profitability and operational resilience, threatening their long-term sustainability (Demirgüç-Kunt and Klapper, 2012).

Regionally, Sub-Saharan Africa had made strides in digital and mobile banking. However, lack of comprehensive research linking these innovations to financial sustainability still remains. (Kaffenberger and Totolo, 2018). Most studies had focused on profitability rather than on sustainability metrics such as risk management, operational efficiency and solvency.

Locally in Kenya, most researches had explored the impact of individual innovations like mobile banking on financial performance. However, there still exists a gap in the literature on how a combination of lending innovations (digital, block chain, open banking, credit card lending) collectively impacted on financial sustainability. This gap formed the basis for the study, which provided insights into how banks could optimize their lending innovations to ensure long-term financial health.

Kenyan banks had made strides in adopting lending innovations. The question whether these innovations were leading to sustained financial health still remained unresolved. While short-term profits might have been realized, the risks associated with

technological disruption, operational inefficiencies and credit defaults needed to be thoroughly managed to ensure long-term sustainability (Ngugi et al., 2017).

In Kenya, the impact of lending innovations on financial sustainability had been significant but not without challenges. The digital lending market, for example, had seen tremendous growth but regulatory concerns and the rising risk of defaults had prompted caution from policymakers and banks alike (FSD Kenya, 2021). Open banking, block chain and credit card innovations were still in early stages, with much potential yet to be realized.

While the discourse on financial lending innovations and their impact on commercial banks had been active, several gaps remain unaddressed particularly with respect to financial sustainability. Most of the existing studies emphasized profitability and short-term financial performance, neglecting the long-term sustainability aspect Demirgüç-Kunt and Klapper, (2012). Financial sustainability remains a broader concept, encompassing not only profitability but also resilience, operational efficiency, risk management and adaptability to changes in the regulatory and economic environment (Olson et al., 2014).

Globally, studies had been skewed towards understanding how financial innovations enhanced immediate returns. For instance, Diniz et al. (2011) investigated mobile money and digital lending in developing countries. The findings revealed that these innovations improved access to credit and enhanced profitability. However, these studies fell short of analyzing how innovations impacted on long-term financial stability and resilience.

Similarly, Gomber et al., (2017) examined FinTech innovations in banking focusing on their immediate operational advantages, neglecting sustainability indicators such as risk mitigation and long-term solvency.

A significant gap existed in understanding how lending innovations contributed to financial sustainability in the context of operational efficiency, credit risk reduction and overall risk management. Deloitte, (2019) suggested that block chain-based lending had the potential to improve transparency and security in lending transactions which could, in turn, enhance long-term sustainability. However, empirical studies on this innovation's impact on bank sustainability were limited. This was particularly in emerging markets such as Kenya where financial environment were more volatile and the regulatory landscape rapidly evolving.

A number of studies had explored the benefits of digital and mobile banking innovations in Sub-Saharan Africa though with fragmented evidence. Kaffenberger and Totolo, (2018) analyzed the rapid growth of digital credit in Kenya. The findings revealed that while these innovations improved access to credit for underserved populations, concerns about repayment behavior and default rates arose. The study noted that digital credit users often borrowed from multiple platforms, increasing the likelihood of default, which could threaten the financial sustainability of banks. Despite these insights, the focus remained on digital credit's short-term effects on financial performance, leaving a gap in research on its long-term sustainability implications.

Other studies such as Muiruri and Ngari, (2014) examined the effects of financial innovations on the performance of commercial banks in Kenya but did not extend their analysis to explore how innovations like block chain, open banking and credit card lending contributed to financial sustainability. The emphasis on financial inclusion and profitability in these studies left out critical aspects of sustainability such as operational resilience and adaptability to regulatory changes.

In Kenya, most studies had focused on digital lending due to its exponential growth. For example, Ngugi et al., (2017) examined the role of mobile lending innovations in financial performance but did not assess their effect on financial sustainability. Kenya had emerged as a leader in mobile money and digital credit solutions, it was essential to assess how these innovations had impacted on long-term sustainability especially in the context of heightened credit risks and regulatory constraints (FSD Kenya, 2021).

Block chain-based lending and open banking have had limited empirical scrutiny in Kenya despite these innovations holding a significant promise for enhancing transparency, reducing fraud and improving operational efficiency (Accenture, 2020). Furthermore, while credit card lending had been promoted by Kenyan banks to target the growing middle class, there was lack of comprehensive studies assessing how the adoption of credit cards influences financial sustainability. Most existing studies focus on the potential for increased revenues from interest and fees. They however, overlooked the challenges associated with managing credit risks especially in a volatile economic environment (Muiruri and Ngari, 2014).

Some of the limitations observed from the existing studies on this field included; emphasis of immediate profitability rather than long-term financial sustainability. For instance, the research conducted by Diniz et al., (2011) and Muiruri and Ngari, (2014) focused on short-term financial performance, overlooking sustainability concerns such as risk management and operational efficiency. Secondly, many studies focused on individual lending innovations like digital lending or mobile banking, neglecting other emerging innovations such as block chain-based lending and open banking (Gomber et al., 2017; Deloitte, 2019). This narrow focus limited the understanding of how multiple innovations interact and contribute to sustainability.

Thirdly, existing studies failed to examine how financial lending innovations impacted on credit risk management and regulatory compliance which are essential components of financial sustainability (Accenture, 2020). Fourthly, Global studies focused on developed markets while African-based research is often fragmented and centered on financial inclusion rather than sustainability. For instance, Kaffenberger and Totolo, (2018) focused heavily on financial inclusion through digital credit, missing critical analysis of long-term implications for bank sustainability.

This proposed study sought to fill the gaps identified in the existing literature by focusing on how financial lending innovations namely; digital lending, open banking, block chain-based lending and credit card lending contributed to the financial sustainability of commercial banks in Kenya. This study was warranted for several reasons:

1.1.1 Addressing Sustainability Concerns

Most existing research focused on profitability and short-term financial performance, overlooking how lending innovations contributed to financial sustainability. This study provided new insights into the role of innovations in sustaining the long-term financial health of banks, particularly in Kenya's dynamic financial sector.

1.1.2 Comprehensive Approach

By examining multiple lending innovations together, this study offered a holistic view of how these innovations worked in tandem to influence sustainability. This contrasted with the narrow focus of many previous studies which tend to isolate individual innovations without considering their combined effects on the banking ecosystem.

1.1.3 Focus on Risk and Efficiency

The study assessed how lending innovations impacted not only profitability but also operational efficiency, risk management, regulatory compliance and all critical factors for financial sustainability. This broader scope ensured that the study goes beyond profitability and considered the resilience and adaptability of banks.

1.1.4 Kenyan Context

Given Kenya's prominence in financial innovation, this study was uniquely positioned to provide empirical evidence on the impact of lending innovations in an emerging market context. It contributed to a better understanding of how these innovations affected the sustainability of banks in environments characterized by regulatory volatility and high credit risks.

1.2 Statement of the Research Problem

The Kenyan banking sector has been experiencing rapid technological transformation through lending innovations such as; digital lending, open banking, block chain-based lending and credit card lending gaining traction. These innovations were credited with increasing financial inclusion, improving access to credit and enhancing short-term financial performance (Kaffenberger and Totolo, 2018; Ngugi et al., 2017). However, while their impact on profitability and operational efficiency had been well documented, there was limited understanding of how these innovations affected the financial sustainability of commercial banks in the long run.

Financial sustainability refers to the ability of banks to maintain long-term viability by balancing profitability with risk management, operational efficiency and adaptability to regulatory and market changes (Olson et al., 2014). In Kenya, commercial banks are faced with significant challenges in achieving sustainability due to high levels of non-performing loans, regulatory constraints and intense competition from fintech firms and other non-traditional financial service providers (FSD Kenya, 2021).

Moreover, many lending innovations though beneficial in the short term, had introduced new risks such as credit defaults, fraud and regulatory non-compliance which had undermined long-term sustainability (Accenture, 2020). For example, digital lending had led to high levels of loan defaults due to multiple borrowing from various platforms posing a threat to the financial sustainability of banks (Kaffenberger and Totolo, 2018). Despite these concerns, there was limited empirical research exploring how a

combination of financial lending innovations impacted on the sustainability of Kenyan banks.

Most studies had focused on the short-term financial performance of these innovations, neglecting long-term sustainability considerations such as operational efficiency, risk management and solvency (Demirgüç-Kunt and Klapper, 2012; Ngugi et al., 2017). Furthermore, the moderating effect of regulatory environment and the mediating role of operational efficiency in this relationship had not been thoroughly explored, representing a significant gap in the literature.

Therefore, the research problem centered on the need to investigate how financial lending innovations influenced the financial sustainability of commercial banks in Kenya, taking into consideration the opportunities and risks they presented. This study sought to fill this gap by examining the impact of digital lending, open banking, block chain-based lending and credit card lending on the sustainability of commercial banks with operational efficiency as a mediating variable.

1.3 Research Objectives

1.3.1 General Objective

The overall aim of the study was to investigate the effect of financial lending innovations on the financial sustainability of commercial banks in Kenya, with a specific focus on the mediating role of operational efficiency.

1.3.2 Specific Objective

The following specific objectives guided the study:

- i. To examine the effect of digital lending on the financial sustainability of commercial banks in Kenya.
- ii. To assess the effect of open banking on the financial sustainability of commercial banks in Kenya.
- iii. To analyze the effect of block chain-based lending on the financial sustainability of commercial banks in Kenya.
- iv. To evaluate the effect of credit card lending on the financial sustainability of commercial banks in Kenya.
- v. To determine the mediating role of operational efficiency in the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

1.3.3 Research Hypotheses

The study tested the following hypotheses based on the above objectives:

- H0₁:** Digital lending has no significant positive effect on the financial sustainability of commercial banks in Kenya.
- H0₂:** Open banking has no significant positive effect on the financial sustainability of commercial banks in Kenya.
- H0₃:** Block chain-based lending has no significant positive effect on the financial sustainability of commercial banks in Kenya.
- H0₄:** Credit card lending has no significant positive effect on the financial sustainability of commercial banks in Kenya.

H05: Operational efficiency does not significantly mediate the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

1.4. Scope of the Study

The scope of this study encompassed the following:

Geographical Scope: The study focused on commercial banks operating within Kenya. Kenya provides a suitable context due to its advanced adoption of digital financial innovations, such as mobile money, digital lending platforms, and emerging technologies like block chain-based lending.

Conceptual Scope: The study focused on four key financial lending innovations; digital lending, open banking, block chain-based lending, and credit card lending. The dependent variable was financial sustainability, encompassing indicators like operational efficiency, profitability, risk management, and adaptability to regulatory changes. The mediating variable was operational efficiency, while the study also accounted for regulatory environment as a moderating factor.

1.5 Significance of the Study

The significance of this study was understood from the perspective of various stakeholders within the economy.

1.5.1 Commercial Banks

a) Strategic Decision-Making: This study provided insights on how various financial lending innovations contributed to long-term financial sustainability. Banks could leverage these findings to implement innovative lending strategies that enhanced both operational efficiency and resilience.

b) Risk Management: By understanding the mediating role of operational efficiency, banks could mitigate risks associated with lending innovations such as; credit defaults, operational challenges and improve their sustainability.

1.5.2 Regulatory Authorities

Policy Formulation: The findings of this study helped regulatory bodies such as the Central Bank of Kenya (CBK) to develop informed policies that promotes the safety and sustainable adoption of lending innovations in the banking sector.

1.5.3 FinTech Firms

a) Partnership Opportunities: FinTech firms that provided innovative lending platforms (such as digital lenders) gained insights into the sustainability benefits of their products. This potentially enhanced collaborations with banks to create more robust and sustainable financial solutions.

b) Product Development: The study findings could help FinTech firms identify opportunities to design products that enhance the operational efficiency of banks thus ensuring long-term partnerships.

1.5.4 Academia and Researchers

- a) Knowledge Contribution: This study contributed to the growing body of literature on financial innovations and sustainability. Particularly, in the context of emerging markets such as Kenya. It provided a framework for future research on lending innovations, operational efficiency and sustainability.
- b) Research Gaps: By addressing gaps in the existing literature, this study offered a comprehensive understanding of the long-term effects of lending innovations on the sustainability of financial institutions.

1.5.5 Investors and Shareholders

Investment Decision-Making: Investors and shareholders would benefit from the study by gaining insights into which innovations enhance the sustainability of banks. This would allow them to make informed decisions when allocating capital to banks adopting such technologies.

1.5.6 General Public

Consumer Protection: The study highlighted risks related to innovations such as digital lending and blocks chain-based lending. This would inform consumers about the sustainability and long-term reliability of banks that would adopt these innovations.

1.6 Justification of the study

This study contributed to the growing body of literature Academia and Researchers.

- a) Knowledge Contribution: This study would contribute to the growing body of literature on financial innovations and sustainability specifically the emerging

markets such as Kenya. It would provide a framework for future research on lending innovations, operational efficiency and sustainability.

- b) Research Gaps: By addressing gaps in the existing literature, this study offered a comprehensive understanding of the long-term effects of lending innovations on the sustainability of financial institutions.

In summary, the Chapter provided a solid foundation for the study titled 'Financial Lending Innovations and Financial Sustainability of Commercial Banks in Kenya'. This emphasized the key issues and defined the research problem thoroughly. It began with an overview of the Kenyan banking sector and highlighted the financial sustainability challenges that commercial banks faced. These challenges included; the rising credit risks, operational inefficiencies and competition from non-traditional financial service providers which were common in the emerging markets. Against this backdrop, the chapter introduced the concept of financial lending innovations specifically focusing on; digital lending, open banking, block chain-based lending and credit card lending as potential tools that could address some of these challenges and enhance the long-term sustainability of banks.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, the key theoretical frameworks anchoring the study were discussed exhaustively. The theories were examined from a general perspective and applied specifically to the study's objectives and context. This focused on; evolution, the authors and their relevance to financial lending innovations and financial sustainability. Each theory was linked to a specific research objective and relevant hypotheses deduced.

2.2 Theoretical Framework

The study was supported by the theory of Financial Intermediation Theory, Transaction Cost Theory and Disruptive Innovation Theory as discussed below:

2.2.1 Financial Intermediation Theory

The Financial Intermediation Theory explained how financial intermediaries such as commercial banks facilitate the flow of funds between savers and borrowers. This was developed by Gurley and Shaw, (1960) and further expounded by Diamond, (1984). The theory posited that financial intermediaries help reduce transaction costs, manage risks, and improve information asymmetry between borrowers and lenders. Banks play a critical role by pooling resources, diversifying risks and providing liquidity thus ensuring efficient capital allocation in the economy. Historically, banks were primarily engaged in traditional forms of intermediation such as; accepting deposits and providing loans. However, technological advancements had revolutionized this model. Digital lending

innovations that use algorithms and big data analytics to assess creditworthiness had transformed the traditional intermediation role of banks. This innovation minimized the need for physical branch networks and personal interactions. Thus, significantly lowering transaction costs and making lending processes faster and more efficient.

In the Kenyan context, digital lending had grown rapidly with M-Shwari and Tala platforms providing quick access to credit. These platforms had expanded financial inclusion by offering loans to individuals who were previously unbanked. While traditional financial intermediation models emphasized risk management through collateral, digital lending relied on alternative data sources such as mobile transaction histories to assess credit risk. This shift represented a significant evolution from conventional intermediation theories and highlighted the impact of technology on banking practices.

Studies conducted by Beck, Demirgüç-Kunt, and Levine, (2007) emphasized that digital lending could enhance financial performance by reducing the cost of borrowing and increasing the speed of credit delivery. However, the challenge of increased loan defaulters' risk had been noted. This was as a result of inadequate credit assessment mechanisms and potential over-reliance on technology without proper regulatory oversight.

Furthermore, the integration of digital lending within the financial intermediation framework challenged traditional banking practices and required a recalibration of risk management strategies. The rapid growth of digital lending had brought to the forefront

issues related to data privacy, cybersecurity and the need for robust regulatory frameworks.

The evolution of Financial Intermediation Theory is marked by the contributions of several scholars including; Gurley and Shaw, Diamond, and later, Boot and Thakor (2010), who examined the impact of market and technological integration on banking practices. These contributions highlighted that while financial intermediaries continued to play a critical role, their traditional functions were increasingly being complemented or replaced by technology-driven innovations.

Initially, financial intermediation was largely based on traditional lending practices where banks provided loans based on depositors' funds. However, with the advent of technology and globalization, the nature of financial intermediation had evolved. Innovations such as digital lending platforms and open banking had altered the intermediary role of banks by incorporating non-traditional players such as FinTech firms. These changes had expanded access to credit but had also introduced new risks, including operational inefficiencies and regulatory challenges.

Recent studies conducted by Boot and Thakor, (2010) and Allen and Carletti, (2012) emphasized the changing role of financial intermediaries in the digital age, where financial innovations such as block chain-based lending and credit card services provided new avenues for capital flow. These innovations challenged traditional banking models, potentially enhanced operational efficiency and financial sustainability if managed effectively.

Hypothesis Based on Financial Intermediation Theory

H₁: Digital lending positively affects the financial sustainability of commercial banks in Kenya.

This hypothesis was grounded in the argument that digital lending improved the efficiency of credit disbursement and reduced transaction costs which could enhance the long-term sustainability of banks.

2.2.2 Transaction Cost Theory

The Transaction Cost Theory was originally developed by Ronald Coase, (1937) and later expounded by Oliver Williamson, (1975). It explained the cost of participating in a market. According to this theory, financial institutions existed to minimize the transaction costs associated with lending and borrowing such as the costs of searching for information, negotiating contracts and monitoring loans. Over time, technological innovations had significantly altered the transaction costs in banking.

The development of open banking allowed third-party service providers to access customer data, reduced the cost of customer acquisition and loan processing. However, it raised concerns about data security, privacy and regulatory compliance which could impact on financial sustainability. The shift from traditional bank-centric lending models to an ecosystem whereby multiple actors shared data and infrastructure represented a significant evolution in transaction cost theory.

Recent studies by Masiak et al., (2020) and King and Nesbitt, (2022) indicated that open banking could enhance financial sustainability by reducing transaction costs, increasing

competition and promote customer-centric financial services. However, its success depended on how well banks manage the associated risks and ensured operational efficiency.

Hypothesis Based on Transaction Cost Theory

H₂: Open banking had a significant positive effect on the financial sustainability of commercial banks in Kenya.

This hypothesis posited that by reducing transaction costs, open banking improved the long-term financial sustainability of banks especially in terms of reducing operational expenses and improving customer retention.

2.2.3 Disruptive Innovation Theory

The Disruptive Innovation Theory was pioneered by Clayton Christensen, (1997). It explained how innovations disrupted existing markets by providing simpler, cheaper or more accessible alternatives to traditional products or services. In the context of banking, block chain-based lending could be seen as disruptive technology. This challenged traditional financial models by offering decentralized and transparent solutions for loan disbursement and management.

Disruptive innovation in banking had evolved from simple technological improvements to full-scale reconfigurations of financial systems. Block chain technology underpins cryptocurrencies and decentralized finance (DeFi) and had transformed the way loans are issued and tracked. It bypassed traditional banking intermediaries, reduced the need for third-party verification and significantly lowered transaction costs. However, these

innovations presented challenges in terms of regulatory oversight, operational risks and integration with existing banking systems.

Iansiti and Lakhani, (2017) expounded on Christensen's theory and applied it to block chain's potential to disrupt traditional financial services. Pilkington, (2016) further explored how block chain innovations offered decentralized trust, redefined the future of banking and its role in ensuring financial sustainability.

Hypothesis Based on Disruptive Innovation Theory

H₃: Block chain-based lending had a significant positive effect on the financial sustainability of commercial banks in Kenya.

This hypothesis was based on the premise that block chain-based lending disrupted traditional banking models, enhanced sustainability through greater transparency, lowered costs and improved security.

2.2.4 Resource-Based View (RBV)

The Resource-Based View (RBV), developed by Barney, (1991) focused on the internal resources and capabilities of an organization as the primary source of competitive advantage. In the context of banking, RBV suggested that banks' internal resources such as; technological capabilities, operational efficiency and human capital played a crucial role in determining their financial sustainability.

In the recent years, banks' reliance on internal capabilities had expanded the integration of new technologies to improve operational efficiency through credit card lending.

External factors such as competition and regulation influenced performance. A bank's ability to efficiently manage resources, deploy technology and maintain customer trust was a key determinant of its long-term sustainability.

Hypothesis Based on RBV

H₄: Credit card lending had a significant positive effect on the financial sustainability of commercial banks in Kenya.

The hypothesis posited that through prudent card management there was reduced credit risk exposure as loyal customers honored repayments. The process was transparent in terms of costs associated with the card leading to customer satisfaction.

Studies conducted by Penrose, (1959) and Grant, (2016) emphasized that operational efficiency as an internal resource. It mediated the relationship between innovations and performance. Banks could effectively utilize their resources to support lending innovations and achieve a sustainable competitive advantage.

Hypothesis Based on RBV

H₅: Operational efficiency mediated the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

This hypothesis suggested that digital and block chain lending only contributed to sustainability if banks could harness their internal capabilities to manage these innovations effectively.

2.3 Conceptual Review of Literature

2.3.1 Digital Lending

Digital lending was a transformative innovation in the financial sector characterized by the use of digital platforms. This included mobile apps, online portals and data-driven algorithms that provide loans to customers. This approach of lending had gained significant traction in the recent years. Thus, playing a crucial role in enhancing the financial sustainability and operational efficiency of commercial banks.

Digital lending contributed to financial sustainability by broadening the customer base. This was particularly among the unbanked and underbanked populations which increased banks' revenue streams. The convenience and accessibility of digital lending platforms attracted new customers who might otherwise be excluded from traditional banking services. Frost et al., (2019) emphasized that digital lending promoted financial inclusion. This directly supported the long-term viability of financial institutions by tapping into previously underserved markets.

This expansion of customer access not only boosted revenue but also stabilized banks' financial performance. Diversified customer base could mitigate the risks associated with over-reliance on traditional banking clients. Additionally, digital lending reduced operational costs that significantly enhanced financial sustainability. By minimizing the need for physical branches, paperwork, and manual loan processing, banks could achieve substantial cost savings. Butt et al., (2020) argued that the efficiency gains from digital lending platforms directly impacted on banks' sustainability by reducing overhead expenses and improving profit margins. This reduction in costs, coupled with increased

customer satisfaction from faster loan processing times, led to a more sustainable business model that prioritized both cost efficiency and customer retention.

From an operational efficiency perspective, digital lending leveraged on technology to streamline loan processing, automate decision-making and reduce the likelihood of human errors. This automation not only enhanced the accuracy of credit assessments but also accelerated the overall lending process and allowed banks to serve more customers with fewer resources. Jagtiani and Lemieux, (2019) highlighted that digital lending platforms optimized resource allocation, enabled banks to lower transaction costs and improved service delivery. The integration of big data analytics and artificial intelligence further refined the risk assessment process, enhancing banks' ability to make informed lending decisions quickly and accurately.

Mugambi and Kagiri, (2021) underscored the role of digital lending in enhancing operational efficiency by eliminating redundant manual processes. Thereby allowing banks to reallocate resources toward more value-added activities. Moreover, Iman, (2019) pointed out that digital lending reduced loan default rates through more sophisticated credit scoring models. This assessed a broader range of data such as social media activity and digital transaction histories contributing to more robust risk management and improved operational performance.

2.3.2 Open Banking

Open banking a key innovation in reshaping the banking landscape allowed third-party financial service providers to access consumer banking, transaction, and other financial

data through APIs (Application Programming Interfaces). This shift towards greater data sharing fostered a more competitive and transparent financial ecosystem, significantly impacting the financial sustainability and operational efficiency of commercial banks.

Open banking had enhanced financial sustainability through facilitating more personalized financial services. This increased customer loyalty and reduced churn rates. Utilizing of customer data to tailor products and services ensured banks meet specific consumer needs more effectively. Thus, boosting revenue generation and long-term financial performance. Gomber et al. (2018) highlighted that open banking enabled banks to innovate continuously, created new value propositions that aligned with evolving customer expectations. This adaptability was crucial for maintaining competitiveness and sustainability in a rapidly changing financial environment.

Furthermore, open banking promoted cost efficiency by reducing transaction costs associated with credit assessments and customer onboarding. By streamlining these processes, banks could operate more efficiently and focused on high-value activities that drive growth. King and Nesbitt, (2022) argued that open banking could transform operational models through automating routine processes. Thus, freeing up resources that could be redeployed to more strategic areas such as customer relationship management and new product development.

Operational efficiency was further enhanced through the collaborative nature of open banking which fostered partnerships between banks and FinTech firms. These partnerships allowed banks to leverage cutting-edge technologies without the need for

significant internal investment, thus optimizing cost structures and improving service delivery. According to Masiak et al., (2020) the collaborative dynamics of open banking led to faster innovation cycles, enabled banks to respond more swiftly to market demands and regulatory changes.

However, the open banking model also introduced challenges related to data security and privacy. This could impact on banks' operational efficiency if not managed properly. Ensuring robust data governance frameworks and compliance with privacy regulations was essential for banks to fully capitalize on the benefits of open banking while safeguarding customer trust. Kumar and Mishra, (2021) emphasized that balancing innovation with security was critical for maintaining both operational efficiency and financial sustainability in an open banking ecosystem.

2.3.3 Block Chain-Based Lending

Block chain-based lending represented a paradigm shift on how financial transactions were being conducted. It offered a decentralized, transparent and secured alternative to traditional lending models. This innovation used block chain technology to facilitate peer-to-peer lending without the need for intermediaries, significantly impacting both financial sustainability and operational efficiency.

Block chain-based lending enhances financial sustainability through reduced costs associated with loan processing and verification. Through elimination of intermediaries, block chain reduces administrative and compliance costs which directly benefits banks' bottom lines. Iansiti and Lakhani, (2017) noted that block chain's decentralized nature

eliminated the need for costly third-party verification allowing banks to operate more efficiently. This reduction in costs combined with the increased security and transparency of block chain transactions supports the long-term financial sustainability of banks.

The technology also offered new revenue opportunities through the creation of innovative lending products that appeal to tech-savvy customers who prioritize speed, security and transparency. According to Pilkington (2016), block chain-based lending could attract a new demographic of borrowers. This included those interested in crypto-backed loans or other digital asset-based lending solutions thereby diversifying banks' income streams. From an operational efficiency standpoint, block chain streamlined the entire lending process by automating contract execution through smart contracts. These were self-executing contracts with the terms of the agreement directly written into code. This automation minimized human intervention, reduced errors and speed up transaction times, significantly enhancing operational performance. Chen et al., (2020) highlighted that block chain's ability to automate key processes not only reduced costs but also improved the accuracy and reliability of lending decisions.

However, integrating block chain technology into mainstream banking systems presented challenges. This included scalability issues, regulatory hurdles and the need for significant technological investment. Despite these challenges, the long-term benefits of block chain in enhancing both operational efficiency and financial sustainability made it a promising area for future investment. Smeets and Van Den Heuvel, (2018) argued that

banks that successfully navigated these challenges could gain a competitive edge by offering more efficient, secure and customer-centric lending services.

2.3.4 Credit Card Lending

Credit card lending was a traditional yet evolving financial product that continued to play a significant role in the financial landscape of commercial banks. It involved issuing credit cards to consumers, allowed them to borrow funds within a predefined limit for purchasing goods and services. In the recent years, credit card lending had been enhanced by technological advancements. This had made it more efficient and accessible, which had a notable implication for financial sustainability and operational efficiency.

Credit card lending contributed to financial sustainability by providing banks with a steady source of income through; interest charges, fees and interchange fees paid by merchants. This diverse revenue stream helped stabilize banks' earnings, even during periods of economic downturns when traditional loan demands might decline. O'Reilly and Haines, (2020) argued that credit cards were among the most profitable lending products for banks. This was due to their high-interest rates and the potential for recurring fees which bolstered overall financial performance.

Furthermore, credit cards enhanced customer loyalty. Consumers who frequently used their cards were more likely to maintain their banking relationships over the long term. This aspect was crucial for financial sustainability. Loyal customers used additional banking products thereby increasing the lifetime value of each client (Nguyen and Sim, 2021). Moreover, the use of data analytics in credit card lending helped banks identify

consumer spending patterns. This enabled targeted marketing and personalized product offerings which would further enhance profitability and sustainability (Mankodi, 2021).

Credit card lending improved operational efficiency by automating credit assessment and approval processes. This reduced the time and costs associated with manual loan processing. Advances in credit scoring models and machine learning algorithms enabled banks to evaluate credit risk more accurately and swiftly. This enhances the speed and efficiency of credit issuance (Zhou and Zhu, 2021). The digitization of credit card services included contactless payments and mobile integration. This reduced transaction times and improved customer experience leading to operational efficiencies.

Additionally, credit card fraud prevention technologies such as; real-time transaction monitoring and biometric authentication enhanced the security and reliability of credit card services. This in turn improved operational performance. According to Patil and Raut, (2022) integrating advanced security measures into credit card systems protected customers. More so, it minimized banks' exposure to fraud-related losses enhancing overall operational efficiency.

2.3.5 Financial Sustainability

Financial sustainability refers to the ability of a financial institution such as a commercial bank maintaining its financial health and performance over a long term. It involves generating sufficient revenue to cover costs, withstand economic shocks and invest in future growth opportunities, *Gomber et al., (2018)*, Financial sustainability is critical for

banks as it ensures their long-term viability, ability to continue serving customers and supporting economic development.

The relationship between financial sustainability and operational efficiency is well-documented in the literature. Banks that manage their resources effectively could lower operating costs contributing to their financial sustainability. According to Beck et al. (2013) efficient banks were better positioned to withstand economic downturns and regulatory changes. They had stronger balance sheets and greater capacity to absorb losses. In the context of lending innovations, financial sustainability was enhanced when banks adopted technologies that reduced costs, improved customer service and generated new revenue streams.

Studies had also shown that sustainable financial practices such as responsible lending and risk management contributed significantly to long-term financial performance. Gatzert and Martin, (2015) emphasized that sustainability-oriented strategies such as the adoption of green finance principles and socially responsible investment criteria, were increasingly important for banks facing regulatory and reputational pressures. Integrating sustainability into their core operations, banks could improve their public image, attract socially conscious investors and reduce the risks associated with unsustainable financial practices.

2.3.6 Operational Efficiency as a Mediator

In the proposed study, operational efficiency serves as a mediating variable that influenced the relationship between financial lending innovations and financial

sustainability. This mediation effect suggested that the benefits of lending innovations on sustainability were enhanced when banks operated efficiently.

The concept of mediation was grounded in the Resource-Based View (RBV) theory. It posited that organizational resources such as technology and efficient processes were key in the achievement of a competitive advantage. Lending innovations adopted by banks such as digital platforms, block chain or open banking had impacted on financial sustainability. This would be more pronounced if these innovations ensured operational efficiencies (Barney, 1991). For instance, efficient use of digital lending platforms not only increased revenue but also reduced operational costs. Thus, maximizing the overall benefits of the innovation (Grant, 2016).

Previous studies had indicated that banks with higher operational efficiency were more successful in leveraging technological advancements in achieving strategic goals. Banks that effectively integrated innovations into their operations reduced costs, improved service delivery and managed risks better. This contributed to an enhanced financial sustainability (Berger and Mester, 2003). Therefore, operational efficiency acted as a critical link between the adoption of new technologies and the achievement of long-term financial goals.

2.4 Empirical Review of Literature

The empirical review of literature examined how different financial lending innovations such as digital lending, open banking, block chain-based lending and credit card lending impacted on the financial sustainability of commercial banks. Financial sustainability, a

critical measure of a bank's long-term viability, had been increasingly linked to how well these institutions adopted and integrated innovative lending practices. In this section, recent studies that supported or challenged the influence of these innovations on the sustainability of commercial banks were explored. This provided a better understanding of the complex dynamics at play.

2.4.1 Digital Lending and Financial Sustainability

Digital lending had emerged as a transformative force in the banking sector. It was characterized by the use of technology to streamline loan application, approval and disbursement processes. Empirical evidence indicated that digital lending significantly impacted on the financial sustainability of banks. This had enhanced efficiency, increased access to new customer segments and reduced costs associated with traditional loan processing.

A study by Gozman, Liebenau, and Mangan, (2018) found out that digital lending platforms improved financial sustainability. It enabled banks to reach the underserved populations particularly the emerging markets. Digital lending allowed banks to realize profitability and increased market share through lowered operational costs and minimal physical infrastructure. This expansion not only boosted revenue but also strengthened financial stability in the long term.

In support of this view, Jagtiani and Lemieux, (2019) examined the impact of fintech lending on the operational efficiency and financial health of U.S. banks. Their findings revealed a positive correlation between digital lending and financial sustainability. It

highlighted that, banks which integrated digital lending technologies experienced faster loan processing times, lowered default rates and experienced higher customer satisfaction. These factors collectively contributed to the improved financial resilience of banks.

However, not all findings were positive. Wang, He, and Kim, (2020) cautioned that while digital lending enhanced operational efficiency, it also introduced new risks. This included cybersecurity threats and algorithmic biasness that undermined financial sustainability if not properly managed. Their study underscored the need for robust risk management frameworks to balance the benefits and potential pitfalls of digital lending.

Ndirangu and Wanjiru, (2023) study revealed that digital lending had the potential to revolutionize access to credit for business enterprises. This was so as traditional banking lending model was obsolete. It subjected businesses to struggle in securing loans. Specifically, the focus was on small business entrepreneurs who were the backbone of the economy. The emerging Digital lending innovations powered by technology provided loans or credit facilities faster without the need for the traditional intermediaries. The speedy loan approvals and disbursements significantly improved the liquidity and operational flexibility of firms especially in times of cash flow crises. This reduced financial stress and enhanced the ability of businesses to maintain operations.

Muturi, (2021) study revealed the risk and weaknesses in adoption of digital lending. This was because some banks became over reliant on digital platforms short term financing leading to credit risk and debt trap. This became unsustainable business practice which

encouraged excessive borrowings. The hidden cost exposed the firm to financial distress in terms of interest rates, penalties, which affected the firm's financial stability, disruption of the long-term financial sustainability and erosion of asset quality.

Karani and Njoroge, (2022) study showed that firms that lacked access to formal credit could leverage on mobile money platforms and digital credit systems to sustain their operations and grow their investment portfolio. This was contrary to Traditional financial institutions in Kenya and other developing economies. They demanded collateral for loans that many SMEs could not provide hence credit restrictions. Digital lending platforms used alternative data set to assess credit worthiness to support the business lacking collaterals as security for loans.

Ochieng and Amaya, (2020) in their study revealed that high interest rates associated with digital loans and debt trap risks were major concerns that hindered financial sustainability. This was due to the capital flight and wastages as a result of the hidden charges. Therefore, based on the study in Kenya, there was lack of regulation on digital lending which was a significant concern in the market as it was affecting the long-term viability of these innovations.

Mugendi and Nyambura, (2020) conducted a study and they found out that Digital lending could help firms improve operational efficiency through; faster access to credit, reducing transaction costs and eliminating the need for intermediaries. This positively contributed to enhanced financial sustainability due to availability of accurate digital data. It allowed

businesses to obtain loan based on performance which was contrary to the requirements for collaterals for loans.

Mutisya and Ochieng, (2021) study revealed contradictions to the positive impact of the digital lending to the businesses. The digital platforms faced challenges in sustaining profitability. This was due to high costs acquired to customers' existing loans, loan default rate and regulatory uncertainty revealed weakness. Other studies suggested that the sustainability of digital lending platforms in the long term might be at risk due to these challenges. Firms that lacked the digital infrastructure or financial literacy to navigate these platforms might be excluded from the benefits of digital lending. Hence, market inequalities gap which informed the research proposal.

Mbithi and Karanja, (2021) study showed that Digital lending provided businesses with short-term working capital. This helped firms to overcome short-term liquidity challenges. This trend if not well managed, could cause financial disruptions. This include incurring of unexpected expenses, profit fluctuations and uncertainty in recovery due to economic shocks.

Lastly, in a study focusing on Sub-Saharan Africa, Mago and Chitokwindo, (2021) highlighted that digital lending had the potential to enhance financial sustainability. This was through diversification of income streams and reduced reliance on traditional banking methods. However, they also noted that the effectiveness of digital lending depended on the regulatory environment and the level of technological literacy among

the users. They suggested that contextual factors played a crucial role in determining the outcomes.

The empirical studies reviewed showed that digital lending innovation and financial sustainability of firms presented significant opportunities and challenges. The opportunity was that digital lending platforms provided finances to the unbanked and the underserved entrepreneurs. This initiative supported operational efficiency and fostered financial inclusion.

However, critical concerns linked to high-interest rates, over-reliance on digital loans, regulatory gaps and the potential for encouraging unsustainable financial practices need to be addressed, for these innovations to truly enhance the long-term financial sustainability. The proposed research sought a deeper exploration on how businesses could leverage on digital lending for both short-term liquidity and long-term sustainability without falling into debt traps.

2.4.2 Open Banking Lending and Financial Sustainability

Open banking lending involved the process where customer data was shared, security of customer data transfer between banks and third-party providers being recognized as a key innovation in modern financial services. Through fostering of competition, transparency and innovation, open banking was believed to contribute to the financial sustainability of banks. This enhanced customer experiences and more tailored financial products.

According to Farrell and Wheatley (2019), open banking initiatives in Europe have led to increased competition among banks, driving them to innovate and improve their service offerings. Their study found that banks that embraced open banking platforms were more likely to enhance their financial sustainability due to the ability to offer personalized financial products that better meet customer needs, thereby increasing retention rates and profitability.

Further evidence from a study by Drasch, Schweizer and Urbach, (2018) indicates that open banking positively influences financial sustainability by reducing the costs associated with customer acquisition and retention. By leveraging data analytics and third-party collaborations, banks can offer more targeted financial solutions, which not only enhance customer satisfaction but also improve the efficiency of lending operations. Contrary to these positive findings, a study by Sia et al., (2020) highlighted potential challenges associated with open banking, such as data privacy concerns and increased regulatory compliance costs, which could negatively affect financial sustainability. They argued that while open banking provides opportunities for growth, it also requires significant investments in cybersecurity and regulatory compliance, which can strain financial resources.

Mutua and Kihoro, (2022) found that the primary motive of banks pursuit for open banking are based on economies of scale that accrue from financial inclusion by tapping in underbanked population, the introduction of open banking revolutionizes banking systems and further deepen financial inclusion, hence offering support to business entrepreneurs to access customized banking services in competitive market. The study is

supported by Wambua and Ndegwa, (2021) who argues that access to affordable credit facilities is enhanced to many firms and bank customers operating in Kenya. Therefore, by availing many opportunities the open banking lending innovations allow business to be adequately funded thus enabling financial sustainability of business. This study seeks to verify why the significant shift of many bank products towards open banking, could it be possible and easier approach and relevant to many bank customers in obtaining credit facilities offered by banks in Kenya.

Njoroge and Kamau, (2020) found that open banking support efficient processing of loans and enhance customer experience through improved service delivery and operational efficiency, the assumption is that open banking delivers a wide range of banking services to customers which is not available from traditional banking, therefore open banking allows business integration by multiple banking services at optimal costs which strengthen financial health and sustainability of banks in long run. The study suggests possibility of open banking opportunity that exposes the bank wide range products to potential customer base and market demand.

Ochieng, Aduda, and Omwoyo (2023) found that despite the economies of scale obtained in long run by commercial banks that embrace open banking, potential risks and challenges exist; these challenges are data related security threats, challenges from legal compliance which restrict free flow of financial services to customers, hence slow business growth.

Omondi and Ngetich, (2021) on the role of digital banking platforms in Kenya, researcher found that Kenyan banking sector is robust in terms of digital support services and development of infrastructure, vibrancy of fin tech service firms contributes to growth of open banking services, which play a significant role that ensures smooth operations, investments and settlements. open banking growth simplify operations and significantly enhance financial profitability and sustainability.

Kamau and Nyambura, (2022) on government regulations and policies regarding growth of open banking landscape in Kenya, the study found that government policies are critical and gateway to licensed bank functions, the Kenyan banking sector is heavily regularized, to ensure that the open banking environment is conducive to customers and promote national values on innovations which if well managed facilitate achievement of financial inclusion and bank financial sustainability.

Moreover, Maas, Fenwick, and Vermeulen, (2021) found that the impact of open banking on financial sustainability varies depending on a bank's ability to integrate third-party services effectively. Banks that struggled with integration often faced higher operational costs, which negated the potential benefits of open banking. This suggests that the success of open banking initiatives is closely tied to a bank's technological capabilities and strategic approach.

Therefore, the study literature reviewed signal both the benefits and challenges and researcher seek to confirm if all Government regulations and policies are essential in open banking innovation, by answering the question as to whether the dominant barriers that

exit in traditional banking model can be eliminated or improved to encourage high consumption of lending banking products offered by commercial banks in Kenya.

2.4.3 Block Chain-Based Lending and Financial Sustainability

Block chain-based lending, which utilizes decentralized ledgers to facilitate transparent and secure transactions, is increasingly seen as a revolutionary force in the banking sector. Its potential to enhance financial sustainability lies in its ability to reduce transaction costs, improve security, and eliminate the need for intermediaries. According to Lee and Shin (2018), block chain technology can significantly enhance the financial sustainability of banks by reducing the costs associated with traditional lending processes. Their study found that block chain-based lending platforms streamline the loan approval process, reduce fraud risk, and enable more efficient cross-border transactions, contributing to improved financial performance.

Chen, Wu, and Yang, (2019) found that block chain-based lending improves the operational efficiency of banks, which, in turn, enhances financial sustainability. By automating loan processing through smart contracts, banks can reduce the time and resources needed for credit assessments and disbursements, thus improving profitability. However, some studies present a more cautious perspective. For example, Treleven, Brown, and Yang, (2021) pointed out that while block chain has the potential to improve financial sustainability, its integration into existing banking systems can be complex and costly. They noted that banks often face significant technical challenges and high initial investment costs when adopting block chain, which can delay the realization of financial benefits.

Mugenda and Mwachiro, (2020) focusing on barriers to block chain based lending system in Kenya, contradict the merit from other researcher's on block chain based lending, the researcher argue that technology implementation is complex and demanding, as upfront investments costs are required specifically intense infrastructure, Kenyan banks in lower tiers may face the challenge in integrating block chain technologies to existing core banking system, the long term implication is financial constraints.

Ngugi and Ochieng, (2020) study finding reveal that block chain promises potential to long term efficiency due to costs reductions to existing bank model system, The bank will however require to upgrade staff skill through mentorship and training development, the initial implementation costs may have a significant financial strain affecting profitability and financial sustainability. Karanja and Kimani, (2021) found that block chain strengthen financial sustainability in the context that innovation improves transparency and security of data is enhanced, this is because the model predominantly transparent and tamper proof due to data immutability features, this technology reduce fraud, enhance accountability and stream line loan processing, by leveraging on block chain lending technology in lending, Kenyan banks may ensure transactions are recorded, stored securely and protected, a process which improve market share, trust and promote investor and customer confidence among financial institutions.

Wambui and Kamau, (2020) study reveal that block chain-based lending facilitate access to credit card to underserved populations and Small micro Enterprises populations who lack credit history for evaluations, the technology avail alternative data based on social

behavior stored on block chain through distributed ledgers, Based on the technology Banks in Kenya can perform due diligence process to determine the creditworthiness of potential customers excluded from banking system. This may enable banks in Kenya to enhance financial inclusion to ignored unbanked or underbanked population that significantly represent potential Market.

Block chain significantly reduce costs associated with operation in traditional banking, intense manual verification process by simplifying and automating loan disbursements, tracking of loans disbursed and repayment administrative management, the technology easy pressure dominant in traditional banking by embracing online banking and competitively manage mobile money banking solutions, Digital Money, (Muturi and Juma, 2021).

Mwangi and Nyambura, (2021) found that weakness exist in block chain based lending, study finding reveal that even though credit card improve access to credit, the assumption is that majority of population have necessary smartphones and have stable internet connections, contrary to the assumptions the reality is that majority of rural Kenya regions have no stable internet connections, the benefits associated with block chain based lending may exclude such regions to equitable access to block chain powered financial services, hence challenge to long-term financial sustainability of banks in Kenya.

Ochieng and Waweru, (2021) findings on block chain-based risk management reveal that the banking model improve risk assessment and management of loan defaults, as it support accurate. Real time data on borrowings by leveraging on robustness of decentralized

ledgers, the bank can use the technology to improve credit risk models, hence reduce default risk of no-performing loans, stream line loan origination and monitoring to maintain financial stability.

Kariuki and Mwangi, (2020) on characteristic of block chain-based lending is the utilization of smart contracts, the system based self- executing contracts, based on bar codes embedded in the system which help improve efficiency and minimizes errors and fraud risks. However, the block chain fell short of other credible assurance as it is vulnerable to cyber securities, which may disrupt loan contract managements, the high risk of default may results to industrial disputes by contracting parties.

Muturi and Nyambura, (2021) on positive implication strengths of how regulatory framework support block chain based lending in Kenya and compared to other financial regulators, the study established that in order to ensure comprehensive guidelines, the study implication to current studies is that without clear regulations Kenyan banks may face uncertainties, when adopting block chain based lending solution, the regulatory uncertainty may slow down investments and development of robust technologies that support banking revolution in Kenya. The block chain-based lending is still a regulatory gray area and guidelines are still unclear, (Muthomi and Okello, 2021).

Mougayar, (2020) emphasized that the success of block chain-based lending depends heavily on regulatory frameworks and market acceptance. Banks operating in regions with unclear regulations or low acceptance of block chain technology may struggle to achieve the anticipated benefits, thus negatively impacting their financial sustainability.

The studies provided other potential areas that seem to affect bank operations hence need to be explored as the current practice in traditional banking could be obsolete or uneconomical in terms of costs, hence need for new knowledge to revolutionise the bank strategic product line and sustainable growth in dynamic market environment. The research thesis seeks to explore and verify Block chain-based lending innovations opportunities and risks that inherently appear to affect the financial sustainability of Kenyan banks. As block chain technologies is still a gray area, particularly for underserved /unbanked populations below the pyramid. Furthermore, the assumptions fronted for adoption of block chain's lending models supporting the bank ability to mitigate risk, default rate management in bank lending practices the assumption need to be tested through the proposed study.

2.4.4 Credit Card Lending and Financial Sustainability

Credit card lending remains a vital aspect of consumer finance, providing banks with a steady revenue stream through interest rates and fees. The relationship between credit card lending and financial sustainability is multifaceted, influenced by factors such as credit risk management, customer spending behavior, and market conditions.

Gomber et al., (2018) argue that credit card lending positively impacts financial sustainability by offering banks a relatively high-margin product that supports profitability. They found that banks with robust credit card portfolios were better able to maintain steady revenue flows, even during economic downturns, thereby enhancing their financial resilience.

Another study by Chakravorti and To, (2019) demonstrated that credit card lending boosts financial sustainability by enhancing customer loyalty and increasing the average lifetime value of clients. Their findings suggest that banks that effectively manage credit card lending can achieve sustainable revenue growth by capitalizing on customer loyalty programs and targeted marketing strategies.

Conversely, a study by Agarwal et al., (2020) highlights the risks associated with credit card lending, particularly in volatile economic environments. They found that high levels of consumer debt and increasing default rates could jeopardize the financial sustainability of banks, emphasizing the need for rigorous credit risk management practices.

Mwangi, (2018) study focused on small business in Kenya urban areas. The researcher was interested in assessing how credit card instruments benefit business. The study found that ability to access credit instruments empowered the entrepreneurs through provision of liquid cash to release short-term pressure, enhance operational efficiency and contribution to financial sustainability was significant. The study is supported by Ochieng and Amaya, (2020) who argued that credit card lending positively impacted on the firm's performance, profitability and financial sustainability. Small micro enterprises earn income stream on short term basis to leverage liquidity constrains and invest in more promising investments portfolios the ultimate goal supports financial stability. The study showed that finance constraint affect small micro enterprises daily operations. This suggest a financing gap

which credit card complement, as a result business continuity is guaranteed in long-term, hence potential opportunity for banks to explore as potential market.

Muthomi, (2019) study found that in market their different types of credit card circulation that support informal lending business, and that access to formal credit facilities in absence of credit cards contribute to financial stability of firms, and that credit cards are formal instruments which can allow firms to manage cashflow gaps experiences by funding expansion programmes. Other studies according to Ngugi and Kamau, (2021) found that financial institutions offering credit cards, support business in Kenya. The study revealed that even though credit cards provide short-term support to firms, the long term impact on sustainability is uncertain, as the cards depend of other long term financing strategic factors. The concern on uncertainty based on other factors makes the credit card lending innovation interest area of study.

Muturi, and Wanyonyi, (2017) study focused on how the adoption of credit cards could influence consumer behavior in Kenya. The study found that consumer purchasing power affect business and the economy at large. Credit usage enabled consumers to have borrowing power of demandable goods in the market, and the final outcome is the ability to purchase goods improved income streams, which end result is to contribute indirectly to financial sustainability in the economy and encourages free flow of factors of production. According to Karani and Njoroge, (2022) credit cards access for firms in Kenya faces the challenge for acceptability by majority of business entrepreneurs in Kenya, the business argue that high interest rates, lack of financial knowledge, and high payments defaults

make the credit card products less attractive and thus disrupt the firm's performance and sustainability.

The studies suggested that by improving the regulatory environment and banks be able to offer customized lower-cost credit card products could make credit cards, a more viable business lending tool for business sustainability by any financial service providers. Kinyua, (2019) study found that credit access had significant impact of sustainability of small and medium enterprises in Kenya. as the study investigation revealed that the strong relation between credit card access had bearing on the sustainability of SMEs, since timely access to credit allows firms to gain sound liquidity position, invest in viable business opportunities and mitigate incidences of financial distress to the business hence positive impact on the financial sustainability. However, the emerging challenges as per the current proposed study indicate that high-interest rates, limited access, and financial knowledge prevent effectiveness of credit cards for business sustainability and credit card lending on financial sustainability for firms in Kenya is a relatively under-researched area, as most studies on credit card usage tend to focus on individual financial behaviors or consumer finance rather than its direct implications to firms.

Lastly, Liao and Lin (2021) noted that while credit card lending can enhance financial sustainability, the benefits are contingent on effective fraud prevention and risk management. Banks that fail to address these challenges may face significant losses, undermining their financial stability and long-term viability. This thesis based on reviewed studies shows that there is a growing interest in understanding how various forms of lending, including credit cards, affect businesses, particularly in terms of access

to credit, financial performance, and long-term sustainability in Kenya, as access to formal credit for businesses, especially small and medium enterprises (SMEs), remains a key challenge, and credit card lending could play a role in improving financial sustainability.

The empirical review demonstrates a complex relationship between financial lending innovations and the financial sustainability of commercial banks. While digital lending, open banking, block chain-based lending, and credit card lending offer significant opportunities for enhancing financial performance, they also present challenges that must be carefully managed. The literature suggests that the impact of these innovations on financial sustainability is highly context-dependent, shaped by factors such as regulatory environments, technological integration capabilities, and effective risk management practices.

2.5 Summary of Literature Review and Gaps

Table 2. 1 Summary of Gaps in Existing Literature

Author(s)	Focus	Methodology	Key Findings	Research Gap
Gozman, Liebenau, and Mangan (2018)	Digital lending in emerging markets	Qualitative analysis of fintech platforms	Digital lending reduces operational costs and expands market reach, enhancing financial sustainability.	Lack of comprehensive studies quantifying digital lending's impact on long-term financial sustainability in varied contexts.
Jagtiani and Lemieux (2019)	Fintech lending and bank financial health	Empirical analysis of U.S. fintech data	Positive correlation between digital lending and financial sustainability through efficiency gains.	Limited focus on commercial banks in developing countries, especially in the African context.
Wang, He, and Kim (2020)	Risks and benefits of digital lending	Mixed-method approach	Digital lending improves efficiency but poses cybersecurity risks that may affect sustainability.	Need for studies on mitigation strategies for emerging risks in digital lending.
Mago and Chitokwinda (2021)	Digital lending in Sub-Saharan Africa	Case study of African markets	Potential to enhance financial sustainability through financial inclusion, influenced by regulations.	Context-specific studies are needed to assess varying regulatory impacts on digital lending sustainability.
Farrell and Wheatley (2019)	Open banking and competition in financial services	Industry surveys and secondary data analysis	Open banking enhances sustainability by fostering competition and customer-centric services.	Limited empirical data on open banking's direct impact on financial sustainability in commercial banks.
Drasch, Schweizer, and Urbach	Bank-fintech cooperation in open banking	Taxonomy development and case	Open banking reduces customer acquisition costs and improves service offerings, boosting sustainability.	Need for longitudinal studies assessing the long-term sustainability impacts of open banking collaborations.

(2018)		studies		
Sia et al. (2020)	Strategic implications of open banking	Expert interviews	Open banking offers growth but raises compliance costs and data privacy concerns affecting sustainability.	Insufficient exploration of the balance between regulatory costs and financial benefits in open banking.
Maas, Fenwick, and Vermeulen (2021)	Integration challenges in open banking	Case study analysis	Success depends on effective integration of third-party services; poor integration can increase costs.	Need for cross-market studies on best practices for effective open banking integration.
Lee and Shin (2018)	Blockchain-based lending and financial sustainability	Conceptual framework and case studies	Block chain reduces costs and fraud risk, enhancing financial sustainability through efficiency.	Empirical data needed on block chain's operational challenges in mainstream banking adoption.
Chen, Wu, and Yang (2019)	Operational efficiency in block chain lending	Case study of block chain in banking	Smart contracts automate lending, reducing costs and time, improving sustainability.	Insufficient evidence on block chain's broader economic impact on financial sustainability.
Treleven, Brown, and Yang (2021)	Technical and cost challenges of block chain	Review of technological integration cases	Integration costs are high, delaying financial benefits; highlights complexity in adoption.	Need for cost-benefit analyses of block chain integration in various banking contexts.
Mougayar (2020)	Block chain's impact on financial services	Theoretical analysis	Success depends on regulatory clarity and market acceptance, varying widely across regions.	Lack of studies on regulatory impacts on blockchain adoption and its financial sustainability outcomes.
Gomber, Koch, and Siering (2018)	Digital finance and fintech in banking	Literature review and secondary data	Credit card lending supports profitability and sustainability through high-margin revenue streams.	Limited empirical focus on managing credit risk in volatile markets for sustained financial stability.
Chakravorti	Credit card	Econometric	Credit cards enhance sustainability by	Gaps in understanding long-term impacts

and To (2019)	lending and customer retention	modeling	increasing lifetime customer value and loyalty.	of customer debt levels on bank sustainability.
Agarwal et al. (2020)	Risks in consumer financial products	Empirical analysis of credit card data	High consumer debt levels can threaten sustainability; emphasizes need for risk management.	Need for studies exploring effective risk management strategies in high-debt environments.
Liao and Lin (2021)	Credit card fraud prevention and sustainability	Review of fraud detection technologies	Fraud prevention is crucial for maintaining sustainability in credit card lending.	Insufficient empirical studies on the impact of fraud management on overall financial sustainability.

Source: Researcher, (2025)

2.5.1 Summary of the Literature Review

The literature review chapter offers an in-depth exploration of the theoretical, conceptual, and empirical aspects of financial lending innovations and their impact on the financial sustainability of commercial banks. It begins by examining key theories, such as the Resource-Based View (RBV), Diffusion of Innovation (DOI), Transaction Cost Theory (TCT), and Financial Intermediation Theory, which collectively provide a foundation for understanding how lending innovations can enhance financial sustainability. These theories suggest that leveraging unique technological capabilities, early adoption of financial innovations, and reducing transaction costs are critical for banks' long-term viability. However, gaps remain in integrating modern digital finance perspectives into these traditional theories, highlighting a need for updated models that reflect the dynamic nature of current lending practices.

Conceptually, the review delves into digital lending, open banking, block chain-based lending, credit card lending, financial sustainability, and operational efficiency. Digital lending is identified as a key innovation that lowers costs and increases market access, though concerns about cyber security and regulatory challenges persist. Open banking fosters competition and customer-centric innovations but lacks sufficient empirical data on its long-term impact on sustainability. Block chain-based lending promises enhanced transparency and reduced costs, yet faces operational and regulatory hurdles. Credit card lending supports financial sustainability through high-margin revenue but requires effective risk management to mitigate associated risks.

Empirical studies highlight both positive and negative relationships between these innovations and financial sustainability. Digital lending and open banking are generally associated with increased efficiency and competitiveness, while blockchain's impact is more mixed, given the high integration costs and regulatory uncertainties. A significant gap exists in the literature, particularly regarding the application of these innovations in developing economies like Kenya. There is a need for empirical studies that explore the balance between the benefits of these innovations and the operational and regulatory challenges they pose.

In summary, the literature review underscores the complex interplay between lending innovations and financial sustainability, identifying critical gaps in theory, concept, and empirical evidence. This sets the stage for the next section on research methodology, which outlines the approach used to address these gaps and test the hypotheses developed in this study. The methodology details the research design, data collection, and analytical techniques aimed at providing a comprehensive understanding of the impact of financial lending innovations on the financial sustainability of commercial banks in Kenya.

Table 2. 2 Operationalization of Variables

Variable	Measure/Indicator	Measurement Scale	Expected Sign of Relationship
Digital Lending	Ease of loan access using mobile money application process	Ordinal (Very Easy, Easy, Moderate, Difficult)	Positive (easier application improves sustainability)
	Agent banking customer satisfaction using digital lending platforms	Ordinal (Very Satisfied, Satisfied, Neutral, Dissatisfied)	Positive (higher satisfaction enhances sustainability)
	Perceived security using cloud computing technologies digital lending	Ordinal (Very Secure, Secure, Neutral, Insecure)	Positive (greater security improves sustainability)
	Digital identity verification of customers using digital lending products	Ordinal (Very Accessible, Accessible, Limited, Not Accessible)	Positive (higher accessibility supports sustainability)
Open Banking	Open –ended Credit score data sharing with third parties	Ordinal (Extensive, Moderate, Limited, None)	Positive (more sharing enhances service efficiency)
	Open banking collaboration and perceived ease of integration with third-party services	Ordinal (Very Easy, Easy, Moderate, Difficult)	Positive (easier integration supports sustainability)
	Open banking application programming interfaces (APIs)with Customer to banking services	Ordinal (Very High, High, Neutral, Low)	Positive (higher trust enhances sustainability)
	Open end and closed-end personalized banking value	Ordinal (High, Medium, Low, None)	Positive (higher customization)

Variable	Measure/Indicator	Measurement Scale	Expected Sign of Relationship
	addition to bank customized service		improves sustainability)
Block chain-Based Lending	Integrated transparent Information system at all level of block chain transactions	Ordinal (Very Transparent, Transparent, Neutral, Opaque)	Positive (greater transparency boosts sustainability)
	Big data and Artificial intelligence technologies efficiencies in delivery of block chain lending	Ordinal (Very Efficient, Efficient, Neutral, Inefficient)	Positive (higher efficiency improves sustainability)
	Distributed ledger enhances system and Compliance with regulatory standards	Ordinal (Full, Partial, Minimal, None)	Positive (higher compliance supports sustainability)
	Data immutability enhanced data security, digital finger print, fraud detection and customer protection	Ordinal (High, Medium, Low, None)	Positive (better protection enhances sustainability)
Credit Lending	Cash bank reward credit card Card lending management effectiveness in delivery of banking services to customers	Ordinal (Highly Effective, Effective, Neutral, Ineffective)	Positive (effective management supports sustainability)
	Customer payment reputation	Ordinal (Very Good, Good, Neutral, Poor)	Positive (better repayment improves sustainability)
	Customer credit score and satisfaction with credit card services	Ordinal (Very Satisfied, Satisfied, Neutral, Dissatisfied)	Positive (higher satisfaction supports sustainability)
	Customer account management fee transparency and credit	Ordinal (Very Transparent,	Positive (greater transparency boosts

Variable	Measure/Indicator	Measurement Scale	Expected Sign of Relationship
	limits	Transparent, Neutral, Opaque)	sustainability)
Operational Efficiency	Superior service delivery and efficiency	Ordinal (High, Medium, Low, Very Low)	Positive (higher efficiency enhances sustainability)
	Process automation at all level of value chain in banking as a service	Ordinal (High, Medium, Low, None)	Positive (more automation supports sustainability)
	Employee productivity and agility at all levels of service and management	Ordinal (Very High, High, Medium, Low)	Positive (higher productivity improves efficiency)
	Efficiency in Resource utilization	Ordinal (Highly Effective, Effective, Neutral, Ineffective)	Positive (better utilization enhances efficiency)
Financial Sustainability	Financial performance	Ordinal (Very Stable, Stable, Unstable, Very Unstable)	Positive (greater stability indicates better sustainability)
	Effective cost Management	Ordinal (Highly Effective, Effective, Neutral, Ineffective)	Positive (effective management improves sustainability)
	Risk Mitigation management capability to eliminate wastages	Ordinal (High, Medium, Low, None)	Positive (better risk management supports sustainability)
	Capital ownership Stakeholder Engagement and bank management performance appraisal	Ordinal (Very Satisfied, Satisfied, Neutral, Dissatisfied)	Positive (higher satisfaction reflects better sustainability)

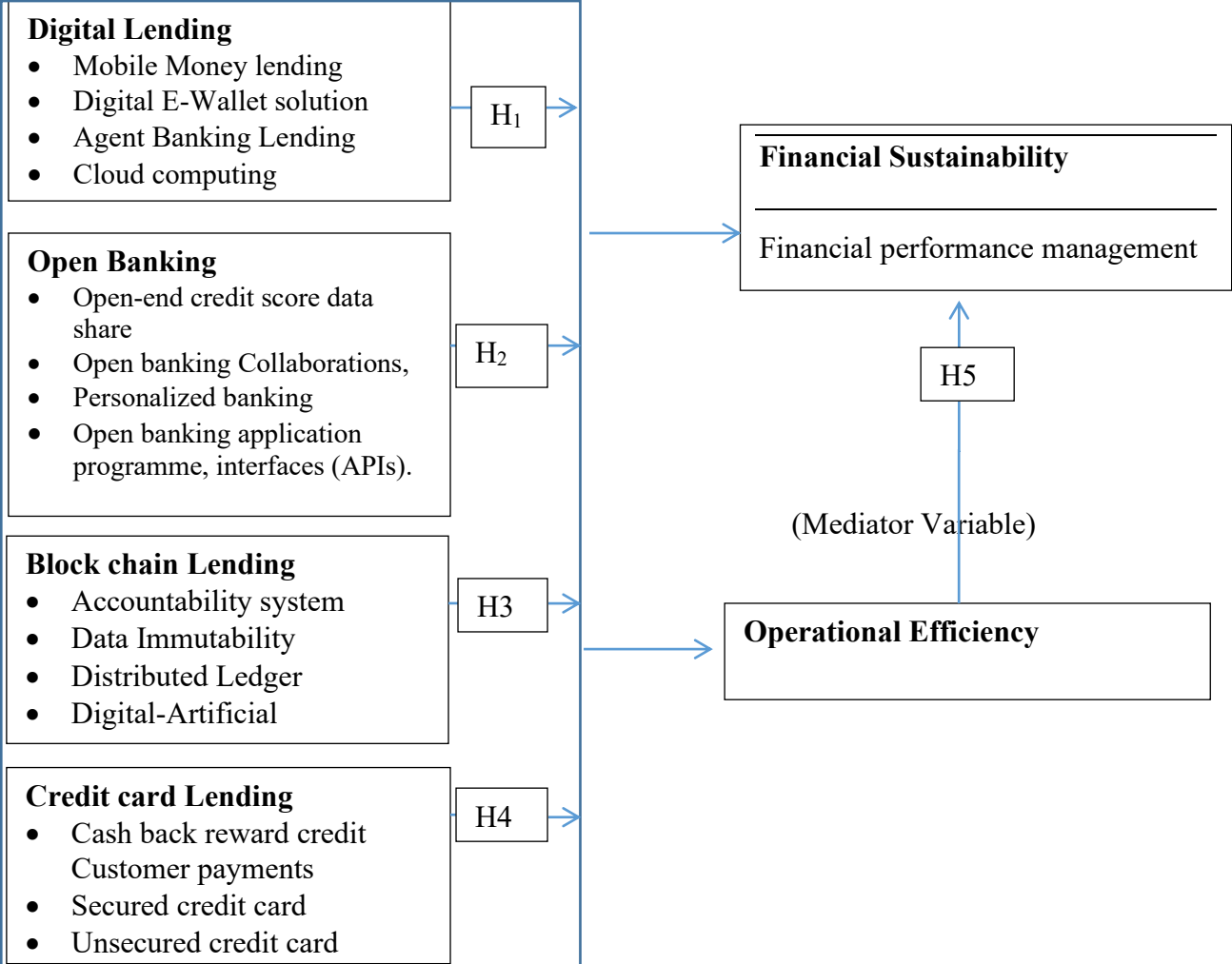
Source: Researcher, (2025)

2.6 Conceptual Framework

Independent Variable

Dependent Variable

Financial lending Innovations



Source: Researcher, (2025)

Figure 2.1: Conceptualizing Framework of the relationship between Financial Lending Innovation and Financial Sustainability

Adapted from:
 Chen, Y., Wu, Y., and Yang, Z. (2019)., Deng, X., Doll, W. J., and Truong, D. (2021)., Accenture. (2020). Butt, I., Murtaza, A., Lodhi, R., and Irfan, M. (2020)., Central Bank of Kenya. (2020). Bank Supervision Annual Report.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research methodology adopted in the study, focusing on the approach used to examine the influence of financial lending innovations on the financial sustainability of commercial banks in Kenya, mediated by operational efficiency. The chapter details the research design, research philosophy, target population, sampling design, data collection methods, and the reliability and validity of the research instruments. The methodological choices are justified based on existing literature, ensuring a robust and scientifically sound approach.

3.2 Research Philosophy

The study adopts the positivist research philosophy, which emphasizes objectivity, quantifiable observations, and statistical analysis (Bryman, 2016). Positivism is appropriate for this study as it supports hypothesis testing through empirical evidence, allowing the researcher to draw generalizable conclusions about the impact of lending innovations on financial sustainability.

According to Easterby-Smith, Thorpe, and Jackson (2018), the positivist philosophy is suitable for studies aiming to explain relationships through measurable variables and statistical tools. This philosophy provides a structured framework that facilitates hypothesis testing, contributing to the reliability and validity of the findings. The

study's alignment with positivism ensures that the findings are based on observable data, reducing researcher bias and enhancing the study's scientific rigor.

3.3 Research Design

The study employs a descriptive research design combined with explanatory research design. The descriptive aspect allows for a detailed depiction of the current state of financial lending innovations among commercial banks, while the explanatory design helps identify and explain relationships between the variables (Saunders, Lewis, and Thornhill, 2019). This dual approach is suitable for exploring the causal links between lending innovations, operational efficiency, and financial sustainability, as it enables the researcher to collect in-depth quantitative data and infer causality.

The use of these designs aligns with studies by Creswell and Creswell (2017), who argue that descriptive and explanatory designs are effective in social science research where understanding complex relationships is crucial. The descriptive component helps establish patterns and trends in the data, while the explanatory design allows for testing hypotheses to determine causal relationships between variables.

3.4 Study Area

The study was carried out in all commercial banks in Kenya at the headquarters in Nairobi Head offices, the study considers banks that have been operational for the past five years, are licensed and registered under the Banking Act, and are regulated by the central bank of Kenya. As of December 31, 2023, the Central Bank of Kenya reported

that there were 39 commercial banks in Kenya that were licensed. Regulated and registered by the Central Bank of Kenya.

A diverse landscape with distinct characteristics and functions is established by the classification of these banks into tiers based on size and market share. The Tier 1 institutions are in charge, controlling more than 70% of the total assets and loans. These banks provide a wide variety of products and services to both corporate and individual customers. They are at the forefront of innovation, facilitating the digital transformation of the sector and broadening its reach through extensive branch networks. Tier 2 institutions occupy the intermediate position. They effectively compete by leveraging their strategic focus and established presence, frequently focusing on specific market segments or industries.

These organizations are essential for the promotion of competition and the provision of a wide range of financial solutions. The Tier 3 institutions complete the landscape. While lesser in size, they frequently exhibit exceptional agility by focusing on niche markets or offering specialized financial products. By reaching underserved communities and investigating innovative solutions, contribution to financial inclusion

3.5 Target Population

The target population refers to entire group that the research seeks to investigate, Bell drynu and Henry (2020), which according to the study comprises all commercial banks in Kenya, licensed and regulated by the Central Bank of Kenya (CBK). As of 2024, there are 39 commercial banks operating in Kenya, including both local and

international banks (Central Bank of Kenya, 2024). The focus on commercial banks is justified by their significant role in the financial sector and their adoption of innovative lending practices. Key respondents within these banks included senior managers, heads of lending departments, risk managers, and IT officers responsible for the implementation of lending innovations. These respondents are considered knowledgeable about the banks' operations and are best positioned to provide insights into how lending innovations influence financial sustainability.

Table 3. 1 Target Population

Bank Tier	Total Number of Banks	Respondents per Bank	Total Respondents
Tier 1 Banks	7	5	35
Tier 2 Banks	19	4	76
Tier 3 Banks	13	3	39
Total	39	-	150

Source: Researcher Computed, (2024)

3.6 Sampling Design and Sample size

A census technique was employed, targeting all 39 commercial banks. Census sampling is chosen because the population size is manageable, and it allows for comprehensive data collection, enhancing the study's external validity. Census sampling ensures that all banks' perspectives are included, providing a complete picture of the sector's approach to lending innovations. Within each bank, a purposive sampling technique was used to select 3 to 5 key informants, ensuring that the respondents have the required expertise and experience. This approach is supported by Etikan, Musa, and Alkassim (2016), who highlight purposive sampling as effective in selecting respondents who can provide in-depth and relevant data.

3.6.1 Sample Size

The study employed Taro Yamane (1967), being a simplified formula for determining sample size,

The sample size was obtained using Yamane formulae

$$\text{Sample size } n = \frac{N}{(1 + Nd^2)}$$

Where N-is the population size 150, and d is the margin of error 0.05, and n is the minimum sample size to be used in determining the census sample in table as indicated.

$$n = 150 / (1 + 150(0.05^2))$$

$$n = 109 \quad \text{Sample Size } n = 109$$

3.6.2 Data Sampling procedure

The sample population and sample size is as tabulated in table 3.2

Tier 1 Banks: These are the largest banks by asset size and market share. A total of 7 Tier 1 banks are targeted, with 4 key informants per bank, yielding 28 respondents.

Tier 2 Banks: These are medium-sized banks, comprising 19 institutions. Each bank had 3 respondents, resulting in a total of 57 respondents.

Tier 3 Banks: The smallest banks by asset size fall into this category, totaling 13 banks. Each bank contributed 2 respondents, making a total of 26 respondents.

Total Respondents: Across all tiers, the study targets 109 respondents, ensuring representation from all segments of the commercial banking sector in Kenya.

Table 3. 2: The Population and Sample Size Distribution per Bank

Bank Tier	Total Number of Banks	Respondents per Bank	Total Respondents
Tier 1 Banks	7	4	28
Tier 2 Banks	19	3	57
Tier 3 Banks	13	2	26
Total	39	-	111

Source: Researcher Computed (2024)

3.7 Data Collection Instruments and Procedures

3.7.1 Data Type

In order to provide a full response to the research hypotheses, the study made use of primary. Primary data was collected using structured questionnaire and interview schedule. This allowed the researcher to acquire comprehensive understanding of the situation and facilitate completion rate of the research work as data was obtained from source by participants.

3.7.2 Data Instrument

The main data was gathered through a standardized questionnaire (Appendix 1). The questionnaire was utilized in this study as it is expected that the respondents are literate and capable of providing acceptable responses to the topics posed. The questionnaire was broken into four sections. Part 1 involve gathering general information from the respondents, while Part 2 focus on collecting data on specific independent variables using closed-ended statements. Part 3 gather data on the moderating variable, and part 4 gathers information on the dependent variable. A Likert scale with five points was employed to measure all dimensions, ranging from 1 (Strongly Agree) to 5 (Strongly Disagree). The scale was labeled as follows: 5 - Strongly Agree, 4 - Agree, 3 - Undecided, 2 - Disagree, and 1 - Strongly Disagree.

The use of structured questionnaires as the primary data collection tool. Questionnaires are preferred due to their efficiency in gathering quantitative data from a large number of respondents. The questionnaire was divided into sections corresponding to the study variables: digital lending, open banking, block chain-based lending, credit card lending,

operational efficiency, and financial sustainability. Data was collected via questionnaire for quicker responses and broader reach. Pre-testing of the questionnaire was conducted with a pilot group of respondents to refine the instrument, ensuring clarity and relevance of the questions.

3.7.3 Variable measures

3.7.4 Data Collection Procedures

The researcher collected qualitative data for the study using questionnaire; to process ethical requirements stipulate that the researcher obtain introduction letter as permission and authorization from the University to collect research data through the school board committee approval. Subsequently, the researcher sought requisite authorization from the National Research Fund prior to commencing the actual process of data collection. Three research assistants was hired primarily to assist distribute and follow up on collection of feedback on primary data distributed and also support participants in providing guidance on areas requiring clarification on the administered questionnaires.

The researcher provided assurance to respondents on confidentiality of information gathered use, purely for research academic purpose only. The questionnaires were distributed to Senior managers, Heads of lending departments, Risk managers, and IT officers. The respondents was given duration of two weeks(14Days), to respond to questionnaire, The primary means of accessing the banks mostly be through the Established directorate corporate communication, existing industry linkage, and customer care services at the head office. In some cases, the data collection activity

employed a drop and pick technique. A checklist was prepared to track response and timely collection of all administered questionnaires for data analysis.

3.8 Reliability and Validity of the Instrument

3.8.1 Pilot Study

Pilot study is a crucial step in the research process as it helps refine the data collection instrument (questionnaire) to ensure clarity, reliability, and validity. The pilot test involved administering the questionnaire to a small, representative sample of respondents included Bank Managers, Bank lending Credit officers, Banks Risk and compliant Managers and IT Officers. The credentials of respondents are similar to the actual study participants but were not form part of the main study. This pilot group included approximately 10-15 respondents drawn from a mix of Tier 1, Tier 2, and Tier 3 bank branches in Kisumu City to capture diverse perspectives.

3.8.3.1 Procedure for Pilot study:

The pilot testing process followed a structured four-step approach to ensure the reliability and clarity of the research instrument. In the first step, participants were purposively selected based on their professional relevance to the study. These included individuals holding key roles such as lending managers and risk officers, whose insights were critical due to their expertise in areas directly related to the study focus.

In the second step, the questionnaire was administered electronically to the selected respondents. A clear timeline—typically one week—was provided for them to complete and return the questionnaire. Once the completed responses were received,

the third step involved gathering feedback on various aspects of the instrument. This included evaluating the clarity, length, relevance, and overall comprehensiveness of the questions. Participants were encouraged to highlight any difficulties encountered in understanding or responding to specific items.

The final step entailed refining the instrument based on the feedback obtained. This included rephrasing unclear questions, adjusting the sequence of items for better logical flow, and eliminating any redundant or irrelevant items. To ensure internal consistency and reliability, the refined instrument was subjected to statistical validation using Cronbach's Alpha, with a minimum acceptable threshold of 0.7.

Further, the researcher discussed the questionnaire with 11 bank branch managers in Tier1, Tier11 and Tier111 banks to ensure the questioned items relate to the bank operations in Kisumu city as a sample participant to identify any ambiguities, redundancies, or capture any missing information (Polit and Beck, 2017). The pilot participants was excluded from the main study. Feedback from pilot participants was used to refine the questionnaire, ensuring clarity and relevance of the items. Additionally, during the actual data collection process, respondents had the opportunity to provide feedback and seek clarification on any questions, further enhancing content validity (DeVellis, 2016).

3.8.2 Reliability Test

To test reliability, the current research study is purely empirical in nature based on commercial banks in Kenya; the reliability was calculated using the Cronbach Alpha

reliability co-efficient for financial lending innovations practices among commercial banks in Kenya. The Cronbach alpha model was utilized in the current study to test reliability.

The empirical Cronbach alpha model

$$\text{Cronbach's alpha } (\alpha) = \frac{(N \times \bar{c})}{(\bar{v} + (N-1) \bar{c})}$$

Where:

N = population for the study,

\bar{c} = Average covariance between items,

\bar{v} = Average covariance

Based on Cronbach alpha (α) model attributes the researcher assumes that the -0.7 less Cronbach model was the most ideal and appropriate for reliability test, accord researcher's opportunity to validate and satisfy the minimum threshold for affirming the study instrument's reliability and dependent.

The reliability of the instrument was assessed using Cronbach's Alpha, with a threshold of 0.7 or higher considered acceptable (Tavakol and Dennick, 2011). Reliability testing ensures that the instrument consistently measures the variables of interest, contributing to the credibility of the findings.

3.8.3 Validity Text

The study employed content validity and construct validity checks. Content validity was ensured through expert reviews, where academic and industry professionals to evaluate the questionnaire items for relevance and coverage of the study variables.

Validating the research instrument is crucial to ensure that it accurately measures the intended constructs and yields reliable results. In this study, validity was assessed across three key areas; content, construct and criteria validity. Content validity ensures that the questionnaire items comprehensively cover the relevant aspects of the research topic. Construct validity examines the extent to which the questionnaire items accurately measure the underlying constructs or dimensions of the research topic.

Construct validity in this study was tested through **factor analysis** to confirm that the items measure the intended constructs (Hair et al., 2019).

In order to ascertain construct validity, the researcher utilized the **Keiser –Meyer Olkin (KMO)** to measure adequacy of sampling to check for variance in the variables which might be because of underlying factors High values (close to 1.0) indicates that factor analysis may be useful in the data collected, Factor analysis helped identify the main components or factors underlying the questionnaire items and assess how well these factors align with the theoretical framework of financial sustainability in commercial banks.

By examining patterns of correlations among variables, factor analysis confirm the presence of distinct dimensions of financial sustainability and validate the measurement model used in the study (Tabachnick and Fidell, 2019). If KMO values is less than 0.05 then the results of the factor analysis may probably not be very useful, Varimax rotation was applied through which factor loading where KMO values less than 0.4 was dropped.

Content validity test was based on Lawshes method for assessing content validity is given by the following Formulae for CVR (Content Validity Ratio)

$$CVR = \frac{N_e - N/2}{N/2}$$

Source Lawshe (1975),

Where:

N_e - the number of panelists identifying an item as essential.

N - the total number of panelists;

$N/2$ - half the total number of panelist

$$CVI = \frac{\sum CVR}{N}$$

Content validity index (CVI), is the mean CVR values for all items meeting the CVR threshold of 0.78 for all items included in the final instrument, where experts agree to the tested new knowledge Devon et al.,(2007), According to Polit Beck and Owen,(2007) suggest that item with CVR 0.78 evidence of good content validity, if below its to be deleted from final values, Tiden, Nelson and May, (1990) suggest values exceed 0.70, however Davis(1992) suggest a CVI exceeding 0.8 is preferred. Therefore, the study utilized Tiden, Nelson and May (1990) threshold of 0.7 for all items included in the instruments as a base for measuring content validity ratio criteria.

Criterion validity evaluates the extent to which the research instrument accurately predicts or correlates with an external criterion or gold standard. In this study, criterion validity could be assessed by comparing the results obtained from the research instrument (e.g., questionnaire responses or financial metrics) with an established measure of financial sustainability, such as credit ratings or financial performance indicators (Trochim and Donnelly, 2008). By demonstrating a significant relationship

between the research instrument and the external criterion, criterion validity provides evidence of the instrument's accuracy and effectiveness in measuring financial sustainability in commercial banks.

Both reliability and validity assessments are crucial for ensuring that the data collection instrument accurately captures the variables and relationships being studied, minimizing errors and enhancing the quality of the research.

3.9 Data Analysis

The study employed multiple regression analysis to examine the impact of digital lending, open banking, block chain-based lending, and credit card lending on the financial sustainability of commercial banks, incorporating operational efficiency as a mediating variable. Steps for Data Analysis involved the following: -

3.9.1 Descriptive Statistics

Data was first summarized using means, standard deviations, and frequencies to understand the distribution and basic characteristics of the data.

Regarding primary data, descriptive statistics predominantly encompassed frequencies and percentages to synopsise categorical variables and offer insights into response distribution. Descriptive statistics primarily based on frequencies and percentages are notably advantageous for summarizing categorical variables, like demographic characteristics and responses to Likert-scale items (e.g., agreement levels with statements) (Trochim and Donnelly, 2008). They afford a lucid and succinct overview

of response distribution, simplifying interpretation and comparison across different categories or groups. These data were visually presented through tables and charts, enhancing accessibility and comprehension.

3.9.2 Correlation Analysis

Correlation Analysis was conducted to investigate the level or degree of association between Independent Variable and Dependent variable, correlation test the magnitude of strength and the direction of relationship between variables used in the study. In this study Pearson correlation coefficients was used to examine the relationships between the independent variables (lending innovations), mediator (operational efficiency), and dependent variable (financial sustainability). This provided preliminary insights into the strength and direction of associations.

The Pearson Correlation Coefficient

The Pearson Correlation Coefficient, often known as Pearson r , is employed to analyze the association between variables (Akoglu, 2018). Pearson's correlation coefficient, denoted as r , quantifies the strength and direction of the linear association between two variables. The correlation coefficient values consistently span from -1 to $+1$. If a value is close to -1 , it indicates a significant negative correlation. Conversely, if a value is close to $+1$, it indicates a strong positive correlation (Rebekić, Lončarić, Petrović and Marić, 2015). A coefficient of 0 indicates the absence of correlation between the variables. This study employed bi-variate correlational analysis to evaluate the magnitude and direction of the association between the variables. Ngumi et al. (2013) state that a significance level below 0.05 indicates a significant correlation, suggesting a linear relationship

between the two variables. Conversely, a relatively large significance level, such as 0.50 or higher, indicates a lack of significance and suggests that the two variables are not linearly related.

3.9.3 Multiple Regression Analysis

The study conducted regression analysis on the data collected by using Linear regression model between the Independent Variables and Dependent variables, By Running a regression analysis assisted to predict the effect of each independent variable of the study on Dependent variable, where financial sustainability is the dependent variable, and lending innovations are the independent variables.

The regression equation model of study took the form:

$$Y_{FS} = \beta_0 + \beta_1 DL + \beta_2 OB + \beta_3 BL + \beta_4 CCL + \epsilon$$

Where:

Y_{FS} = Financial Sustainability

DL = Digital Lending

OB = Open Banking

BL = Block Chain-Based Lending

CCL = Credit Card Lending

β_0 = Constant

$\beta_1 - \beta_4$ = Coefficients of independent variables

ϵ = Error term

This analysis is important as it help identify how well financial lending innovation could predict financial sustainability decision of commercial banks in Kenya.

3.9.4 Equations for Mediating Effect

Mediation analysis examines whether the effect of an independent variable on a dependent variable is transmitted through a mediator variable. In this study, operational

efficiency is considered the mediator between financial lending innovations (independent variables) and financial sustainability (dependent variable).

Baron and Kenny's Mediation Steps

According to Baron and Kenny (1986), mediation involves a series of three regressions Equations. The mediator is considered to have a causal pathway from the independent variable to the dependent variable.

The steps to establish mediation include:

Step 1: Testing the Direct Effect of Independent Variables on the Dependent Variable, in this step, the direct effect of financial lending innovations (X) on financial Sustainability (Y) is tested without including the mediator.

Equation 1: Direct Effect

$$Y_{FS} = \beta_0 + \beta_1 X + \epsilon$$

Y_{FS} : Financial Sustainability (dependent variable)

1. X: Financial Lending Innovations (e.g., digital lending, open banking)
2. β_0 : Intercept
3. β_1 : Coefficient for the direct effect of X on Y
4. ϵ = Error term

Step 2: Testing the Effect of Independent Variables on the Mediator,

This step involves testing the effect of the independent variables (X) on the Mediator (M), operational efficiency.

Equation 2: Effect on the Mediator

$$Y_M = \alpha_0 + \alpha_1 X + \epsilon \quad \text{or Expand to } Y_M = \beta_0 + \beta_1 DL + \beta_2 OB + \beta_3 BL + \beta_4 CCL + \epsilon$$

M: Operational Efficiency (mediator)

X: Financial Lending Innovations

α_0 : Intercept

α_1 : Coefficient for the effect of X on M

v = Error term

Testing the Combined Effect of Independent Variables and Mediator on the Dependent Variable. This equation tests the effect of financial lending innovations (X) and Operational efficiency (M) on financial sustainability (Y). If the mediator is significant, the direct effect β_1 from Step 1 should diminish in significance or magnitude. Equation 3: Combined Effect Including the Mediator

$$Y_{FS} = \gamma_0 + \gamma_1 X + \gamma_2 M + \epsilon \quad \text{or} \quad (Y_{FS} = \beta_0 + \beta_1 DL + \beta_2 OB + \beta_3 BL + \beta_4 CCL + \beta_5 M + \epsilon)$$

Y_{FS} : Financial Sustainability

X: Financial Lending Innovations

M: Operational Efficiency

γ_0 : Intercept

γ_1 : Coefficient of the direct effect of X on Y, considering M

γ_2 : Coefficient of the mediator (M) on Y

ϵ : Error term

Interpreting the Mediation Effect

Total Effect (β_1): The total effect of financial lending innovations on financial sustainability without considering the mediator.

Indirect Effect ($\alpha_1 \times \gamma_2$): The pathway through which X affects Y via M. This is the product of the coefficient of X on M (α_1) and the coefficient of M on Y (γ_2).

Direct Effect (γ_1): The effect of X on Y when the mediator M is included in the model. This value indicates the remaining effect of the independent variable after accounting for the mediator.

Total Effect: The sum of the direct and indirect effects.

3.9.5 Diagnostic Test for mediation

Sobel Test for Mediation Significance, the Sobel test is used to determine if the indirect effect of the mediator is statistically significant.

Sobel Test Statistic:

$$Z = \frac{\alpha_1 \times \gamma_2}{\sqrt{(\gamma_2^2 \times S_{\alpha_1}^2 + \alpha_1^2 \times S_{\gamma_2}^2)}}$$

- α_1 : Coefficient of X on M
- γ_2 : Coefficient of M on Y

- $s\alpha_1$: Standard error of α_1
- $s\gamma_2$: Standard error of γ_2

Interpretation

The mediating role is confirmed when the indirect effect ($\alpha_1 \times \gamma_2$) is significant, indicating that part of the impact of lending innovations on financial sustainability is transmitted through changes in operational efficiency

3.9.6 Testing Assumptions and Measurement of Sobel Test Mediation Model

According to Baron and Kenny (1986). The researcher as per current thesis study measured the Sobel test assumptions, by considering to assess the mediation effect of operational efficiency on the relationship between financial lending innovations (digital lending, open banking innovation, block chain-based lending, and credit card lending) and financial sustainability of commercial banks in Kenya, this procedure is critical as it ensure that the data and model meet the necessary assumptions.

The following are assumptions on the model which help to give assurance on the validity of the Sobel test and the mediation analysis.

3.9.6.1. Linear Relationship Assumption

The research Assumption is that the relationships between the independent variable (IV-Financial Lending innovations), the mediator (M-Operational efficiency), and the dependent variable (DV-Financial sustainability) are assumed to be linear. The linearity assumption was assessed using two primary methods: scatterplots and correlation analysis.

Scatterplots were employed to visualize the relationships among key variables specifically, Digital Lending (independent variable), Operational Efficiency (mediator), and Financial Sustainability (dependent variable). The scatterplots illustrated that data points generally aligned along an upward-sloping pattern for each variable pairing, suggesting a positive linear trend. This visual evidence supports the assumption that the relationships among the variables are linear in nature, which is a prerequisite for valid linear regression modeling.

Correlation analysis further confirmed these visual findings. A correlation matrix was generated, showing statistically significant positive correlations between digital lending and operational efficiency, operational efficiency and financial sustainability, and digital lending and financial sustainability. While none of the coefficients were perfect (i.e., below 1.0), they were sufficiently strong and significant, reinforcing the presence of linear relationships. This outcome validates the linearity assumption required for subsequent mediation and regression analyses.

3.9.6.2 Independence of Errors Assumption

Durbin and Watson (1951) provides guidance on Assumption on independence of errors, therefore in this study the residuals (errors) from the regression models should be independent. This means that errors from one observation should not correlate with errors from other observations as per Sobel Test. The residuals (errors) assumption was evaluated using two standard techniques: the Durbin-Watson Test and residual plots.

The Durbin-Watson Test was employed to detect autocorrelation in the residuals of the regression models. A value close to 2 indicates that residuals are uncorrelated, which satisfies the assumption of independent errors. In this study, the Durbin-Watson statistic fell within the acceptable range of 1.5 to 2.5, suggesting no significant autocorrelation among residuals and confirming that the independence assumption was met.

Additionally, residual plots were generated by plotting residuals against the predicted values of the dependent variable. These plots were examined for randomness and absence of discernible patterns. The results indicated that residuals were randomly dispersed around the horizontal axis, further supporting the assumption of independence. Together, these findings confirm that the residuals meet the required assumptions for reliable regression analysis.

3.9.6.3 Normality of Errors Assumption

Shapiro and Wilk (1965) on Normality of Errors assumption is that the residuals in each regression model summed to follow a normal distribution. The normality of errors assumption was assessed using both visual and statistical methods to ensure that the residuals from the regression models were approximately normally distributed. First, a histogram of residuals was generated, revealing a roughly bell-shaped distribution, which visually supports the assumption of normality. This was further confirmed using a Q-Q (Quantile-Quantile) plot, where most of the residual points fell along the 45-degree reference line, indicating alignment with a theoretical normal distribution.

To validate these visual findings statistically, the Shapiro-Wilk Test was conducted. The resulting p-value was greater than 0.05, suggesting that the null hypothesis of normally distributed residuals could not be rejected. Together, these results confirmed that the residuals adhered to the assumption of normality, supporting the validity of regression-based inference in the study.

3.9.6.4. No Multicollinearity Assumption

O'Brien (2007), study on Sobel Test, No Multicollinearity assumption is that there should be no high correlation among the predictors (IV and M). Multicollinearity can inflate standard errors and undermine the significance of the mediation effect. The assumption of no multicollinearity was evaluated using two diagnostic techniques:

Firstly, the Variance Inflation Factor (VIF) was calculated for each independent variable, including Digital Lending, Blockchain-Based Lending, and Operational Efficiency. All variables recorded VIF values well below the critical threshold of 10, suggesting that no single predictor was excessively correlated with the others. This indicates that multicollinearity is not a concern and that each variable contributes uniquely to the model.

Secondly, a correlation matrix was examined to assess the bivariate relationships between the independent variables and the mediator. None of the correlation coefficients exceeded 0.80, further supporting the absence of multicollinearity. These results confirm that the predictors do not overlap substantially and that the regression coefficients can be interpreted reliably without distortion from multicollinearity effects.

3.9.6.5. Homoscedasticity or Homogeneity of Variance

Breusch and Pagan (1979) study on Sobel test of Homoscedasticity or Homogeneity of Variance assumption, the study indicate that the residuals of the regression models should have constant variance (homoscedasticity) at all levels of the independent variable. The assumption of homoscedasticity, or constant variance of residuals, was assessed using two key methods:

First, a residual-on-fitted plot was examined. This involved plotting the residuals against the fitted values from the regression model. In this plot, the residuals appeared randomly scattered around the horizontal axis with no clear pattern or funnel shape, indicating that the variance of the errors remained constant across all levels of the predicted values. This randomness suggested that the assumption of homoscedasticity was likely upheld.

Second, the Breusch-Pagan test was conducted to statistically test for heteroscedasticity. The test produced a p-value greater than 0.05, confirming that the null hypothesis of homoscedasticity could not be rejected. Therefore, the results provided statistical support that the residuals had equal variance, and the homoscedasticity assumption was met. These findings reinforced the reliability and validity of the regression estimates used in the study.

3.9.6.6. Causality and Directionality

Hayes, (2013) asserted that Sobel test assumes that the relationships between the IV Financial lending innovation, mediator (M) Operational Efficiency, and DV Financial

sustainability are causal. The IV must precede the mediator, and the mediator must precede the DV.

The assumption of causality and model direction in a mediation analysis is assessed by ensuring that the relationships among the variables are both theoretically and temporally grounded. First, the model must be supported by a robust theoretical framework that logically positions financial lending innovations—such as digital lending, open banking, blockchain-based lending, and credit card lending—as independent variables (IVs) that influence operational efficiency (the mediator). In this structure, operational efficiency is expected to function as a mechanism through which financial lending innovations impact the dependent variable, which is financial sustainability. This theoretical alignment is crucial for justifying the assumed causal pathways.

Secondly, the temporal order of variables must be clearly established to support causality. This means demonstrating that the implementation or existence of financial lending innovations occurs before improvements in operational efficiency, and that improvements in operational efficiency subsequently influence the financial sustainability of commercial banks. Ensuring this sequence strengthens the claim of directional causality in the proposed mediation model.

3.9.6.7. Sufficient Sample Size

MacKinnon, (2008), did a study on Sobel test of Sufficient Sample Size assumption is that a sufficiently large sample size is required to ensure reliable results in mediation analysis.

Model:

Power Analysis: Conduct a power analysis to determine the required sample size for detecting the mediation effect with a given effect size. A sample size of 100-200 is generally recommended for mediation analyses with Sobel tests.

Rule of Thumb: For the Sobel test, a larger sample size (e.g., 100 or more) is typically necessary for reliable results.

3.9.6.8. No Omitted Variables

Cole and Maxwell (2003) conducted a study on Sobel Test Assumption is that the mediation model should include all relevant variables. Therefore, omitting important variables could lead to biased estimates of the mediation effect. To ensure the accuracy and robustness of the regression analysis, two critical components of the model were evaluated: model specification and model fit.

First, model specification was addressed by incorporating all relevant variables identified through a thorough literature review and expert consultation. This ensured that no key predictors of operational efficiency or financial sustainability were omitted. Variables such as digital lending, open banking, blockchain-based lending, and credit card lending were included, as they have been widely supported in existing empirical research as significant factors influencing both the mediator and the dependent variable.

Second, the fit of the model was assessed using statistical indicators such as R^2 and Adjusted R^2 . The high R^2 value (e.g., 0.665) and closely aligned Adjusted R^2 (e.g., 0.652) confirmed that the model had strong explanatory power. These results met theoretical

expectations, indicating that the financial lending innovations significantly explain the variance in financial sustainability.

Table 3. 3: Summary of Sobel Test Assumptions and Methods

Assumption	Model Specification
Linear Relationship	Scatterplots, Correlation Matrix
Independence of Errors	Durbin-Watson Test, Residual Plots
Normality of Errors	Histogram, Q-Q Plot, Shapiro-Wilk Test
No Multicollinearity	Variance Inflation Factor (VIF), Correlation Matrix
Homogeneity of Variance	Residual vs. Fitted Plot, Breusch-Pagan Test
Causality and Directionality	Theoretical Framework, Temporal Order
Sufficient Sample Size	Power Analysis, Rule of Thumb for Sample Size
No Omitted Variables	Model Specification, Control Variables

Source: Researcher, (2024)

Measuring the assumptions and ensuring the requirements are fulfilled, the researcher can confidently use the Sobel test to assess the mediation effect of operational efficiency on the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

In conclusion the Significance of Sobel test measurement in the proposed study is that the approach ensures the reliability and validity of mediation analysis.

3.9.7 Testing Assumptions of the Classical Linear Regression Model (CLRM)

The Classical Linear Regression Model (CLRM) assumptions are critical to ensure the reliability and validity of regression results (Jeewantha, 2021). The study aims to test the following assumptions to ensure that the model's inferences about the relationship between financial lending innovations and financial sustainability, with operational efficiency as a mediator, are valid. Each assumption was tested using statistical methods and validated against established thresholds.

3.9.7.1 Linearity

The linearity assumption posits that there is a straight-line relationship between the independent variables (financial lending innovations) and the dependent variable (financial sustainability). This relationship must be accurately represented by a linear model for valid inferences (Hansen, 2019).

3.9.7.1.1 Scatter Plots

Scatter plots of the dependent variable against each independent variable visually assess the linearity of relationships. A clear linear pattern in scatter plots supports the assumption. Non-random patterns or curves suggest non-linearity (Roustaei, 2024).

3.9.7.1.2 Collinearity

These indicated the strength and direction of relationships between variables, supporting or questioning the assumption of linearity. Values close to -1 or 1 indicate strong linear relationships, while values near 0 suggest weak or no linearity (Kock, 2024).

3.9.7.2 Normality of Residuals

Normality assumes that the residuals (errors) of the regression model are normally distributed. Normality is essential for accurate hypothesis testing, particularly when constructing confidence intervals and p-values (Das and Imon, 2016). Shapiro-Wilk Test which is a formal statistical test that checks if the data distribution significantly deviates from normality. A p-value > 0.05 indicates that the residuals are normally distributed (Schmidt and Finan, 2018). Histogram which is a visual representation of the residuals' distribution. A bell-shaped histogram and residual points closely following the 45-degree line in the Q-Q plot validate normality (Cardoso, Berri, Borges and de Mattos (2025). Q-Q Plot (Quantile-Quantile Plot) which is a graphical method that compares the observed residuals to a normal distribution (Ben and Yohai, 2024).

3.9.7.3 Homoscedasticity

Homoscedasticity means that the residuals exhibit constant variance across all levels of the independent variables. It ensures that the regression model's estimates are unbiased and efficient (Ganiyat, 2024). Breusch-Pagan Test is a statistical test used to detect heteroscedasticity, where the null hypothesis states that variance is constant. A p-value > 0.05 indicates homoscedasticity (i.e., no significant difference in variances). Residual Plots are visual plots of residuals against predicted values help identify patterns that indicate non-constant variance (Ilori and Tanimowo, 2022). A random scatter of residuals without clear patterns supports homoscedasticity. Patterns such as funnels or clear clustering suggest heteroscedasticity (Abdul-Hameed and Matanmi, 2021).

3.9.7.4 Autocorrelation

Autocorrelation assumes that residuals are independent of each other, with no sequential correlation, especially relevant for time-series data. Autocorrelation can inflate type I errors, leading to incorrect inferences. Durbin-Watson Statistic test measures the presence of autocorrelation in the residuals of the regression model. Values between 1.5 and 2.5 suggest no significant autocorrelation. Values closer to 0 or 4 indicate positive or negative autocorrelation, respectively (Baltagi, Song, Jung and Koh, 2017).

3.9.7.5 Multicollinearity

Multicollinearity occurs when independent variables are highly correlated, undermining the stability of coefficient estimates. It makes it challenging to determine the unique effect of each predictor on the dependent variable (Oke, Akinkunmi and Etebefia, 2019).

3.9.7.5.1 Variance Inflation Factor (VIF)

This measures how much the variance of a regression coefficient is inflated due to multicollinearity. VIF values > 10 suggest severe multicollinearity, whereas values < 5 indicate low multicollinearity (Cheng, Sun, Yao, Xu and Cao, 2022).

3.9.7.5.2 Tolerance Value

The reciprocal of VIF; low tolerance values indicate multicollinearity. Values below 0.1 indicate problematic multicollinearity (Senaviratna and Cooray, 2019).

3.9.8 Qualitative Data Analysis

Elliott (2018) suggests that while analyzing qualitative data, it is important for the researcher to characterize the textual data in a manner that accurately represents the context and individuals who created the text, rather than relying on predetermined measurements and hypotheses. This point was further underscored by Edwards-Jones (2014). The qualitative data obtained from interviews was transcribed and categorized depending on thematic criteria. A comprehensive examination was conducted, and the results was given through detailed descriptions and direct citations.

In this study Qualitative data was used primarily to cross-reference the quantitative data provided by the respondents in order to enhance the accuracy and dependability of all variables related to the study.

3.9.9 Hypothesis Testing

Hypothesis testing is a methodical process used to determine whether the findings of a research study provide evidence in favor of a specific hypothesis or model that is applicable to a larger population. In hypothesis testing, the researcher utilized sample data to assess the impact of creative funding on financial sustainability. The five hypotheses was examined using the framework outlined in Table 3.4:

Table 3. 4 Hypothesis testing

	Hypothesis Statement	Model	Hypothesis Testing
I	“H ₀₁ : Digital lending innovations have no significant effect on financial sustainability among commercial banks in Kenya.	$FS = \beta_0 + \beta_1 DL_1 + \varepsilon$	H ₀₁ : $\beta = 0$ H _{0A} : $\beta \neq 0$ Reject H ₀₁ if $\beta \neq 0$ and P value ≤ 0.05 otherwise fail to reject H ₀₁ if $\beta = 0$ and P value $> \alpha$ $\alpha = 0.05$
ii	H ₀₂ : Open banking lending have no significant effect on financial sustainability among commercial banks in Kenya.	$FS = \beta_0 + \beta_2 OB_2 + \varepsilon$	H ₀₂ : $\beta = 0$ H _{0A2} : $\beta \neq 0$ Reject H ₀₁ if $\beta \neq 0$ and P value ≤ 0.05 otherwise fail to reject H ₀₂ if $\beta_2 = 0$ and P value $> \alpha$ $\alpha = 0.05$
iii	H ₀₃ : There is no significant effect of Block chain -based lending on financial sustainability among commercial banks in Kenya.	$FS = \beta_0 + \beta_3 BC_3 + \varepsilon$	H ₀₃ : $\beta = 0$ H _{0A3} : $\beta \neq 0$ Reject H ₀₃ if $\beta = 0$ and P value ≤ 0.05 otherwise fail to reject H ₀₃ if $\beta = 0$ and P Value $> \alpha$ $\alpha = 0.05$
Iv	H ₀₄ : There is no significant effect of Credit card lending on financial sustainability among commercial in Kenya.	$FS = \beta_0 + \beta_4 CC_4 + \varepsilon$	H ₀₄ : $\beta = 0$ H _{0A4} : $\beta \neq 0$ Reject H ₀₄ if $\beta = 0$ and P value ≤ 0.05 otherwise fail to reject H ₀₄ if $\beta = 0$ and P Value $> \alpha$ $\alpha = 0.05$
V	H ₀₅ : There is no mediating effect of Operational efficiency between financial lending and financial sustainability among commercial banks in Kenya	$Y = \beta_0 + \beta_1 DL_1 + \beta_2 OB_2 + \beta_3 BC_3 + \beta_4 CC_4 + \beta_5 M + \beta_6 DL_1 M + \beta_7 OB_2 M + \beta_8 BC_3 M + \beta_9 CC_4 M + \varepsilon$	Change in R ² to assess change in financial sustainability which is due to its relationship the interaction term If X*M has a p value ≤ 0.05 , then mediating effect is supported else is not supported $\beta_i > 0$ signifies positive mediation effect $\beta_i < 0$ signifies negative mediating effect”

Source: Researcher, (2024)

Table 3. 5 Summary Table for Regression Assumptions Tests

Assumption	Test	Threshold
Linearity	Scatter Plot, Correlation	Visual linearity, Correlation
Normality	Shapiro-Wilk Test, Q-Q Plot	p-value > 0.05, Normal Curve
Homoscedasticity	Breusch-Pagan Test	p-value > 0.05
No Autocorrelation	Durbin-Watson Statistic	1.5 - 2.5
No Multicollinearity	VIF, Tolerance	VIF < 10, Tolerance > 0.1

Source: Researcher, (2024)

3.10 Observation of Ethical Standards

The research adhered to established code of conduct, ethical norms and in compliance to legal Notice Data protection Act No.24 of 2012, guidelines and regulations. The standards stipulate ethical considerations that guaranteed professionalism in research process. The study research ensured confidentiality, protection of the dignity and privacy of participant. Consent was obtained from respondents and participants had an option to withdraw from data collection in event of breach of legal standards, information obtained is purely for intended purpose academic research work. There was no coercion or incentives used to persuade an individual to participate in research data collection.

Authority to conduct research permit was obtained from the National Research Fund for Authentication. Stringent measures were observed to prevent any form of scientific misconduct, plagiarism, fabrication, falsification, flawed data collection methods, and deceptive authorship. The research was conducted rigorously and impartially, adhering to objective scientific principles in its design, data interpretation, data analysis, and methodology. The ethical norms of the respondents in the study effort adhered to intellectual property rights regulations are honored by properly acknowledging the sources of information and their authors.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

This chapter contains the findings and debates derived from the overall aim of the study, which was to investigate the effect of financial lending innovations on the financial sustainability of commercial banks in Kenya. The data was gathered by the administration of questionnaires, thereafter subjected to both descriptive and inferential analysis, and ultimately presented in the form of tables.

4.2 Response Rate

The study involved the administration of a total of 111 questionnaires to bank personnel using purposive sampling. Out of the 111 questionnaires sent, 103 were successfully completed by the respondents, resulting in a response rate of 92%. The response rate of the distributed questionnaire was important for the study as it indicated data collected, the collected data from the returned questionnaire contributed to understanding the effect of financial lending innovation on financial sustainability within the context of commercial banks in Kenya.

Table 4. 1: Response Rate

		Frequency	Percentage
Valid	Returned	103	92
	Not Returned	8	8
	Total	111	100

Source: (Researcher, 2025)

The feedback responses provided a solid basis for drawing findings and formulating recommendations.

4.3 Reliability Tests

A sample of 13 respondents drawn from a mix of Tier 1, Tier 2, and Tier 3 bank branches in Kisumu City to capture diverse perspectives were given the questionnaires to ascertain whether the questionnaires were valid and reliable. The staff composition was of similar stature. The four independent variables (digital lending, open banking, block-chain based lending, credit card lending and operational efficiency) and the dependent variable (financial sustainability) were subjected to reliability test using SPSS and the results obtained were shown in table 4.2.

Table 4. 2: Reliability Test

Level of education	Frequency	Cronbach Alpha
Digital Lending	5	.797
open banking	5	.904
block chain-based lending	5	.701
Credit card lending	5	.851
Operational efficiency	5	.979
Financial Sustainability	5	.965

Source: Researcher’s Pilot survey, (2025)

Construct Validity using KMO and Barlett’s Test

Source: Researcher’s Pilot Survey (2025)

Table 4.2 above showed that the variables under study achieved the recommended Cronbach’s Alpha of greater than 0.7. This was important for internal consistency of

data (Mugenda and Mugenda, 2008). The results from the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity provide essential information about the suitability of the dataset for factor analysis. These preliminary tests help determine whether it is appropriate to proceed with factor extraction procedures.

KMO and Barlett's Test			
Variables	KMO Test	Barlett's Test of Sphericity	
		Chi-Square	Sig. P. Value
Financial sustainability	.779	78.608	.000
Digital lending innovation	.778	50.391	.000
Open banking services	.774	78.195	.000
Block chain-based lending	.701	22.800	.012
Credit card lending	.762	33.624	.000

Table 4.3 Validity Test

Source: Researcher, (2025)

The KMO value of 0.778 indicates that the sample is adequate for factor analysis. According to Kaiser (1974), KMO values range between 0 and 1, where values closer to 1 signify that patterns of correlations are relatively compact, thus indicating that factor analysis should yield distinct and reliable factors. A KMO value above 0.7 is considered "middling" to "good," suggesting that the data is suitable for structure detection through factor analysis.

The Bartlett's Test of Sphericity tests the null hypothesis that the correlation matrix is an identity matrix, which would imply that variables are unrelated and unsuitable for

structure detection. In this case, the test produced an approximate chi-square value of 50.391 with 10 degrees of freedom and a significance level (p-value) of 0.000. Since the p-value is less than 0.05, the null hypothesis is rejected. This implies that there are significant relationships among the variables, supporting the appropriateness of factor analysis.

In summary, the KMO value of 0.778 and the highly significant Bartlett's Test ($p < 0.001$) collectively confirm that the dataset is suitable for factor analysis. These results indicate that the variables share sufficient common variance and are likely to reveal meaningful underlying factors. Therefore, the researcher can proceed with confidence to extract factors and interpret them to understand the structure of the data.

4.3. Demographics of the respondents

The study sought to establish the demographic data of the respondents. These data included Gender, age, and highest level of education, work experience and the designation of the respondents. The inclusion of demographic data such as gender, age, highest level of education, work experience, and the designation of respondents is of critical importance. These variables help in understanding the context and background of the respondents, which in turn enhances the interpretability and applicability of the research findings.

4.3.1. Gender of the respondents

The study sought to establish the gender of the respondents. Gender is a vital demographic variable as it provides insights into the diversity and inclusivity of decision-making processes within commercial banks.

Understanding gender distribution among key respondents can help determine whether lending innovations are being perceived and implemented equitably across genders. Studies have shown that gender diversity in financial decision-making may influence the adoption and success of technological innovations due to different risk appetites, preferences, and leadership styles (Sahay et al., 2015). Therefore, analyzing gender helps in uncovering any gender-based disparities or advantages in the implementation of financial innovations. The analysis of the gender distribution of respondents is presented in Figure 4.1.

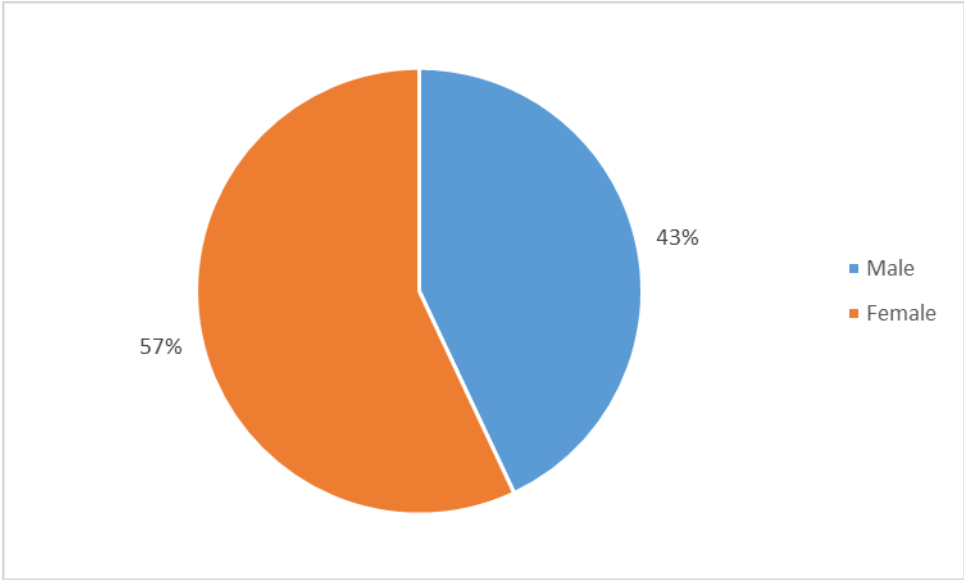


Figure 4. 1: Gender Distribution

The results in Figure 4.1 on the gender distribution of the respondents reveals a slightly higher representation of females compared to males. Specifically, out of the 103 total respondents, 59 (57%) were female and 44 (43%) were male.

The findings indicate a higher representation of female respondents compared to male respondents among the responses. This gender distribution may influence the perspectives and experiences shared in relation to digital lending, open banking, block chain-based lending, credit card lending and the financial sustainability of commercial banks in Kenya. Understanding this demographic was important for interpreting the results of the study by considering the digital lending, open banking, block chain-based lending, credit card lending both genders within the banks.

Gender inclusivity can influence perspectives on financial lending innovations, particularly in understanding how men and women differently perceive and interact with emerging financial technologies. According to Sahay et al. (2015), gender diversity in financial institutions is positively linked to innovation, decision-making, and institutional performance. Therefore, capturing gender demographics enriches the analysis by allowing for the assessment of gender-related trends in the adoption and impact of financial lending innovations on both financial sustainability and operational efficiency.

4.3.2. Level of Education of Respondents

The study sought to establish the level of education of the respondents. The highest level of education of the respondents provides insights into their capacity to understand,

interpret, and implement financial innovations. Education shapes analytical thinking, openness to change, and familiarity with emerging trends in the financial sector (Beck et al., 2011). Respondents with higher educational attainment may possess a deeper understanding of the strategic implications of financial innovations and are more likely to support practices that enhance operational efficiency and long-term financial sustainability. The analysis of highest level of education of the participant is presented in Figure 4.2.

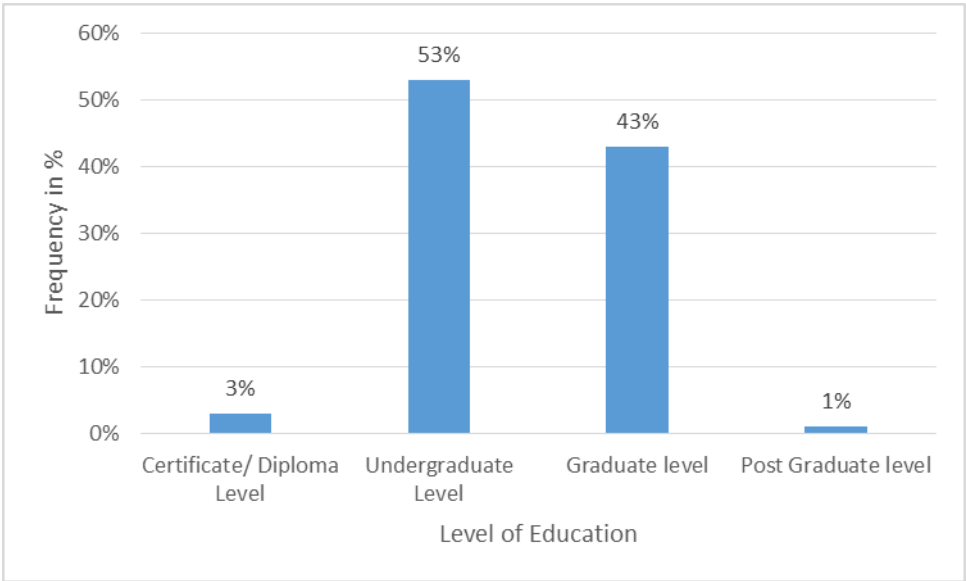


Figure 4. 2: Level of education of respondents

The findings indicate that 55 (53%) of the participants their highest level of education was undergraduate, 44 (43%) was graduate level, 3 (3%) certificate/diploma level and 1 (1%) post-graduate level.

The distribution of the respondents' level of education in this study provides significant insights into the findings regarding the effect of financial lending innovations on financial sustainability and operational efficiency among commercial banks in Kenya.

According to the data, a majority of respondents had attained an undergraduate level of education (53%), followed closely by those with graduate-level qualifications (43%). Only a small proportion of respondents held certificate/diploma (3%) or postgraduate (1%) qualifications.

This distribution suggests that the respondents were largely composed of highly educated individuals, which has implications for the interpretation of the study findings. Higher levels of education are often associated with greater awareness, understanding, and acceptance of financial innovations. According to Beck et al. (2011), individuals with university-level education tend to have better financial literacy, are more adept at embracing new technologies, and are more likely to support the implementation of systems that promote efficiency and sustainability in financial institutions.

The dominance of undergraduate and graduate degree holders in this study implies that the respondents were well-positioned to understand and evaluate the relevance, usability, and strategic value of financial lending innovations such as mobile lending platforms, credit scoring algorithms, and digital loan processing systems. As a result, their views on the impact of these innovations on financial sustainability and operational efficiency are likely to be well-informed and grounded in both academic and practical understanding of financial systems.

These findings are consistent with prior studies which have emphasized the importance of employee education in the successful adoption of financial innovations. For instance, Zhou (2012) found that the level of staff education directly influenced how financial

institutions in emerging markets implemented risk management tools and new lending technologies. Similarly, research by Siaw and Yu, (2020) in Ghana's banking sector indicated that institutions with more educated personnel were better able to integrate financial technologies that enhance service delivery and cost-efficiency.

Moreover, the relatively high representation of graduate-level respondents could explain a positive association if any between lending innovations and enhanced operational outcomes in the current study. This group likely brings critical thinking skills and advanced knowledge into operational decisions, which are essential for maximizing the benefits of financial innovations, such as cost reduction, improved turnaround time, and increased access to underserved markets.

On the other hand, the minimal presence of respondents with postgraduate qualifications (1%) could reflect the typical staffing structure within commercial banks in Kenya, where middle-level and operational staff are more directly involved with the day-to-day implementation of lending innovations than those in senior research or policy-making roles. As such, the results should be interpreted with an understanding that while strategic direction may come from higher management, the operational feedback in this study comes predominantly from well-educated but practically engaged personnel.

The high levels of education among respondents lend credibility to the findings on the influence of financial lending innovations. These results affirm prior research that links education to innovation adoption and operational efficiency (Venkatesh et al., 2003), and

suggest that the effectiveness of such innovations in enhancing sustainability and efficiency in Kenya’s commercial banks is, in part, a function of the educational competencies of the staff involved in their implementation.

4.3.3. Tier of the respondents’ bank

The study sought to establish the tier of the respondents’ bank. The banks were categorised into Tier 1 – Large established banks, Tier 2 – medium-sized banks and Tier 3 – Small banks. The results are summarised in Figure 4.3.

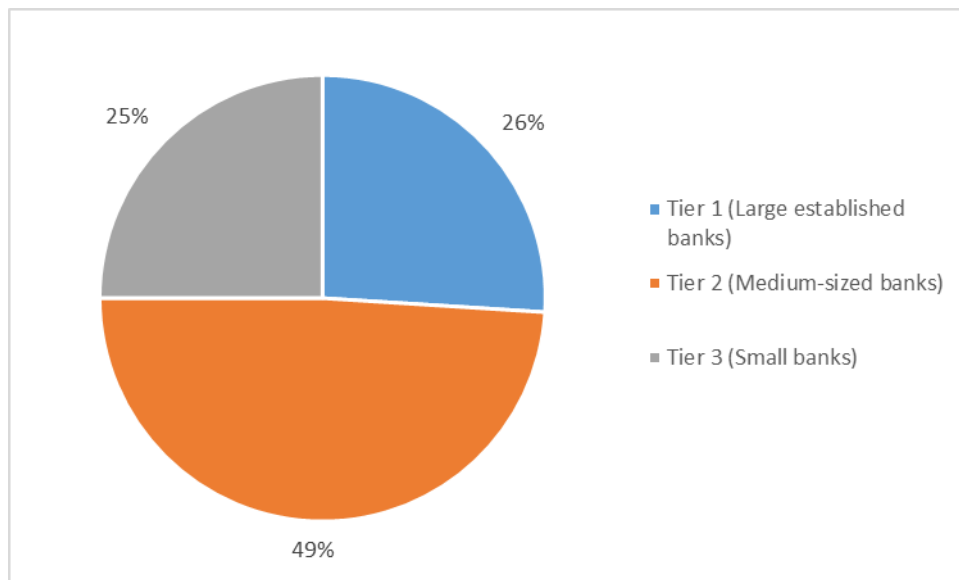


Figure 4. 3: The Category/Tier that Participants’ Banks

Figure 4.3 shows the distribution of banks across the tiers. The distribution of responses from the study Tier 1 (26%), Tier 2 (49%), and Tier 3 (25%) banks provides important insights into how financial lending innovations are perceived and implemented across different sizes of commercial banks in Kenya. This demographic breakdown aligns with Kenya's banking landscape, where Tier 2 and Tier 3 institutions represent the majority of

licensed banks, while Tier 1 banks, though few, hold a significant share of total assets and customer base (Central Bank of Kenya [CBK], 2023).

The relatively higher representation of Tier 2 banks (49%) suggests that medium-sized banks are highly engaged in or affected by financial lending innovations. These banks often operate under pressure to compete with Tier 1 banks while managing tighter resources than their larger counterparts. As a result, they may be more receptive to adopting financial technologies and innovative lending models such as digital credit scoring, mobile loan platforms, and automated risk assessment tools to improve operational efficiency and remain sustainable (Mburu and Kaijage, 2017). The high engagement from this tier indicates that lending innovations are not just tools for large banks but are crucial for the survival and competitiveness of medium-sized institutions.

Tier 1 banks, while only making up 26% of the sample, typically have the infrastructure, financial capacity, and human resources to lead in the adoption of complex lending technologies. Prior studies, such as those by Wainaina (2018), show that Tier 1 banks in Kenya have been pioneers in digital banking and financial innovation due to their ability to invest in robust IT systems and strategic partnerships. Although they represent a smaller portion of the study's respondents, their influence on sector-wide innovation trends and regulatory expectations remains significant.

The 25% representation of Tier 3 banks illustrates their increasing interest in financial lending innovations despite facing constraints such as limited capital, lower market penetration, and higher operational costs. Smaller banks may adopt simplified or outsourced technological solutions to enhance operational efficiency and financial

sustainability. According to Mwanja and Muganda (2019), Tier 3 banks often partner with fintech firms or adopt modular platforms to reduce the cost of innovation. Their inclusion in the study allows for a comprehensive understanding of the varied challenges and opportunities across the banking tiers.

In line with past research, these results affirm that the effect of financial lending innovations is not uniform across all commercial banks. For instance, Kamau and Oluoch (2020) found that while all banks benefit from innovations like mobile banking and digital credit scoring, Tier 2 and 3 banks reported a more significant improvement in operational efficiency due to reduced turnaround times and enhanced customer outreach. Tier 1 banks, on the other hand, noted improvements in risk management and service personalization due to more advanced data analytics capabilities.

Therefore, the interpretation of the study's results shows a balanced representation across Kenya's banking tiers and underscores the critical role of bank size in shaping the implementation and outcomes of lending innovations. The diversity in the sample allows the research findings to reflect the nuanced impact of financial innovations across institutions with varying capacities and strategic orientations.

4.3.4. Participants Work experience in Years

The study sought to establish the work experience of the respondents. Work experience reflects the practical exposure of respondents to banking operations and innovations. Those with extensive experience may have witnessed various shifts in lending practices and can offer more informed perspectives on the impact of such innovations. Experienced professionals are also likely to have developed strategic thinking skills and

risk evaluation capabilities that are crucial in assessing the sustainability of financial innovations (Berger and Udell, 2006). Hence, work experience is a critical factor in understanding how deeply rooted and widely accepted the innovations are within the banking institutions.

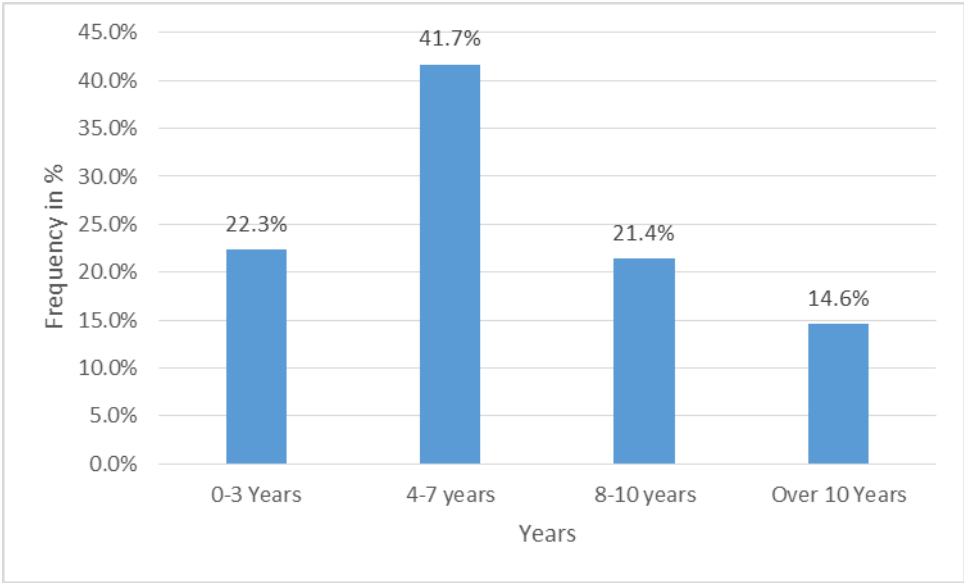


Figure 4. 4: Work experience of the respondents

Figure 4.4 shows the distribution shows that a significant majority 43 (41.7%) of respondents have between 4 to 10 years of work experience in the banking sector, while only 15 (14.6%) have over 10 years of experience, and 23 (22.3%) have less than 4 years.

This suggests that most respondents are mid-career professionals who have accumulated enough experience with greater understanding traditional banking culture, practices that are still adaptable to new technologies and innovations. According to Berger and Udell (2006), mid-career employees often possess a balanced perspective, having witnessed both conventional and modern financial systems, which makes them ideal candidates for assessing the effectiveness of financial lending innovations.

The relatively high percentage of respondents with 4–7 years of experience (41.7%) indicates that the study captures opinions from individuals likely involved in day-to-day operations, particularly in implementing or interacting with newer digital lending platforms. These individuals are positioned at a stage where they have sufficient exposure to evaluate changes brought by lending innovations but are not so entrenched in traditional systems that they resist change. This aligns with the findings of Venkatesh et al. (2003), who observed that openness to technology adoption tends to be higher among professionals who are not at the extreme ends of the experience spectrum.

On the other hand, the smaller proportion of respondents with over 10 years of experience (14.6%) may indicate that senior-level perspectives are less represented. While these individuals may provide strategic oversight on financial innovation policies, their smaller representation could reflect a gap in top-level managerial perspectives, which might be important for assessing long-term financial sustainability outcomes.

Moreover, the presence of respondents with less than 3 years of experience (22.3%) introduces views from newer employees who may be more tech-savvy and inclined to favor digital innovations. However, their limited experience might constrain their ability to assess the broader financial implications of such innovations on sustainability and operational efficiency. As noted by Beck et al. (2011), less experienced employees may overestimate short-term gains without fully appreciating long-term risks or resource implications.

In conclusion, the data reveals a robust representation from mid-level professionals, suggesting that the study’s findings are likely reflective of the practical realities on the ground regarding the implementation of financial lending innovations. However, the limited input from very senior staff might suggest the need for complementary qualitative approaches, such as key informant interviews, to capture high-level strategic insights. These findings are consistent with past research, which emphasizes the need for a mix of operational and strategic perspectives when evaluating financial innovations (Zhou, 2012).

4.3.5 Major Lending Segments of Participants Commercial Banks

The study sought to know the major lending segments of participants. The analysis of major lending segments of participants’ commercial banks in Kenya is presented in the Figure 4.5

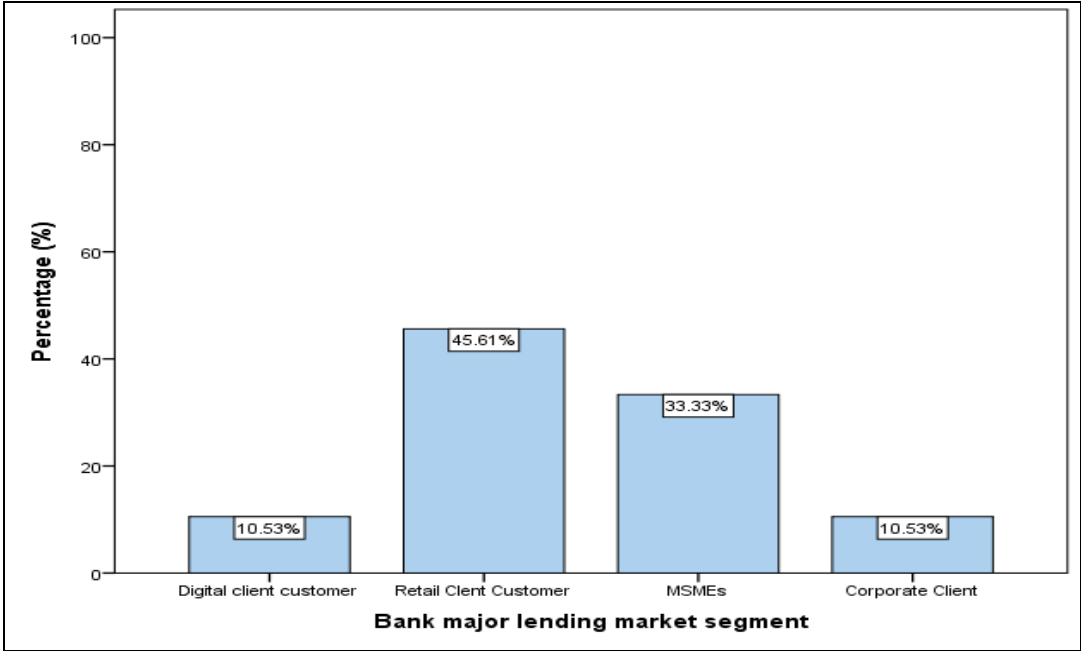


Figure 4. 5: Major Lending Market Segment

The major lending market segment is Retail Client Customer with 52 (45.61%) of participants, MSMEs 38 (33.33%) and the participants who indicated that the major lending market segments of their banks as digital client were equal to those who indicated corporate client at 12 (10.53%).

4.3.6 The Banks’ Lending Services and Practice

The participants were asked to indicate whether the bank lending services and practice are either; fully digital, manual or both manual and digital for applicable process in their assisted lending (branches). Their responses were analyzed and the results presented in the Figure 4.6.

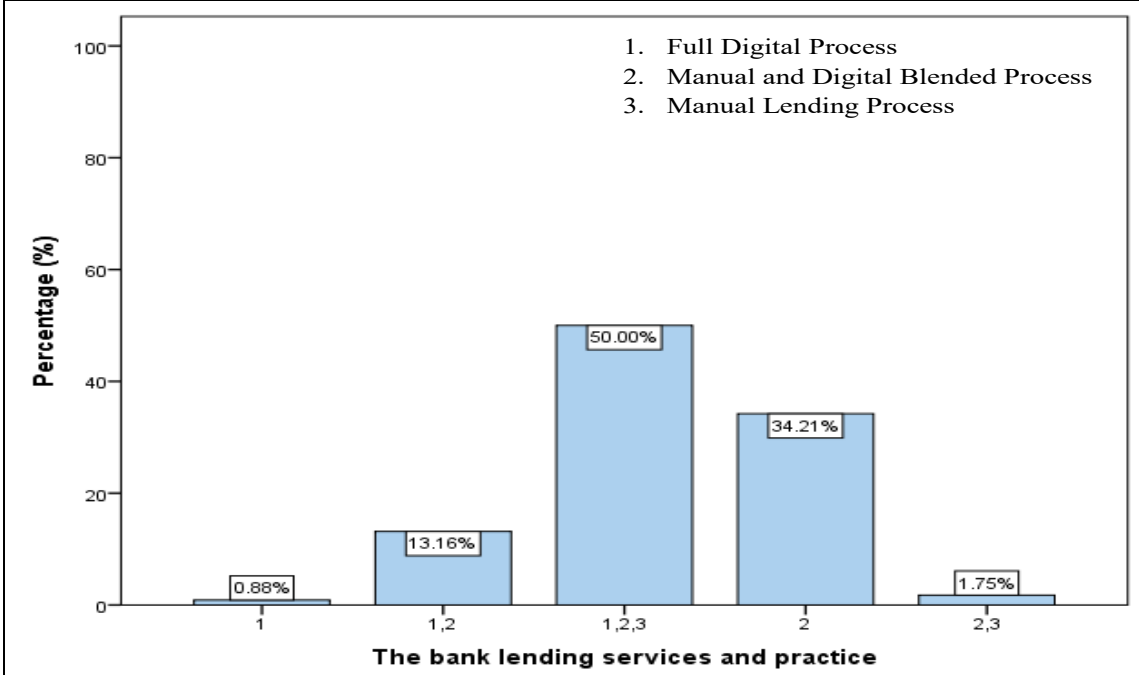


Figure 4. 6: The Bank Lending Services and Practice

A majority of participants 57 (50%) indicated that their banks’ lending services are both digital lending, manual and digital blended and manual lending processes, 39 (34.21%) indicated that their banks have manual and digital blended process and 15

(13.16%) indicated to practice both digital lending and manual and digital blended process.

4.4. Descriptive Statistics

4.4.1. Digital lending on the financial sustainability of commercial banks in Kenya

The study's first objective was to assess the effect of digital lending on financial sustainability of commercial banks in Kenya. The respondents were requested to rate statements related to digital lending to a scale of 1 – 5 where 1= Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree. The feedback was summarized in Table 4.4.

Table 4. 4: Digital Lending

Statements	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total		
	f	%	f	%	f	%	f	%	f	%	N	M	SD
Digital lending improves customer service Turnaround Time	0	0%	0	0%	20	19%	55	53%	28	27%	103	4	1
Digital lending increase satisfaction level, Customer base and Experience in the bank services	0	0%	0	0%	7	7%	48	47%	48	47%	103	4	1
Digital Lending increase market shares and products usage	0	0%	0	0%	14	14%	60	58%	29	28%	103	4	1
Stringent Bank regulation compliance prevent product launch	0	0%	2	2%	13	13%	35	34%	53	52%	103	4	1
Digital services may generate erroneous credit score	0	0%	13	13%	30	29%	39	38%	21	20%	103	4	1

Source: Researcher, (2025)

From Table 4.3 The statement "Digital lending improves customer service turnaround time" received the most favorable responses, with 53% of respondents agreeing and 27% strongly agreeing. This result suggests that digital lending is highly regarded for its ability to enhance operational efficiency, particularly in improving the speed of customer service. This aligns with previous studies by Ghosh and Ghosh (2014), who found that digital lending platforms significantly reduce processing times, which in turn leads to higher customer satisfaction and operational efficiency. The mean score of 4 and the low standard deviation (1) further indicate a strong consensus among respondents that digital lending positively impacts turnaround time.

Similarly, the statement "Digital lending increases satisfaction levels, customer base, and experience in the bank services" also garnered positive responses, with 47% agreeing and another 47% strongly agreeing. This demonstrates that digital lending is perceived as a driver of customer satisfaction and the expansion of the bank's customer base. This finding is consistent with the study by Ouma, (2017) who highlighted that digital lending services enhance customer experiences by offering convenience and accessibility, which ultimately leads to increased customer loyalty and market growth. The mean of 4 and the standard deviation of 1 further support the reliability of these perceptions among the respondents.

On the question of whether "Digital lending increases market share and product usage," 58% of respondents agreed, and 28% strongly agreed, indicating that digital lending is seen as a key factor in expanding the bank's reach and usage of its products. This is in line with the research by Waweru and Kasamani, (2020) who noted that digital innovations in

financial services often result in increased market penetration by providing access to a larger and more diverse group of customers, especially those in remote areas. The mean score of 4 and standard deviation of 1 suggest a general consensus on the positive impact of digital lending on market share.

The results regarding "Stringent bank regulation compliance preventing product launches" revealed that a majority of respondents (52%) strongly agreed and 34% agreed with the statement. This suggests that regulatory challenges are a significant barrier to the successful implementation and expansion of digital lending products. This finding is consistent with global studies, such as those by Di Castri, (2016) which found that regulatory constraints often hinder the pace at which banks can launch new financial innovations. These barriers can impact financial sustainability by delaying the adoption of potentially profitable innovations. The mean of 4 and standard deviation of 1 indicate strong agreement among respondents on this issue.

Finally, when asked about the statement "Digital services may generate erroneous credit scores," 38% agreed, 20% strongly agreed, and 29% were neutral. This highlights concerns about the accuracy and reliability of digital lending platforms, with a portion of respondents indicating that errors in credit scoring could negatively affect the bank's operations and its customers' financial well-being. The mean score of 4 and the low standard deviation indicate that, while the concern is significant, it does not dominate the overall perceptions of digital lending. Previous studies, such as those by Jagtiani and Lemieux, (2018) found that errors in credit scoring systems are a known challenge in

digital lending, which can undermine trust and the long-term sustainability of such services.

In conclusion, the study results suggest that while digital lending is viewed positively for improving customer service, increasing market share, and customer satisfaction, regulatory challenges and concerns about the accuracy of credit scores remain significant barriers. These factors must be addressed to ensure the long-term financial sustainability and operational efficiency of digital lending services within Kenya's commercial banking sector.

4.4.2. Open banking innovations practices on the financial sustainability of commercial banks

The study's second objective was to assess the effect of open banking innovations on financial sustainability of commercial banks in Kenya. The respondents were requested to rate statements related to digital lending to a scale of 1 – 5 where 1= Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree. The results are summarized in Table 4.5.

Table 4. 5 Open banking innovations

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total		SD	
	f	%	f	%	f	%	f	%	f	%	N	M		
Training and job security of Staff has increased confidence level, moral, the face to face disruption has widened open banking services to customers	0	0%	0	0%	23	22%	57	55%	23	22%	103	4	1	
Customers have embraced open banking services in the bank boosting customer Experience and loyalty.	0	0%	0	0%	14	14%	51	50%	38	37%	103	4	1	
Open banking have reduced bank operational costs and increased value chain and products usage	0	0%	0	0%	16	16%	46	45%	41	40%	103	4	1	
Stringent Bank regulation compliance prevents risks and protects consumers using opened banking services.	0	0%	0	0%	17	17%	38	37%	48	47%	103	4	1	
Customer complains on erroneous credit score are resolved faster using open bank policy and decentralized services	0	0%	4	4%	25	24%	41	40%	33	32%	103	4	1	

Source: Researcher, (2025)

Table 4.4 shows the results of the study on the effect of financial lending innovations, particularly open banking, on financial sustainability and operational efficiency in commercial banks in Kenya. The responses indicate a generally positive perception towards the impact of open banking on key factors such as customer experience, operational efficiency, and bank sustainability.

For the statement *“Training and job security of staff has increased confidence level, morale, and the face-to-face disruption has widened open banking services to customers,”* the majority of respondents (55%) agreed with this statement, suggesting that staff training and job security play a crucial role in increasing confidence and morale, which are essential in embracing and implementing open banking services. This aligns with past studies, such as those by Dastgir et al. (2020), which highlight that well-trained staff are more likely to confidently engage with customers and embrace new technologies, leading to higher customer satisfaction and improved service delivery, contributing to the sustainability of financial institutions.

The statement *“Customers have embraced open banking services in the bank boosting customer experience and loyalty”* also received significant agreement, with 50% of respondents agreeing and 37% strongly agreeing. This is consistent with research by Fung et al. (2017), which found that open banking innovations significantly enhance customer experience by offering personalized services, greater transparency, and improved financial accessibility, which in turn increases customer loyalty. The positive response here suggests that open banking not only enhances customer service but also plays a pivotal role in strengthening the bank’s financial sustainability through increased customer retention.

Regarding *“Open banking has reduced bank operational costs and increased value chain and product usage,”* the responses also indicate strong agreement (45% agreed and 40% strongly agreed). This is in line with studies such as those by Milne and Parboteeah (2018), who found that open banking leads to reduced operational costs through automation, improved efficiency, and the utilization of data-driven insights to optimize

service offerings. These improvements in operational efficiency directly impact the financial sustainability of banks by reducing overhead costs and enhancing revenue generation through diversified products and services.

The results for the statement *“Stringent bank regulation compliance prevents risks and protects consumers using open banking services”* reveal a strong positive outlook, with 47% of respondents strongly agreeing. This is consistent with previous studies like those by Bech and Garratt (2017), who emphasized that robust regulatory frameworks are essential in mitigating risks associated with open banking and ensuring consumer protection, which in turn builds trust and contributes to the overall sustainability of financial institutions.

Finally, *“Customer complaints on erroneous credit scores are resolved faster using open bank policy and decentralized services”* received substantial agreement (40% agreed and 32% strongly agreed). This suggests that open banking's decentralized approach leads to faster resolution of issues, a finding supported by research such as that of Rajan (2019), who observed that decentralized banking systems help to address customer grievances more efficiently by enabling quicker access to data and streamlining communication channels. By resolving customer complaints swiftly, banks can improve customer satisfaction, which is critical for maintaining financial stability and operational efficiency.

Overall, the study's findings corroborate previous research that indicates open banking enhances the financial sustainability of banks by improving operational efficiency, reducing costs, and fostering better customer relationships. These innovations, when

implemented with strong regulatory frameworks and adequate staff training, can lead to greater financial stability and long-term sustainability for commercial banks in Kenya.

4.4.3. Block Chain Based Lending on the financial sustainability of commercial banks

The study's third objective was to assess the effect of block chain-based lending on financial sustainability of commercial banks in Kenya. The respondents were requested to rate statements related to digital lending to a scale of 1 – 5 where 1= Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree. The results are summarized in Table 4.6.

Table 4. 6 Block Chain Based Lending

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total N	Mean	SD
	f	%	f	%	f	%	f	%	f	%			
The block chain protects the bank against digital risks, hence stability in operations.	0	0%	2	2%	45	44%	38	37%	18	18%	103	4	1
The Central Bank of Kenya regulates licensing, approval to implement the global market block chain lending system, has the process is been finalized by your bank.	0	0%	2	2%	13	13%	42	41%	46	45%	103	4	1
Block chain technology if utilized in the lending operations and can contribute to financial sustainability of your bank	1	1%	6	6%	37	36%	36	35%	23	22%	103	4	1
Use of block-chain technology support system security due to data mutability, accountability and transparency in capital allocation and sustainability of bank services.	0	0%	4	4%	26	25%	50	49%	23	22%	103	4	1
The block chain lending services and digital currency impact lending, as standardized digital services, currency, enhances customer experience (%).	1	1%	3	3%	26	25%	44	43%	29	28%	103	4	1

Source: Researcher, (2025)

The results in Table 4.5 on the effect of block chain-based lending on financial sustainability in Kenyan commercial banks highlight several key insights into how block chain is perceived in terms of its ability to protect against digital risks, enhance financial sustainability, and improve operational efficiency. These insights, when compared with past studies, contribute to a broader understanding of block chain's role in the financial sector.

In response to the statement "The block chain protects the bank against digital risks, hence stability in operations," 44% of respondents were neutral, and 37% agreed, with 18% strongly agreeing. This suggests that while a majority of respondents (55%) have a favorable view of block chain's potential to safeguard against digital risks, a significant proportion remains uncertain or only moderately convinced. Similar findings were reported by Moser and Gupta (2020), who observed that while block chain could reduce cybersecurity risks through its decentralized nature, banks still grapple with understanding its full potential in mitigating all digital threats. The overall mean score of 4 and a standard deviation of 1 indicate a general agreement but with some variance in opinion, reflecting the mixed implementation of block chain in Kenyan banks.

Regarding the Central Bank of Kenya's regulation on block chain licensing, 41% of respondents agreed and 45% strongly agreed that their bank is in the final stages of implementing the block chain lending system. This is consistent with studies by TechnoVista (2021), which found that regulatory frameworks, such as those in Kenya, have been crucial in enabling financial institutions to adopt block chain technology. The clear indication that a majority of the banks are working on or have finalized their

adoption of block chain technology for lending suggests that regulatory clarity is driving innovation in this area. The mean score of 4 and the low standard deviation indicate strong consensus on the role of the Central Bank's regulation in supporting block chain integration.

On the statement "Block chain technology, if utilized in lending operations, can contribute to the financial sustainability of your bank," 35% agreed and 22% strongly agreed, indicating a generally positive outlook towards block chain's role in enhancing financial sustainability. This finding resonates with past research by Allen et al. (2019), who found that block chain enhances transparency and efficiency in financial transactions, thus contributing to long-term sustainability. The mean score of 4 and the standard deviation of 1 further reflect the consensus on block chain's potential contribution, although there remains a notable proportion of respondents (36%) who were neutral, indicating that some banks may still be uncertain about the technology's long-term benefits.

The question regarding the security of block chain systems and its impact on data mutability, accountability, and transparency in capital allocation saw 49% agree and 22% strongly agree, suggesting that block chain is largely recognized for enhancing security and operational transparency. This is consistent with the findings of Gai et al. (2018), who highlighted block chain's capacity to improve trust, reduce fraud, and provide accountability in financial systems. The high percentage of agreement, with a

mean of 4, underscores the confidence in blockchain's ability to improve the security and sustainability of bank services.

Lastly, the statement on the impact of block chain on lending services and customer experience, with 43% agreeing and 28% strongly agreeing, reflects a positive outlook on blockchain's ability to standardize digital services and enhance customer experience. These findings align with research by Puschmann (2017), who found that block chain's role in digital currency and standardized lending services could significantly improve customer satisfaction by ensuring faster and more reliable transactions.

Overall, the study indicates a strong agreement among respondents regarding the positive impact of block chain on operational efficiency and financial sustainability, with some respondents still unsure or neutral about its full potential. This highlights the need for continued education and demonstration of block chain's benefits in the Kenyan banking sector to increase adoption and trust.

4.4.4. Credit Card Lending on financial sustainability of commercial banks

The study's third objective was to assess the effect of credit card lending on financial sustainability of commercial banks in Kenya. The respondents were requested to rate statements related to digital lending to a scale of 1 – 5 where 1= Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree. The results are summarized in Table 4.7.

Table 4. 7 Credit card lending

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	f	%	F	%	f	%	f	%	f	%
Key innovation in credit card lending improved overall loan portfolio growth sustainability of your bank.	67	65%	30	29%	3	3%	2	2%	1	1%
The Bank's interest rates and loan structures conditions on credit cards encourage responsible borrowing, which contribute to financial sustainability of bank.	30	29%	67	65%	4	4%	2	2%	0	0%
There is notable improvement in customer experience after your bank introduced flexible repayment arrangement to customers with lower interest rates conditions depending on usage of card.	47	46%	48	47%	6	6%	1	1%	1	1%
Flexible repayment models as innovations has improved customer base growth, customer retention and long-term profitability of bank	29	28%	67	65%	4	4%	1	1%	2	2%
Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and long-term sustainability	46	45%	53	51%	1	1%	2	2%	1	1%

The results of the study on the effect of credit card lending on the financial sustainability and operational efficiency of commercial banks in Kenya reveal a mixed response, offering valuable insights into how these lending innovations contribute to the sustainability of banks.

The statement "Key innovation in credit card lending improved overall loan portfolio growth sustainability of your bank" saw a strong majority (65%) of respondents strongly disagreeing with the assertion, while 29% disagreed, and only 3% remained neutral. This suggests that most respondents do not perceive credit card innovations as significantly contributing to the long-term sustainability of the loan portfolio. This aligns with past studies, such as those by Ahmed et al. (2013), which found that while credit card lending can increase loan volumes, it does not always lead to improved sustainability if credit risk management practices are not sufficiently robust. Therefore, these results may indicate concerns regarding the risks associated with credit card lending that could overshadow its positive effects on financial sustainability.

In contrast, when asked about the role of the bank's interest rates and loan structures in encouraging responsible borrowing, 65% of respondents disagreed with the statement, indicating skepticism about whether these factors foster financial sustainability. This is consistent with the findings of Liu (2014), who highlighted that high-interest rates on credit cards often lead to defaults, undermining the potential for long-term financial sustainability. However, a significant 29% of respondents strongly disagreed, which suggests that credit conditions may not be sufficiently incentivizing responsible borrowing behavior, a factor crucial for maintaining financial stability in the long run.

On the other hand, the introduction of flexible repayment arrangements was generally seen positively, with 46% of respondents agreeing that such innovations have improved customer experience. This result corroborates findings from Zhang et al. (2017), who reported that flexibility in repayment models can enhance customer satisfaction and retention, which in turn could contribute to increased customer base growth. Moreover, 47% of respondents disagreed, and 6% remained neutral, reflecting some ambivalence about the full effectiveness of these innovations in improving the customer experience.

The statement on flexible repayment models improving customer base growth and long-term profitability had a negative response, with 65% of respondents disagreeing. This suggests that while flexible repayment options may be seen as helpful for customer retention, they do not necessarily correlate with sustained profitability or growth, a result that aligns with studies like those of Shaban (2016), who found that such models could reduce short-term profits by lowering interest income from customers who repay their loans earlier.

Finally, regulatory changes surrounding consumer protection, transparency, and interest rate caps were seen as influential on credit card lending strategies, with 45% agreeing that these changes impacted their bank's long-term sustainability. This result is in line with global trends, where studies have shown that regulatory frameworks designed to protect consumers and ensure transparency can enhance financial sustainability by preventing predatory lending practices (Chen and Chen, 2015).

In conclusion, while the study suggests that credit card lending innovations have had a mixed impact on the financial sustainability of commercial banks in Kenya, it highlights the need for improved credit risk management and more effective lending strategies to fully realize the potential of these innovations. The results reflect both the promise and limitations of credit card lending as a financial tool, suggesting that commercial banks may need to adopt a more nuanced approach to credit card innovations in order to foster long-term sustainability.

4.4.5. Mediating role of operational efficiency in the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

The study's last objective was to assess mediating role of operational efficiency in the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya. The respondents were requested to rate statements related to digital lending to a scale of 1 – 5 where 1= Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree.

The results are summarized in Table 4.8

Table 4. 8: Mediating role of operational efficiency in the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total N	Mean	SD
	F	%	f	%	f	%	F	%	f	f%			
Digitization of the branches networks impacted efficiency levels in the bank.	2	2%	1	1%	16	16%	52	50%	32	31%	103	4	1
Enterprise resource planning systems in my banks are stable, up-to-date, and reliable and support bank lending services	3	3%	1	1%	9	9%	55	53%	35	34%	103	4	1
The Bank's operational shift toward digital banking has affected the skills required from bank employee; the skill gap may affect efficiency and work performance.	1	1%	1	1%	27	26%	50	49%	24	23%	103	4	1
The bank uses negotiated approach and legal process to enforce loan collection of defaulted loans and Non-Performing loans.	2	2%	2	2%	18	17%	53	51%	28	27%	103	4	1
Staff Technological skill and experience has broadened bank product outreach to wider market	2	2%	0	0%	18	17%	50	49%	33	32%	103	4	1
The bank takes appropriate approaches to manage inherent internal system challenges and risks affecting lending innovations process.	3	3%	0	0%	17	17%	53	51%	30	29%	103	4	1
Technology has played a role in improving the operational efficiency of your bank	2	2%	0	0%	8	8%	49	48%	44	43%	103	4	1

Source: Researcher, (2025)

The data shows that a significant proportion of respondents, 50% strongly agreeing and 31% agreeing, believe that the digitization of branch networks positively impacted efficiency levels in the bank. This highlights the critical role of credit cards as part of the broader digital banking transformation, which has been shown to enhance customer access and streamline operations, thereby contributing to financial sustainability (Akpan and Atser, 2015). As credit cards are integral to digital banking services, their widespread adoption can be seen as a driving force behind improved operational processes.

Additionally, the results related to the stability, up-to-date nature, and reliability of enterprise resource planning (ERP) systems, with 53% agreeing and 34% strongly agreeing, suggest that the use of technology, such as credit card processing systems, supports the effectiveness of bank lending services. Stable and reliable systems facilitate smoother transactions and improve the accuracy of loan disbursement and repayment, which directly influences the bank's financial sustainability (Sahay et al., 2015). The fact that a large portion of respondents recognize the importance of these systems further confirms that credit cards and digital lending tools play an essential role in improving the financial outcomes of banks.

The impact of the bank's operational shift towards digital banking on employees' skill sets was also a key finding, with 49% agreeing and 23% strongly agreeing that the skill gap might affect efficiency and work performance. While this might suggest challenges in terms of human capital, it also reflects a broader trend where credit card systems, as part of the digital banking ecosystem, require banks to invest in upskilling their workforce to handle new technologies effectively (Venkatesh et al., 2003). Therefore, the challenge of

closing the skill gap can be seen as a necessary step in maximizing the efficiency and sustainability benefits offered by financial innovations, including credit cards.

The data further supports the idea that the management of loan collections and non-performing loans (NPLs) through negotiated approaches and legal processes plays a significant role in the operational efficiency of the bank, with 51% agreeing and 27% strongly agreeing with this statement. The role of credit cards in improving loan collection is evident, as automated systems reduce the time and resources required to track and manage loan repayments, leading to better control over NPLs and, consequently, better financial sustainability (Berger and Udell, 2006).

Finally, the bank's approach to managing internal system challenges and risks associated with lending innovations is crucial, as reflected by 51% of respondents agreeing and 29% strongly agreeing that the bank takes appropriate approaches to mitigate these issues. The integration of credit cards into the lending process can be seen as a risk management tool, helping banks to diversify their offerings and reduce reliance on traditional forms of credit, thereby enhancing their operational resilience (Zhou, 2012).

In conclusion, the results emphasize the importance of digital lending innovations, such as credit cards, in enhancing the operational efficiency and financial sustainability of commercial banks. As these technologies contribute to better system stability, improved loan collection processes, and enhanced market outreach, they provide a strong foundation for sustainable growth and performance in the competitive banking sector.

4.4.6. Financial Sustainability

The study's sought to assess statements related to financial sustainability. The respondents were requested to rate statements related to digital lending to a scale of 1 – 5 where 1= Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree.

The results are summarized in Table 4.9.

Table 4. 9: Financial Sustainability

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	f	%	f	%	f	%	f	%	f	%
The introduction of lending innovations improved your bank target lending segment in the market and business Growth.	2	2%	1	1%	18	17%	55	53%	27	26%
The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs.	1	1%	3	3%	12	12%	47	46%	40	39%
The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contribute to the financial sustainability and profitability of your bank in Kenya	3	3%	0	0%	15	15%	41	40%	44	43%
Your bank has employed customer focused strategies to manage customer relation, experience and retention to which reduces bad credit, default and minimizes level of Non-performing loans?	2	2%	1	1%	18	17%	55	53%	27	26%
Your bank ensures financial sustainability by diversification of revenue streams product lines, Digital banking and prudent lending for long term stability	3	3%	0	0%	12	12%	49	48%	39	38%

Source: Researcher (2025)

In examining the effect of financial lending innovations on financial sustainability among commercial banks in Kenya, the results from the survey responses highlight significant trends that suggest a positive impact of lending innovations on financial sustainability. The responses for each of the statements reflect a consensus toward the affirmative, indicating that banks perceive lending innovations as key drivers for their financial sustainability.

The statement "The introduction of lending innovations improved your bank target lending segment in the market and business growth" had a high agreement rate, with 53% of respondents agreeing and 26% strongly agreeing. This is consistent with studies such as those by Beck et al. (2011), who found that financial innovations often enhance banks' ability to reach under-served market segments, thereby improving business growth. The high percentage of respondents affirming this statement suggests that lending innovations, particularly those targeting new customer segments, contribute to enhanced market presence and business growth, which are essential components of financial sustainability.

Similarly, the statement "The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs" saw 46% agreeing and 39% strongly agreeing. This indicates that the adoption of lending innovations has a tangible effect on performance and income growth. This finding aligns with prior research by Berger and Udell (2006), who concluded that financial innovations contribute to improved bank performance by enhancing operational efficiencies and reducing costs, which are critical for sustaining profitability and long-term financial stability. The reduction in operational costs due to automation and digitalization, part of lending innovations, can directly boost income growth.

The response to "The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contributes to the financial sustainability and profitability of your bank in Kenya" saw 43% of respondents strongly agreeing and 40% agreeing. This is a strong endorsement of the idea that regulatory frameworks and digital transformation are integral to financial sustainability. This finding is supported by research from Sahay et al. (2015), who emphasized that strong risk management frameworks and compliance with regulatory standards are foundational for the long-term viability of financial institutions. Furthermore, the increased adoption of digital tools enhances not only compliance but also operational efficiency, which contributes to profitability and sustainability.

The statement regarding customer-focused strategies for managing relations, experience, and retention, which reduce bad credit and non-performing loans, had 53% agreeing and 26% strongly agreeing. This finding suggests that customer retention strategies, underpinned by innovations in lending, play a critical role in mitigating risks associated with non-performing loans (NPLs). Studies such as those by Zhou (2012) also point out that effective customer relationship management is essential in maintaining loan repayment rates, which is directly tied to a bank's financial sustainability.

Finally, "Your bank ensures financial sustainability by diversification of revenue streams, product lines, digital banking, and prudent lending for long-term stability" also received strong support, with 48% agreeing and 38% strongly agreeing. This shows that banks are diversifying their offerings and integrating digital banking solutions to safeguard against economic volatility and ensure long-term stability. Beck et al. (2011) highlighted the

importance of diversifying revenue streams and digital banking in enhancing financial resilience, which is further affirmed by these findings.

In triangulation with past studies, these results align well with the broader body of research suggesting that financial lending innovations ranging from digital transformation and customer relationship management to prudent lending and diversification are crucial for improving the financial sustainability of banks. By reducing costs, expanding market segments, and enhancing customer retention, these innovations contribute to both short-term profitability and long-term stability.

4.5 Diagnostics Tests of Variables

4.5.1 Normality Test

Table 4. 10: Normality Test

Variables	Kolmogorov-Smirnov ^a			Shapiro-Wilk			
	Statistic	df	Sig.	Statistic	df	P values	Sig.
Digital Lending	.206	103	.200*	.919	103	.347	.206
Open Banking	.188	103	.200*	.911	103	.251	.188
Block Chain based lending	.273	103	.200*	.852	103	.201	.273
Credit card lending	.250	103	.150	.932	103	.534	.250
Operational efficiency	.206	103	.200*	.884	103	.172	.206

Source: Researcher (2025)

*This is a lower bound of the true significance. a. Lilliefors Significance Correction

The normality of the data was assessed using both the Kolmogorov-Smirnov and Shapiro-Wilk tests. The significance values (p-values) for all variables under the

Shapiro-Wilk test were greater than 0.05, indicating that the data were not significantly different from a normal distribution. Specifically, Digital Lending ($p = .347$), Open Banking ($p = .251$), Blockchain-based Lending ($p = .201$), Credit Card Lending ($p = .534$), and Operational Efficiency ($p = .172$) all exhibited p -values above the 0.05 threshold. These results suggest that the assumption of normality is met for all variables, allowing for the use of parametric statistical methods in subsequent analyses. Notably, while the Kolmogorov-Smirnov test also reported values suggesting normality ($p \geq .150$), the Shapiro-Wilk test is considered more reliable for small sample sizes ($n < 50$) and was therefore used as the primary reference for interpretation.

4.5.2. Homoscedasticity Test

When using a linear regression model, the homoscedasticity assumption must hold true. Homoscedasticity refers to a circumstance in which the error term is identical for all values of the independent variables. In order to achieve consistent responses and high-quality findings, this study controlled for error variation over the range of independent variables (homoscedasticity). Nevertheless, heteroscedasticity occurs when the magnitude of the error component changes across the values of the independent variables. The degree to which a breach of the homoscedasticity assumption influences the outcomes is proportional to the degree of heteroscedasticity (Gelfand, 2015).

According to Cohen, West, and Aiken (2013), heteroscedasticity occurs when responses are not normally distributed or when the variance of the error term is not constant. To test for heteroscedasticity in the independent variables, we utilized a scatter plot of residuals

and a graphical approach. The predicted scores should have identical residuals and residual variance (homoscedasticity) and the scatter plot should resemble a rectangle with scores clustered near the zero line (Sounders, et al., 2012; Gibson, 2017). As a result, the score distribution was fully random, and any systematic pattern or grouping of the data is a violation.

Table 4. 11: Breusch-Pagan Test for Heteroskedasticity

Chi-Square	Df	Sig.
1.435	1	.231

a. Dependent variable: Financial Sustainability
 b. Tests the null hypothesis that the variance of the errors does not depend on the values of the independent variables.
 c. Predicted values from design: Intercept + Operational Efficiency + Digital lending + Open Banking + Block Chain + Credit Card

Source: Researcher (2025)

Since the p-value (.231) is greater than 0.05, we fail to reject the null hypothesis of the Breusch-Pagan test. This indicates that there is no significant evidence of heteroskedasticity in the model. Therefore, the assumption of homoskedasticity holds, and the regression model's residuals have constant variance across all levels of the predictors.

4.5.3 Multi-collinearity

Multi-collinearity arises when two or more independent variables in a regression model exhibit a high degree of correlation, potentially distorting the reliability of the coefficient estimates. In this study, the Pearson Product-Moment Correlation coefficient (r) was used to examine the relationships among the independent variables. This coefficient ranges from -1 to +1, where -1 indicates a perfect negative correlation and +1 denotes a perfect

positive correlation. Correlation values approaching either extreme may signal the presence of multicollinearity.

As a general guideline, multicollinearity may be suspected when the correlation between two predictor variables exceeds +0.9 or falls below -0.9. To explore these relationships, a correlation analysis was performed on all independent variables. The resulting correlation coefficients are presented in the table 4.12.

The study conducted diagnostic test to confirm that the data set was reliable for regression analysis. This was done in line with the model assumption that must be met before conducting the analysis. Collinearity diagnostic test sought to reveal if multi-collinearity existed among the predictor variables. Multi-collinearity occurs when independent variables in a regression model are correlated. Correlation is a problem because independent variables should be independent otherwise if the degree of correlation between the variables is high it can cause problem (Brooks, 2008). Multi-collinearity test was done and results are as indicated in Table 4.12.

Table 4. 12: Collinearity Diagnostics

Independent Variable	Tolerance	VIF
Digital lending	.308	3.243
Open Banking	.329	3.036
Block Chain	.513	1.950
Credit Card	.419	2.386
Operational Efficiency	.360	2.774

Source: Researcher (2025)

VIF values are supposed to be more than 1 but less than 10. From Table 4.11, VIF for all the variables were within the range hence there was absence of multi-collinearity among the independent variables. This implies that the variation contributed by each of the

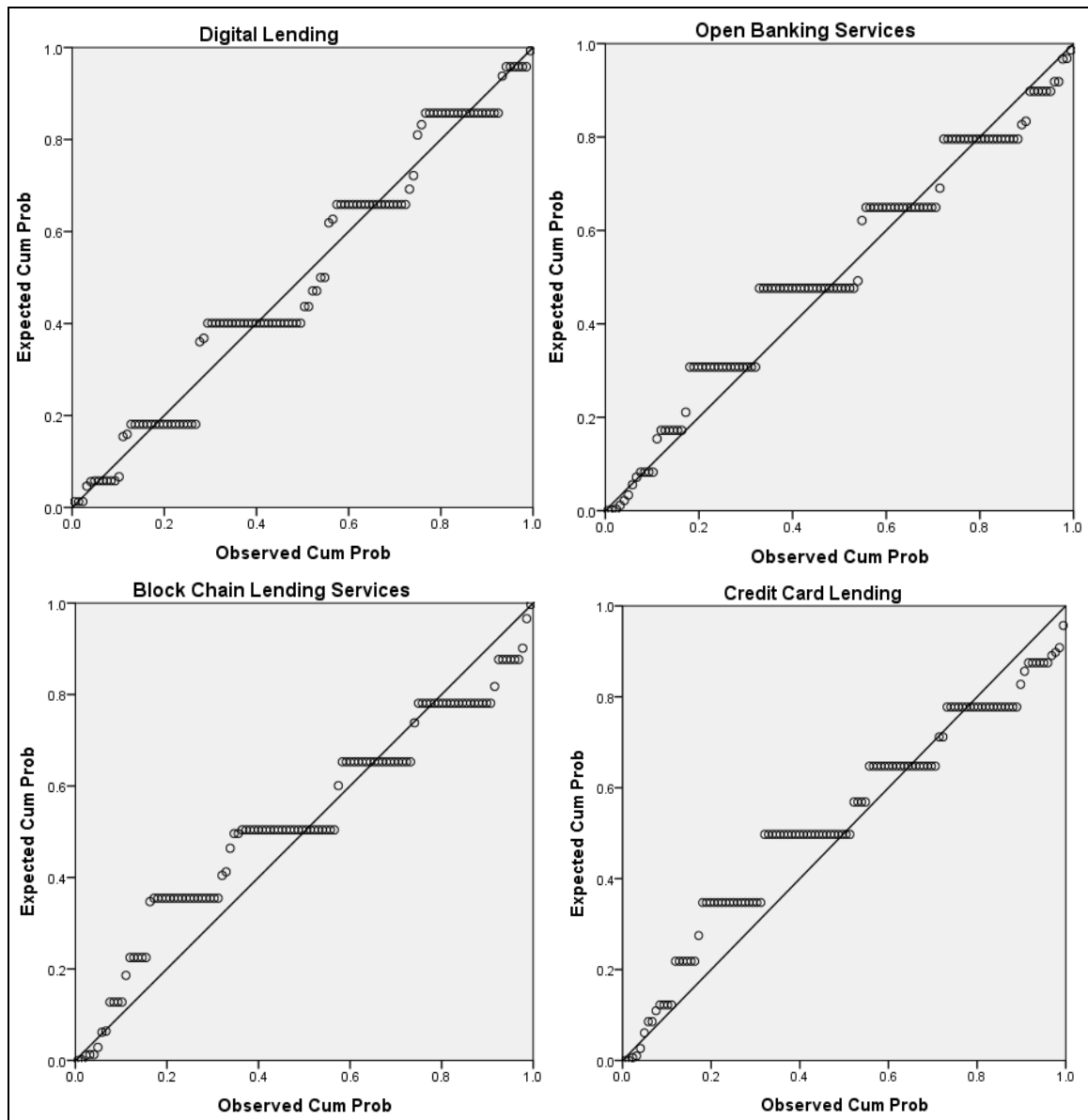
independent factors was significant and all the factors should be included in the prediction model.

4.5.4. Linearity Test

The purpose of Linearity test is to ascertain the presence of a relationship between independent and dependent variables.

The test for linearity between the dependent and independent variables was done using Normal P-P plots as shown in Figure 4.8.

Figure 4. 8: Normal P-P Plot of Regression Standardized Residual



Source: Researcher, (2025)

The points generally fall along the 45-degree reference line (diagonal line from bottom-left to top-right) indicating that the regression standardized residuals follow a normal distribution reasonably well. A linear pattern in a normal P-P plot suggests that the assumption of normality of residuals in your regression model is not violated. Minor deviations observed in the plots between the dependent variable and independent variables;

Block Chain Services and Credit Card Lending are normal, especially at the extremes, but the plots do not show any severe departures from linearity. The plot shows linearity, supporting the assumption of normally distributed residuals for the regression model with the dependent variable Financial Sustainability.

4.6 Correlation Analysis

Table 4. 13: Correlation Analysis

		Open Banking	Digital lending	Block Chain	Credit Card	Operational Efficiency	Financial Sustainability
Open Banking	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	103					
Digital lending	Pearson Correlation	.760**	1				
	Sig. (2-tailed)	.000					
	N	103	103				
Block Chain	Pearson Correlation	.616**	.527**	1			
	Sig. (2-tailed)	.000	.000				
	N	103	103	103			
Credit Card	Pearson Correlation	.665**	.727**	.537**	1		
	Sig. (2-tailed)	.000	.000	.000			
	N	103	103	103	103		
Operational Efficiency	Pearson Correlation	.690**	.707**	.657**	.669**	1	
	Sig. (2-tailed)	.000	.000	.000	.000		
	N	103	103	103	103	103	
Financial Sustainability	Pearson Correlation	.731**	.734**	.600**	.714**	.755**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	103	103	103	103	103	103

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Researcher (2025)

The correlation analysis reveals a strong positive relationship between digital lending and the financial sustainability of commercial banks, with a Pearson correlation coefficient of 0.734 and a significance value of 0.000. This indicates that the relationship is statistically significant at the 0.01 level. The strength of the correlation suggests that as

banks adopt and expand digital lending platforms, their financial sustainability tends to improve. This could be attributed to the operational cost savings, increased outreach to previously underserved markets, and improved credit assessment capabilities that digital lending technologies provide. The results are supported by Gozman et al. (2018), Jagtiani and Lemieux (2019), and Ndirangu and Wanjiru (2023) who showed that digital lending improves operational efficiency, liquidity, and access to credit. Similarly, Mugendi and Nyambura (2020) and Karani and Njoroge (2022) highlighted enhanced credit access and cost efficiency. However, concerns raised by Muturi (2021), Ochieng and Amaya (2020), and Mutisya and Ochieng (2021) on credit risks and regulatory gaps caution against overreliance, urging robust risk management.

The findings indicate a strong and statistically significant correlation between open banking and financial sustainability, as evidenced by a Pearson correlation coefficient of 0.731 and a p-value of 0.000. This suggests that open banking initiatives, which promote data sharing, customer-centric services, and the integration of third-party financial service providers, are positively associated with enhanced financial outcomes for banks. Open banking may enable better risk management, personalized product offerings, and improved customer engagement, all of which contribute to increased profitability and financial resilience in the highly competitive Kenyan banking sector.

This is well supported by empirical studies such as those by Farrell and Wheatley (2019) and Drasch et al. (2018), who found that open banking improves customer acquisition efficiency and enhances profitability. Njoroge and Kamau (2020), as well as Omondi and Ngetich (2021), echo similar outcomes within Kenya, highlighting that streamlined services and integration of fintech solutions enhance bank resilience and competitiveness.

Mutua and Kihoro (2022) also noted improved credit access and financial inclusion through open banking. However, challenges highlighted by Sia et al. (2020) and Maas et al. (2021), including high compliance costs, security risks, and integration difficulties, temper the optimism. Despite these risks, the strong correlation in the findings affirms open banking's substantial potential to support sustainable banking operations in Kenya.

Block chain-based lending also demonstrates a positive and significant relationship with financial sustainability, though the strength of the association is relatively moderate compared to other lending innovations. The Pearson correlation coefficient is 0.600, with a significance level of 0.000, confirming statistical relevance. This indicates that as block chain technologies are incorporated into lending processes, banks may experience improved transparency, security, and fraud prevention, all of which are conducive to stable financial performance.

These results reflect findings from several studies. Lee and Shin (2018) and Chen et al. (2019) affirm that block chain enhances operational efficiency and reduces fraud, supporting the idea that it promotes stable financial performance. Karanja and Kimani (2021) and Ochieng and Waweru (2021) also emphasize transparency, trust, and improved risk assessment through decentralized ledgers. However, the moderate strength of the relationship aligns with cautionary findings from Treleaven et al. (2021), Mugenda and Mwachiro (2020), and Mwangi and Nyambura (2021), who point to high integration costs, infrastructure gaps, and regulatory uncertainties. Muthomi and Okello (2021) further stress that the lack of a clear regulatory framework may inhibit the technology's full impact in Kenya.

The correlation between credit card lending and financial sustainability is found to be strong and statistically significant, with a Pearson correlation coefficient of 0.714 and a p-value of 0.000. This result implies that credit card products contribute meaningfully to the financial health of commercial banks. The positive relationship could be driven by the consistent fee and interest income generated from credit card usage, as well as the ability to capture and retain high-value customers through tailored credit offerings.

The results are supported by several empirical studies. Gomber et al. (2018) and Chakravorti and To, (2019) affirmed that credit cards enhance profitability through high-margin interest income and increased customer loyalty. Studies by Mwangi (2018), Ochieng and Amaya (2020), and Kinyua (2019) further support the positive impact of credit cards on firm-level liquidity, operational efficiency, and long-term sustainability for SMEs in Kenya. However, cautionary findings from Agarwal et al. (2020) and Karani and Njoroge (2022) noted risks linked to default rates, high-interest burdens, and limited financial literacy, which can disrupt bank stability if not properly managed. Ngugi and Kamau (2021) highlighted that while short-term gains exist, long-term sustainability depends on broader financing strategies. Thus, while the correlation is strong, its impact remains contingent on effective credit risk controls, customer education, and conducive regulatory frameworks.

Operational efficiency is shown to have strong and statistically significant correlations both with financial sustainability ($r = 0.755$, $p = 0.000$) and with each of the lending innovations: digital lending ($r = 0.707$), open banking ($r = 0.690$), blockchain-based lending ($r = 0.657$), and credit card lending ($r = 0.669$). These results suggest that operational efficiency may serve as a mediating factor in the relationship between

financial lending innovations and financial sustainability. In other words, innovations in lending are likely to improve operational processes such as faster service delivery, reduced transaction costs, and improved risk control which in turn contribute to better financial outcomes.

4.7 Hypothesis testing

4.7.1. The Effect of Digital Lending on the Financial Sustainability of Commercial Banks in Kenya.

The first objective of the study was to examine the effect of digital lending on the financial sustainability of commercial banks in Kenya. The study set out a hypothesis where a linear regression was utilized to ascertain. The research employed, the following hypothesis was tested at an alpha level of 0.05 using Regression analysis:

H1: Digital lending has a significant positive effect on the financial sustainability of commercial banks in Kenya.

The independent variable is digital lending while the dependent variable financial sustainability of Commercial Banks in Kenya. The regression analysis for the effect of digital lending on the financial sustainability of commercial banks in Kenya is presented in Table 4.14 and Table 4.15.

Table 4. 14: The Effect of Digital Lending on Financial Sustainability of Commercial Banks in Kenya

Table 4. 15: Model Summary of Digital Lending on Financial Sustainability of Commercial Banks in Kenya

Model	R	Adjusted R Square	Std. Error Change Statistics			F Change	df1	df2	Sig. F Change
			R Square	Estimate	R Square Change				
1	.734 ^a	.538	.534	.50615	.538	117.750	1	101	.000

a. Predictors: (Constant), Digital lending

Source: Researcher, (2025)

The Model Summary table indicates the strength of the relationship between digital lending and financial sustainability. The R-value of 0.734 signifies a strong positive correlation, while the R Square value of 0.538 means that 53.8% of the variance in financial sustainability is explained by digital lending. The Adjusted R Square (0.534) confirms the model's reliability after adjusting for the number of predictors. The standard error of 0.50615 suggests a moderate prediction error. The F Change statistic of 117.750 with a significance value of 0.000 confirms the model is statistically significant, validating digital lending as a strong predictor.

Table 4. 16: Analysis of Variance of Digital Lending on Financial Sustainability of Commercial Banks in Kenya

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30.166	1	30.166	117.750	.000 ^b
	Residual	25.875	101	.256		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability
b. Predictors: (Constant), Digital lending

Source: Researcher, (2025)

With 1 degree of freedom for regression and 101 for residuals, the model yields an F-statistic of 117.750. The associated p-value (0.000) indicates that the model is highly statistically significant. This confirms that digital lending contributes meaningfully to explaining differences in financial sustainability among commercial banks in Kenya, supporting the hypothesis of a strong linear relationship.

Table 4. 17: Coefficients of Digital Lending on Financial Sustainability of Commercial Banks in Kenya

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.666	.331		2.012	.047
	Digital_ending	.889	.082	.734	10.851	.000

a. Dependent Variable: Financial Sustainability

Source: Researcher, (2025)

The following regression equation was formulated: $Y=0.666+0.889DL_1$

The Coefficients table provides insights into the effect size and significance of digital lending on financial sustainability. The unstandardized coefficient (B = 0.89) implies that a one-unit increase in digital lending leads to a 0.968-unit increase in financial sustainability, holding other factors constant. The standardized Beta value of 0.734 reflects a strong positive effect. The t-statistic of 10.851 and p-value of 0.000 confirm the effect is statistically significant. The constant term (B = 0.666, p = 0.047) is significant, indicating that digital lending is the primary driver. Overall, the results affirm a significant and positive influence.

This outcome aligns with empirical studies such as those by Jagtiani and Lemieux (2019), who found that fintech lending improves financial resilience through faster loan processing, reduced default rates, and enhanced customer satisfaction. Similarly, Gozman, Liebenau, and Mangan (2018) observed that digital lending helps banks reduce operational costs and reach underserved markets, thereby promoting financial stability. Ndirangu and Wanjiru (2023) further emphasized that digital lending enhances liquidity and operational flexibility, especially for SMEs, supporting sustained business operations.

Karani and Njoroge (2022) also support these findings, noting that digital credit systems empower firms that lack traditional collateral to secure financing and grow their investment portfolios. Additionally, Mago and Chitokwindo (2021) highlighted digital lending's role in diversifying income streams and reducing dependence on conventional banking, provided the regulatory environment and user literacy are supportive.

However, some scholars present a more cautious view. Wang, He, and Kim (2020) warned of risks such as cybersecurity threats and algorithmic bias, which could undermine the sustainability benefits of digital lending. Muturi (2021) argued that over-reliance on digital credit may expose firms to credit risk and debt traps, particularly due to hidden charges and short-term borrowing patterns. Similarly, Ochieng and Amaya (2020) noted that high interest rates and lack of regulation could lead to capital flight and financial instability, while Mutisya and Ochieng (2021) pointed to digital exclusion and profitability concerns for platforms due to customer acquisition costs and defaults.

4.7.2. Effect of open banking on the financial sustainability of commercial banks in Kenya.

The second objective of the study was to assess the effect of open banking on the financial sustainability of commercial banks in Kenya. The study set out a hypothesis where a linear regression was utilized to ascertain if open banking has a substantial effect on the financial sustainability of commercial banks in Kenya. The research employed the following, hypothesis was tested at an alpha level of 0.05 using Regression analysis: which was examined at a significance level of 0.05.

H₂: Open banking has a significant positive effect on the financial sustainability of commercial banks in Kenya.

In this case the independent variable is open banking and the dependent is financial sustainability of commercial banks in Kenya. The regression analysis for the effect of open banking on Financial Sustainability of Commercial Banks in Kenya is presented in Table 4.18.

Table 4. 18: Model Summary of Open Banking effect on Financial Sustainability of Commercial Banks in Kenya

Model	R	Adjusted Square	Std. Error Change Statistics				Sig. F Change		
			R Square	of the Estimate	R Square Change	F Change		df1	df2
1	.731 ^a	.535	.530	.50813	.535	116.048	1	101	.000

a. Predictors: (Constant), Open banking

Source: Researcher, (2025)

The Model Summary shows a strong positive correlation (R = 0.731) between open banking and financial sustainability. The R Square value of 0.535 indicates that 53.5% of

the variation in financial sustainability is explained by open banking. The Adjusted R Square (0.530) confirms model validity after adjusting for predictors. The standard error (0.50813) suggests moderate dispersion from the regression line. An F-change value of 116.048, with significance (p-value) of 0.000, indicates that the model is statistically significant at the 0.05 level. This supports the hypothesis that open banking has a meaningful effect on financial sustainability.

Table 4. 19: Analysis of Variance of Open Banking effect on Financial Sustainability of Commercial Banks in Kenya

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	29.963	1	29.963	116.048	.000 ^b
	Residual	26.078	101	.258		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability
b. Predictors: (Constant), Open banking

Source: Researcher (2025)

The ANOVA table evaluates the overall statistical significance of the regression model. The regression sum of squares (29.963) is substantially higher than the residual sum of squares (26.078), suggesting that a significant portion of the variation in financial sustainability is explained by open banking. The model has 1 degree of freedom for regression and 101 for residuals, resulting in an F-value of 116.048. The associated p-value of 0.000 is well below the 0.05 threshold, confirming that the model is highly significant. Thus, open banking is a statistically significant predictor of financial sustainability in Kenyan commercial banks.

Table 4. 20: Coefficients of Open Banking effect on Financial Sustainability of Commercial Banks in Kenya

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.087	.387		.226	.822
	Open Banking	1.012	.094	.731	10.773	.000

a. Dependent Variable: Financial Sustainability

Source: Researcher (2025)

The following regression equation was formulated: $Y=0.087+1.012OB_2$

The Coefficients table shows the magnitude and direction of the effect of open banking on financial sustainability. The unstandardized coefficient (B = 1.012) suggests that a one-unit increase in open banking corresponds to a 1.012-unit increase in financial sustainability. The standardized Beta coefficient is 0.731, indicating a strong positive effect. The t-value of 10.773 and the p-value of 0.000 show that the relationship is statistically significant. The constant term (B = 0.087, p = 0.822) is not significant, meaning open banking is the key influencing factor. These results support Hypothesis H2, affirming a significant positive effect.

These results are well supported by various empirical studies. Farrell and Wheatley (2019) and Drasch et al. (2018) confirm that open banking enhances customer experiences, lowers customer acquisition costs, and enables banks to offer tailored products that improve retention and profitability. Similarly, Mutua and Kihoro (2022), as well as Wambua and Ndegwa (2021), note that open banking fosters financial inclusion, thereby improving business funding and supporting sustainable growth. Njoroge and Kamau (2020) also report that open banking improves operational efficiency and expands market reach, thus strengthening the financial stability of banks.

However, several studies highlight challenges that may undermine the positive impact of open banking. Sia et al. (2020) raise concerns about data privacy, increased regulatory costs, and cybersecurity threats, which could limit financial gains. Maas et al. (2021) argue that banks struggling with third-party integration may incur higher costs, negating expected benefits. Similarly, Ochieng, Aduda, and Omwoyo (2023) caution that regulatory and legal constraints may hinder smooth service delivery. While Omondi and Ngetich (2021) and Kamau and Nyambura (2022) acknowledge government support as critical, they also stress that the regulatory environment must evolve to keep pace with innovation. Therefore, though open banking holds strong promise, successful outcomes depend heavily on strategic integration, technological readiness, and supportive policy frameworks.

4.7.3. The Effect of Block Chain-based Lending on the Financial Sustainability of Commercial Banks in Kenya

The third objective of the study was to analyze the effect of block chain-based lending on the financial sustainability of commercial banks in Kenya. In determining whether block chain-based lending had effect, the following null hypothesis was tested at an alpha level of 0.05 using Regression analysis: The study set out a hypothesis where a linear regression was utilized to ascertain.

***HO₃:** Block chain-based lending has a significant positive effect on the financial sustainability of commercial banks in Kenya.*

The independent variable is block-based chain and the dependent variable is financial sustainability of commercial banks in Kenya. The regression analysis for the effect of

block chain-based lending on Financial Sustainability of Commercial Banks in Kenya is presented in Table 4.21 and 4.22.

Table 4. 21: The Effect of Block Chain-Based Lending on Financial Sustainability of Commercial Banks in Kenya

Table 4. 22: Model Summary of Block Chain based lending effect on Financial Sustainability of Commercial Banks in Kenya

Model	R	Adjusted Square	Std. Error of the Estimate	Change Statistics			Sig. F Change		
				R Square	F Change	df1		df2	
1	.600 ^a	.359	.353	.59616	.359	56.683	1	101	.000

a. Predictors: (Constant), Block chain-based lending

Source: Researcher, (2025)

The model summary reveals a moderately strong relationship between blockchain-based lending and the financial sustainability of commercial banks in Kenya, with a correlation coefficient (R) of 0.600. The R Square value of 0.359 indicates that 35.9% of the variation in financial sustainability can be explained by blockchain-based lending. The adjusted R Square of 0.353 further validates the model's reliability. The F Change value of 56.683 and a significance level (Sig. F Change) of 0.000 indicate the model is statistically significant at the 0.05 level, affirming that the inclusion of blockchain-based lending meaningfully improves the model's explanatory power.

Table 4. 23: Analysis of Variance of Block Chain based lending effect on Financial Sustainability of Commercial Banks in Kenya

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	20.145	1	20.145	56.683	.000 ^b
	Residual	35.896	101	.355		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability
b. Predictors: (Constant), Block chain-based lending

Source: Researcher, (2025)

The ANOVA table supports the statistical significance of the regression model. The regression sum of squares is 20.145, while the residual sum is 35.896, giving a total sum of squares of 56.041. The computed F-statistic of 56.683, which is considerably high, indicates that the model significantly explains the variability in financial sustainability. The associated significance level (p-value) of 0.000 is well below the 0.05 threshold, confirming that block chain-based lending contributes significantly to the prediction of financial sustainability. These results validate that the overall regression model is a good fit and not a result of random chance.

Table 4. 24 Coefficients of Block Chain based lending effect on Financial Sustainability of Commercial Banks in Kenya

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
1(Constant)	1.831	.323		5.678	.000
Block chain-based lending	.626	.083	.600	7.529	.000

a. Dependent Variable: Financial Sustainability

Source: Researcher, (2025)

The following regression equation was formulated: $Y=1.831+0.626X_3$

The coefficients table demonstrates a statistically significant and positive relationship between block chain-based lending and financial sustainability. The unstandardized coefficient (B) for block chain-based lending is 0.626, indicating that a one-unit increase in block chain-based lending corresponds to a 0.626 increase in financial sustainability. The standardized Beta coefficient of 0.600 highlights a strong influence of the independent variable. A t-value of 7.529 and a significance value of 0.000 confirm the robustness and significance of the predictor. The constant term (1.831) suggests the baseline level of financial sustainability when block chain-based lending is absent. Overall, block chain-based lending is a key driver of sustainability.

These results align with studies by Lee and Shin (2018), Chen et al. (2019), and Karanja and Kimani (2021), who found that blockchain enhances operational efficiency, transparency, fraud prevention, and cost reduction—factors that promote financial resilience. Ochieng and Waweru (2021) and Kariuki and Mwangi (2020) support this view, emphasizing improved credit risk management and the use of smart contracts to minimize lending risks and processing delays. Similarly, Wambui and Kamau (2020) noted that blockchain can widen access to underserved customers, which supports long-term sustainability through financial inclusion.

However, the findings are not without caveats. Mugenda and Mwachiro (2020), Treleaven et al. (2021) and Mwangi and Nyambura (2021) point to barriers such as high infrastructure costs, limited rural internet access, and technological complexities that may hinder blockchain's effectiveness. Additionally, studies by Muthomi and Okello

(2021) and Mougayar (2020) underscore the regulatory uncertainty in Kenya, which poses significant risks to blockchain integration and long-term viability. Thus, while the results confirm blockchain's potential as a sustainability driver, they also highlight contextual limitations that must be addressed to maximize its impact in Kenyan banking.

4.7.4. The Effect of Credit Card Lending on the Financial Sustainability of

Commercial Banks in Kenya

In determining whether credit card lending had effect on the financial sustainability of commercial banks in Kenya, the fourth objective of the study which was to evaluate the effect of variable on dependent variable. The study set out a null hypothesis tested at an alpha level of 0.05 using Regression analysis, hypothesis where a linear regression was utilized to ascertain.

H₄: Credit card lending has a significant positive effect on the financial sustainability of commercial banks in Kenya.

The independent variable is credit card lending and the dependent variable is financial sustainability of commercial banks in Kenya. The regression analysis for the effect of credit card lending on Financial Sustainability of Commercial Banks in Kenya is presented in Table 4.25 and Table 4.26.

Table 4. 25: The Effect of Credit Card Lending on Financial Sustainability of Commercial Banks in Kenya

Table 4. 26: Model Summary of Credit Card lending effect on Financial Sustainability of Commercial Banks in Kenya

Model	R	R Square	Adjusted R Square	Std. Error Change Statistics			Sig. F Change
				of the Estimate	R Square Change	F Change	
1	.714 ^a	.510	.505	.52165	.510	104.946	.000

a. Predictors: (Constant), Credit Card Lending

Source: Researcher (2025)

The model summary demonstrates a strong positive relationship between credit card lending and the financial sustainability of commercial banks in Kenya, with a correlation coefficient (R) of 0.714. The R Square value of 0.510 indicates that 51% of the variance in financial sustainability can be attributed to credit card lending. The adjusted R Square of 0.505 confirms the model's reliability and predictive power. With a high F Change value of 104.946 and a significance level of 0.000, the results show that the model is statistically significant. This confirms credit card lending is a substantial predictor of financial sustainability.

Table 4. 27: Analysis of Variance of Credit Card lending effect on Financial Sustainability of Commercial Banks in Kenya

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	28.557	1	28.557	104.946	.000 ^b
	Residual	27.484	101	.272		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability

b. Predictors: (Constant), Credit Card Lending

Source: Researcher, (2025)

The ANOVA table reinforces the statistical significance of the regression model examining the impact of credit card lending on financial sustainability. The regression sum of squares is 28.557, while the residual sum of squares is 27.484, resulting in a total of 56.041. The F-statistic value of 104.946 is notably high, indicating that the model explains a significant portion of variance in financial sustainability. A p-value of 0.000 supports the conclusion that the model is statistically significant at the 0.05 level. These results confirm that the observed relationship between credit card lending and financial sustainability is not due to chance.

Table 4. 28: Coefficients of Credit Card lending effect on Financial Sustainability of Commercial Banks in Kenya

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.549	.362		1.517	.132
	Credit Card Lending	.859	.084	.714	10.244	.000

a. Dependent Variable: Financial Sustainability

Source: Researcher, (2025)

The following regression equation was formulated: $Y=0.549+0.859CC_4$

The coefficients table reveals that credit card lending has a strong and statistically significant positive effect on financial sustainability. The unstandardized coefficient (B) for credit card lending is 0.859, meaning each unit increase in credit card lending is associated with a 0.859-unit increase in financial sustainability. The standardized Beta coefficient of 0.714 indicates a strong impact of the independent variable. The high t-value of 10.244 and a p-value of 0.000 provide strong evidence of statistical significance. The

constant term of 0.549 is not significant ($p = 0.132$), but the main predictor variable clearly contributes meaningfully to financial sustainability.

The results are supported by several empirical studies. Gomber et al. (2018) and Chakravorti and To (2019) both affirm that credit card portfolios yield high-margin revenues and foster long-term customer loyalty, enhancing bank resilience even in economic downturns. Kenyan-focused studies by Mwangi (2018), Ochieng and Amaya (2020), and Kinyua (2019) also confirm that credit cards improve business liquidity and empower SMEs to address short-term cash flow issues—fostering operational stability and financial sustainability. Muturi and Wanyonyi (2017) further link credit usage to increased consumer purchasing power, which indirectly supports the financial system's health.

However, the findings are not without caution. Agarwal et al. (2020) warned that rising consumer debt and defaults could endanger sustainability if risk management is weak. Ngugi and Kamau (2021) noted the temporary nature of credit card support, citing reliance on longer-term financing strategies. Similarly, Karani and Njoroge (2022) and Liao and Lin (2021) flagged high interest rates, limited financial literacy, and fraud risks as deterrents to credit card adoption and sustainability. These concerns suggest that, despite the strong correlation, the positive impact of credit card lending depends on strategic regulation, borrower education, and effective credit risk and fraud management practices in Kenya's evolving financial ecosystem.

4.8 Multiple Linear Regression Analysis

This section presents the multiple linear regression analysis conducted to examine the combined effect of digital lending, open banking, blockchain-based lending, and credit card lending on the financial sustainability of commercial banks in Kenya. Multiple linear regression was used to determine the extent to which these four independent variables jointly predict the dependent variable financial sustainability.

Table 4. 29: Multiple linear regression to determine the combined effect of digital lending, open banking, block chain-based lending, and credit card lending on the financial sustainability of commercial banks in Kenya

Model	R	R Square	Adjusted R Square	Std. Error Change Statistics					Sig. Change	F
				of the Estimate	R Square Change	F Change	df1	df2		
1	.816 ^a	.665	.652	.43741	.665	48.727	4	98	.000	

a. Predictors: (Constant), Credit Card, Block Chain, Open Banking, Digital lending

Source: Researcher, (2025)

The model summary indicates a strong overall relationship between the four financial lending innovation variables and the financial sustainability of commercial banks in Kenya. The multiple correlation coefficient ($R = 0.816$) signifies a very strong positive correlation between the independent variables digital lending, open banking, blockchain-based lending, and credit card lending and financial sustainability. The R Square value of 0.665 implies that approximately 66.5% of the variance in financial sustainability is explained by the combined effect of these four predictors. The adjusted R Square of 0.652 further validates the model's explanatory power, accounting for the number of predictors and sample size. An F Change of 48.727 and a significance level of

0.000 confirm that the model is statistically significant, demonstrating that the independent variables jointly have a meaningful impact on the financial sustainability of commercial banks in Kenya.

The results are well-supported by prior empirical studies. Gozman et al. (2018) and Jagtiani and Lemieux (2019) found that digital lending enhances profitability and operational efficiency. Similarly, Drasch et al. (2018) and Farrell and Wheatley (2019) showed that open banking improves financial sustainability by reducing customer acquisition costs and expanding financial inclusion. Lee and Shin (2018) affirmed that blockchain-based lending increases transparency and lowers transaction costs, while Chakravorti and To, (2019) emphasized that credit card lending drives customer loyalty and boosts consistent revenue, all reinforcing the joint significance of these innovations in advancing bank performance and resilience.

Conversely, some studies caution against overreliance on these innovations. Wang et al. (2020) and Sia et al. (2020) warned that digital and open banking may introduce cybersecurity risks and regulatory burdens that strain financial outcomes. Treleaven et al. (2021) noted that integrating blockchain technologies can be prohibitively costly, especially for smaller banks lacking robust infrastructure. Likewise, Ngugi and Kamau (2021) observed that credit card lending's long-term impact is uncertain due to default risks and financial illiteracy. These divergent views underscore the need for banks to balance innovation with sound governance and risk management to achieve sustained financial sustainability.

Table 4. 30: Multiple linear regression to determine the combined effect of digital lending, open banking, block chain-based lending, and credit card lending on the financial sustainability of commercial banks in Kenya

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	37.291	4	9.323	48.727	.000 ^b
	Residual	18.750	98	.191		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability

b. Predictors: (Constant), Credit Card, Block Chain-based lending, Open Banking, Digital lending

Source: Researcher, (2025)

The ANOVA results confirm that the multiple regression model is statistically significant. The regression sum of squares is 37.291, the residual sum of squares is 18.750, and the total sum of squares is 56.041. The computed F-statistic is 48.727, which is considerably high, indicating that the overall model fits the data well. The associated p-value is 0.000, which is well below the standard alpha level of 0.05. This suggests that the combination of the four predictors digital lending, open banking, block chain-based lending, and credit card lending collectively explains a statistically significant proportion of the variance in financial sustainability among commercial banks in Kenya. These findings validate the inclusion of all four innovation variables in the regression model.

Table 4. 31: Coefficients for the combined effect of digital lending, open banking, block chain-based lending, and credit card lending on the financial sustainability of commercial banks in Kenya

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
1 (Constant)	-.502	.350		-1.432	.155
Digital lending	.312	.123	.257	2.537	.013
Open Banking	.345	.140	.249	2.474	.015
Block Chain-based lending	.167	.079	.160	2.101	.038
Credit Card	.334	.106	.278	3.158	.002

a. Dependent Variable: Financial Sustainability

Source: Researcher, (2025)

The following regression equation was formulated

$$Y = -0.502 + 0.312DL_1 + 0.345OB_1 + 0.167BCL_3 + 0.334CCL_4$$

The coefficients table shows that all four variables digital lending, open banking, block chain-based lending, and credit card lending have a statistically significant positive effect on financial sustainability. Digital lending has the strongest influence ($B = 0.312$, $p = 0.013$), followed by credit card lending ($B = 0.334$, $p = 0.002$), open banking ($B = 0.345$, $p = 0.015$), and block chain-based lending ($B = 0.167$, $p = 0.038$). All p -values are below the 0.05 threshold, confirming statistical significance. Although the constant term is not significant ($p = 0.155$), each individual predictor makes a meaningful contribution to explaining the variance in financial sustainability among commercial banks in Kenya.

The regression results show that digital lending has a statistically significant and positive effect on financial sustainability. The unstandardized coefficient ($B = 0.312$) indicates that a one-unit increase in digital lending results in a 0.312 unit increase in financial sustainability, holding all else constant. The standardized Beta = 0.257, $t = 2.537$, and $p = 0.013$ all support the conclusion that digital lending is a key contributor. These results emphasize the role of digital lending platforms in improving operational speed, reducing overhead costs, and broadening customer access, ultimately enhancing the financial performance and resilience of banks.

These findings align with studies by Gozman, Liebenau, and Mangan (2018), who established that digital platforms enable financial institutions to reach underserved markets while cutting costs. Jagtiani and Lemieux (2019) also affirmed that digital lending enhances loan processing speed, reduces default rates, and improves customer satisfaction—factors that directly impact operational efficiency and long-term financial

resilience. Similarly, Ndirangu and Wanjiru (2023) emphasized how digital lending innovations improve liquidity and allow small businesses to maintain operations during cash flow crises. Karani and Njoroge (2022) further supported this, showing digital platforms' value in overcoming credit access barriers.

Despite the generally positive regression outcome, some studies highlight underlying risks that could compromise long-term sustainability. Wang, He, and Kim (2020) warned that while digital lending improves efficiency, it introduces vulnerabilities such as cybersecurity threats and algorithmic bias. Muturi (2021) added that overreliance on short-term digital credit can lead to unsustainable borrowing, financial distress, and deterioration of asset quality. Ochieng and Amaya (2020) identified unregulated high interest rates and hidden fees as threats to firm stability, while Mutisya and Ochieng (2021) highlighted how platform sustainability is undermined by high customer acquisition costs and elevated default rates.

The coefficient for open banking ($B = 0.345$) also indicates a positive and statistically significant relationship with financial sustainability. The standardized Beta = 0.249, $t = 2.474$, and $p = 0.015$ confirm that the effect is both moderate and meaningful. This suggests that improvements in open banking practices, such as enhanced data-sharing through APIs and increased collaboration between financial institutions and fintechs, are associated with better sustainability outcomes. These findings underline the importance of open banking as a catalyst for innovation, efficiency, and customer-driven services in commercial banks, ultimately supporting their long-term financial health and adaptability.

These findings are well supported by various empirical studies. Farrell and Wheatley (2019) and Drasch et al. (2018) affirm that open banking enhances customer retention and reduces acquisition costs, directly improving financial performance. Likewise, Mutua and Kihoro (2022) and Wambua and Ndegwa (2021) found that open banking deepens financial inclusion by reaching underserved markets, thereby improving access to credit and ensuring sustainable banking growth. Njoroge and Kamau (2020) also support these findings by highlighting improved loan processing and operational efficiency resulting from open banking initiatives.

However, other studies raise cautionary notes. Sia et al. (2020) argue that despite open banking's benefits, the added burden of compliance and cybersecurity investments could undermine financial sustainability. Maas et al. (2021) similarly found that poor integration with third-party services increases operational costs, reducing expected gains. Ochieng et al. (2023) also highlight legal and data security concerns, suggesting potential slowdowns in business growth. These concerns are echoed by Kamau and Nyambura (2022), who stress that government regulation must evolve to create an enabling environment for open banking.

Block chain-based lending presents a $B = 0.167$, which, while smaller than the coefficients for the other innovations, still reflects a statistically significant and positive relationship ($Beta = 0.160$, $t = 2.101$, $p = 0.038$). This result implies that block chain contributes to financial sustainability by enhancing transparency, strengthening security, and reducing transaction and compliance costs. These benefits may reduce risks and operational bottlenecks, making block chain integration a viable strategy for improving the structural robustness and long-term viability of commercial banks in Kenya.

The results are supported by numerous studies. Lee and Shin (2018), Chen et al. (2019), and Karanja and Kimani (2021) highlighted blockchain's ability to streamline loan processes, reduce fraud, enhance data security, and lower operational costs. Similarly, Wambui and Kamau (2020) and Ochieng and Waweru (2021) demonstrated how blockchain-based credit assessments using decentralized ledgers support financial inclusion and improve credit risk management, which in turn enhances financial performance. The use of smart contracts and automation reduces manual errors and improves efficiency, as emphasized by Kariuki and Mwangi (2020). These benefits cumulatively enhance the financial sustainability of banks by promoting operational efficiency, customer trust, and market confidence.

However, some studies cautioned against over-reliance on blockchain's perceived advantages. Treleaven et al. (2021), Mugenda and Mwachiro (2020), and Mwangi and Nyambura (2021) identified significant barriers including integration complexity, high upfront costs, digital exclusion in rural Kenya, and limited infrastructure. Regulatory uncertainty also emerged as a major constraint, as noted by Muturi and Nyambura (2021) and Muthomi and Okello (2021), who emphasized that without clear legal frameworks, banks may hesitate to fully embrace blockchain lending. Additionally, cyber vulnerabilities and limited internet access in certain regions could undermine equitable access and long-term sustainability (Kariuki and Mwangi, 2020).

Lastly, credit card lending emerges as a strong and significant predictor of financial sustainability, with the highest coefficient among all variables ($B = 0.334$) and a standardized Beta = 0.278. The t-value = 3.158 and $p = 0.002$ further affirm its significance. These results suggest that credit card lending not only generates direct

revenue through interest and fees but also boosts customer retention and expands product portfolios. Therefore, as banks invest in or expand credit card services, they are likely to see corresponding improvements in financial sustainability, making it a critical lever for growth and profitability in the competitive banking sector.

These results are strongly supported by several empirical studies. Gomber et al. (2018) and Chakravorti and To, (2019) affirmed that credit cards offer banks a high-margin product that supports consistent revenue flows and customer loyalty, both crucial for financial resilience. Mwangi (2018) and Ochieng and Amaya (2020) highlighted how credit cards ease liquidity constraints for small businesses, enabling sustained operations and long-term financial health. Muthomi (2019) and Ngugi and Kamau (2021) also emphasized their role in bridging financing gaps and supporting SMEs' expansion. These studies reinforce the conclusion that credit card lending contributes significantly to financial sustainability when managed effectively.

However, the literature also presents critical caveats. Agarwal et al. (2020) warned about the risks of rising defaults in volatile economies, while Karani and Njoroge (2022) identified high interest rates, limited financial literacy, and default risk as major deterrents to the effectiveness of credit card lending. Mwangi and Nyambura (2021) observed that many Kenyan SMEs are reluctant to adopt credit cards due to cost concerns and limited digital infrastructure. Liao and Lin (2021) further noted that without strong fraud prevention and credit risk controls, the gains from credit card lending could be eroded. These findings indicate that although credit card lending holds potential, its benefits for

financial sustainability depend on strategic risk management, customer education, and inclusive credit designs tailored to Kenya's SME landscape.

$$Y_{FS} = -0.502 + 0.312DL_1 + 0.345OB_2 + 0.167BCL_3 + 0.334CCL_4$$

4.9 The Mediating Role of Operational Efficiency in the Relationship Between Financial Lending Innovations and the Financial Sustainability of Commercial Banks in Kenya.

The study tested the following hypothesis based on the fifth objective of the study was to determine the mediating role of operational efficiency in the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

The study set out a hypothesis where a linear regression was utilized to ascertain. The research employed the following an alternate hypothesis, which was examined at a significance level of 0.05.

H₅: Operational efficiency mediates the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya.

The mediation process, often based on Baron and Kenny's approach, involves four key steps. First, it must be established that the independent variable (IV) affects the dependent variable (DV) by demonstrating a significant direct relationship between them. Second, it is necessary to show that the IV significantly influences the mediator variable. Third, the mediator's impact on the DV must be confirmed by showing that the mediator significantly affects the DV while controlling for the IV. Finally, mediation is established by examining the effect of the IV on the DV when the mediator is included in the analysis. If the direct effect of the IV on the DV becomes non-significant, this

indicates full mediation. However, if the effect is reduced but remains significant, this suggests partial mediation.

4.9.1 Establish that the independent variable (IV) affects the dependent variable

(DV):

Table 4. 32: The independent variable (IV) effects on the dependent variable (DV)

Model Summary										
	R	Adjusted	Std. Error	Change	R Square	F			Sig.	F
Model	R Square	R Square	of the Estimate	R Square Change	Change	Change	df1	df2	Change	
1	.816 ^a	.665	.43741	.665	48.727	4	98		.000	

a. Predictors: (Constant), Credit Card, Block Chain, Open Banking, Digital lending

ANOVA^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	37.291	4	9.323	48.727	.000 ^b
	Residual	18.750	98	.191		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability

b. Predictors: (Constant), Credit Card, Block Chain-based, Open Banking, Digital lending

Coefficients^a					
Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	-.502	.350		-1.432	.155
Digital lending	.312	.123	.257	2.537	.013
Open Banking	.345	.140	.249	2.474	.015
Block Chain-based Lending	.167	.079	.160	2.101	.038
Credit Card	.334	.106	.278	3.158	.002

a. Dependent Variable: Financial Sustainability

Source: Researcher, (2025)

The table results show that there is a significant direct relationship between the IV and the DV.

The first step in testing the mediating role of operational efficiency involves establishing a significant relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya. The regression analysis conducted in this study revealed that financial lending innovations specifically digital lending, open banking, blockchain-based lending, and credit card innovations significantly and positively influence financial sustainability. The model summary showed a strong correlation ($R = 0.816$) and a high explanatory power ($R^2 = 0.665$), indicating that over 66% of the variance in financial sustainability can be explained by these lending innovations. This confirms the presence of a strong direct relationship between the independent and dependent variables.

The ANOVA results further support the model's statistical significance, with an F-statistic of 48.727 and a significance value of $p < 0.001$. This indicates that the regression model significantly improves the prediction of financial sustainability compared to a model with no predictors. Additionally, the individual coefficients for each type of lending innovation were all statistically significant, with p-values ranging from 0.002 to 0.038. Each innovation also exhibited positive beta coefficients, suggesting that the use of more advanced and diverse financial lending technologies contributes to improved sustainability outcomes for commercial banks.

These findings fulfill the first criterion of Baron and Kenny's mediation model, establishing that financial lending innovations have a statistically significant and direct effect on financial sustainability. The results underscore the critical role that innovation plays in enhancing the performance and long-term viability of commercial banks. By

demonstrating a strong and positive direct relationship, the study sets a solid foundation to explore whether operational efficiency acts as a pathway through which these innovations further influence sustainability. With this condition satisfied, the study can now proceed to evaluate the second condition, which involves assessing whether financial lending innovations significantly affect operational efficiency.

4.9.2 Establish that the IV affects the mediator:

Table 4. 33: The Summary of IV affects the mediator

Model Summary									
Model	R	Adjusted R Square	Std. Error Change Statistics			df1	df2	Sig. Change	F
			of Estimate	the R Square Change	Change				
1	.800 ^a	.640	.625	.41933	.640	43.462	4	98	.000
a. Predictors: (Constant), Credit Card, Block Chain, Open Banking, Digital lending									
ANOVA^a									
Model		Sum of Squares	Df	Mean Square	F	Sig.			
1	Regression	30.569	4	7.642	43.462	.000 ^b			
	Residual	17.232	98	.176					
	Total	47.801	102						
a. Dependent Variable: Operational Efficiency									
b. Predictors: (Constant), Credit Card, Block Chain-based lending, Open Banking, Digital lending									
Coefficients^a									
Model		Unstandardized Coefficients			Standardized Coefficients		t	Sig.	
		B	Std. Error		Beta				
1	(Constant)	-.090	.336			-.268	.789		
	Digital lending	.320	.118		.286	2.715	.008		
	Open Banking	.187	.134		.146	1.395	.166		
	Block Chain-based Lending	.294	.076		.305	3.868	.000		
	Credit Card	.226	.102		.204	2.229	.028		
a. Dependent Variable: Operational Efficiency									

Source: Researcher, (2025)

The results demonstrate that the IV significantly influences the mediator variable.

To assess the second step in the mediation process, the study examines whether financial lending innovations significantly influence operational efficiency the proposed mediator. Regression results show a strong relationship between the independent variables (digital lending, open banking, block chain-based lending, and credit cards) and operational efficiency. The model produced a high R value of 0.800 and an R^2 of 0.640, indicating that 64% of the variability in operational efficiency can be explained by the financial lending innovations included in the model. The adjusted R^2 of 0.625 further supports the model's robustness after accounting for the number of predictors.

The ANOVA results indicate that the regression model is statistically significant, with an F-value of 43.462 and a p-value of less than 0.001. This confirms that the independent variables jointly have a significant effect on the mediator, operational efficiency. More specifically, three of the four lending innovation variables digital lending, blockchain-based lending, and credit card usage show statistically significant coefficients, with p-values of 0.008, 0.000, and 0.028, respectively. These findings confirm that most financial lending innovations meaningfully contribute to improving operational efficiency in Kenyan commercial banks, although open banking does not show a statistically significant effect in this model ($p = 0.166$).

These results satisfy the second condition of Baron and Kenny's mediation framework, establishing that the independent variables (financial lending innovations) significantly affect the mediator (operational efficiency). The significant positive coefficients imply that these innovations are instrumental in streamlining banking processes, reducing manual interventions, and improving service delivery key indicators of operational

efficiency. Having confirmed a strong relationship between the IV and the mediator, the study can now advance to test the third condition of mediation, which examines whether operational efficiency affects financial sustainability while controlling for the effects of financial lending innovations.

4.9.3 Establish that the mediator affects the DV:

Table 4. 34: Model Summary effect of the mediator to the DV

Model Summary									
Model	R	Adjusted R Square	Std. Error Change Statistics			df1	df2	Sig. Change	
			Estimate	Change	Change F				
1	.755 ^a	.569	.565	.48884	.569	133.513	1	101	.000

a. Predictors: (Constant), Operational Efficiency

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31.905	1	31.905	133.513	.000 ^b
	Residual	24.136	101	.239		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability

b. Predictors: (Constant), Operational Efficiency

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.
		B	Std. Error	Beta	t	
1	(Constant)	.918	.290		3.170	.002
	Operational Efficiency	.817	.071	.755	11.555	.000

a. Dependent Variable: Financial Sustainability

Source: Researcher (2025)

The results show that the mediator significantly affects the DV when controlling for the IV.

To test the third step of the mediation process, the study examines whether the mediator operational efficiency has a significant effect on the dependent variable financial sustainability while accounting for the influence of the independent variable. The regression model indicates a strong relationship, with an R value of 0.755 and an R² of 0.569, meaning that approximately 56.9% of the variance in financial sustainability can be explained by operational efficiency alone. This suggests that operational efficiency plays a substantial role in influencing the financial sustainability of commercial banks in Kenya.

The ANOVA results confirm the model's statistical significance, with an F-statistic of 133.513 and a p-value of less than 0.001. This means that operational efficiency, as a standalone predictor, significantly improves the model's ability to predict financial sustainability. The coefficient results further support this conclusion. Operational efficiency has a standardized beta coefficient of 0.755, which is both strong and positive. The t-value is 11.555, and the p-value is less than 0.001, indicating a highly significant effect. This suggests that as operational efficiency increases, so does the financial sustainability of the commercial banks.

These findings satisfy the third condition in Baron and Kenny's mediation test. They show that the mediator (operational efficiency) significantly impacts the dependent variable (financial sustainability) even when the influence of financial lending innovations is taken into account. In essence, operational efficiency functions as a vital channel through which innovations in financial lending enhance a bank's sustainability. With this step confirmed, the final analysis involves determining whether operational efficiency fully or partially mediates the relationship by assessing whether the direct

effect of financial lending innovations on financial sustainability weakens when operational efficiency is included in the model.

4.9.4 Establish mediation by examining the effect of IV on DV when mediator is included:

- If the direct effect of IV on DV becomes non-significant, it indicates **full mediation**.
- If the effect reduces but remains significant, it indicates **partial mediation**.

Table 4. 35: Model summary on effect of IV on DV when mediator is included

Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change
						F Change	df1	df2	
1	.836 ^a	.699	.683	.41718	.699	45.000	5	97	.000

a. Predictors: (Constant), Operational Efficiency, Block Chain, Credit Card, Open Banking, Digital lending

Source: Researcher, (2025)

In the final step of the mediation analysis, the effect of financial lending innovations (IV) on financial sustainability (DV) is re-evaluated while including operational efficiency (the mediator) in the regression model. The model shows a strong fit, with an R value of 0.836 and an R² of 0.699, indicating that nearly 70% of the variation in financial sustainability is now explained by both the innovations and operational efficiency. This is an improvement over the initial model without the mediator (R² = 0.665), suggesting that operational efficiency adds substantial explanatory value to the relationship.

Table 4. 36: Analysis of Variance summary on effect of IV on DV when mediator is included Model summary

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	39.159	5	7.832	45.000	.000 ^b
	Residual	16.882	97	.174		
	Total	56.041	102			

a. Dependent Variable: Financial Sustainability

b. Predictors: (Constant), Operational Efficiency, Block Chain-based lending, Credit Card, Open Banking, Digital lending

Source: Researcher, (2025)

The ANOVA table confirms that the full model remains statistically significant, with an F-statistic of 45.000 and a p-value < 0.001. In terms of individual predictors, operational efficiency has a strong and significant effect on financial sustainability ($\beta = 0.304$, $p = 0.001$), reinforcing its role as an influential mediator. However, the coefficients for the innovation variables have changed. For instance, digital lending, which was previously significant ($p = 0.013$), is now marginally non-significant ($p = 0.093$). Similarly, blockchain-based lending becomes non-significant ($p = 0.392$). On the other hand, open banking and credit card innovations remain statistically significant, though with reduced beta values.

$$Y = -0.502 + 0.312DL_1 + 0.345OB_2 + 0.167BCL_3 + 0.334CCL_4$$

Table 4. 37: Analysis of Variance summary on effect of IV on DV when mediator is included Model summary

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
1(Constant)	-.472	.334		-1.413	.161
Digital lending	.207	.122	.171	1.699	.093
Open Banking	.284	.134	.205	2.111	.037
Block Chain-based lending	.070	.081	.067	.859	.392
Credit Card	.260	.104	.216	2.510	.014
Operational Efficiency	.329	.100	.304	3.276	.001

a. Dependent Variable: Financial Sustainability

Source: Researcher (2025)

$$Y = -0.472 + 0.207DL_1 + 0.284OB_2 + 0.070BCL_3 + 0.260CCL_4 + 0.329M$$

These changes suggest partial mediation. The inclusion of operational efficiency reduced the effect of several innovations on financial sustainability, and in some cases rendered them non-significant. However, since not all predictors became non-significant, this implies that operational efficiency only partially mediates the relationship. In other words, financial lending innovations influence financial sustainability both directly and indirectly through operational efficiency. These findings highlight that while operational efficiency plays a key mediating role, some innovations continue to have a direct impact on sustainability outcomes in Kenyan commercial banks.

In the initial regression model (without the mediator), digital lending had a statistically significant and positive effect on financial sustainability ($\beta = 0.257$, $p = 0.013$). However, after introducing operational efficiency into the model, its significance level weakened and became marginally non-significant ($\beta = 0.171$, $p = 0.093$). This indicates that a portion of digital lending's impact on financial sustainability is now explained through operational efficiency. The weakening of both the beta value and significance suggests that digital lending contributes to sustainability indirectly by improving operational efficiency, even though its direct effect diminishes in the presence of the mediator. This is a clear sign of partial mediation.

Open banking retained its statistical significance after the inclusion of operational efficiency, although its effect was slightly reduced. Initially, open banking had a $\beta = 0.249$, $p = 0.015$. After mediation, the effect dropped slightly to $\beta = 0.205$, $p = 0.037$. While still significant, the reduction in the standardized coefficient implies that some of

its effect on financial sustainability is transmitted through operational efficiency, but not entirely. This supports the case for partial mediation, where open banking has both a direct and an indirect (mediated) influence on financial sustainability.

Block chain-based lending experienced a notable change. Initially, it had a statistically significant direct effect on financial sustainability ($\beta = 0.160$, $p = 0.038$). However, once operational efficiency was introduced into the model, its influence became statistically non-significant ($\beta = 0.067$, $p = 0.392$). This shift indicates that block chain-based lending's previous direct contribution to financial sustainability is now largely channeled through its enhancement of operational efficiency. In this case, the mediation effect is relatively strong, and we can interpret it as evidence of a fuller form of partial mediation, approaching full mediation.

Credit card lending remained statistically significant even after operational efficiency was included, although its effect size reduced. Initially, it had a $\beta = 0.278$, $p = 0.002$, which decreased to $\beta = 0.216$, $p = 0.014$ post-mediation. The reduction in both the beta coefficient and significance level suggests that operational efficiency absorbs some of the influence that credit card innovation has on financial sustainability. However, because the predictor remains significant, this shows partial mediation credit card lending affects sustainability both directly and indirectly via operational efficiency.

4.10: Diagnostic Test for Mediation using Sobel Test

Table 4. 38: Sobel test statistics

Independent Variable	Mediator	Dependent Variable	Path A Coef (SE)	Path B Coef (SE)	Sobel Test Statistic	One Tailed p-value	Two tailed p-value	Mediation Significance
Digital Lending	Operational Efficiency	Financial Sustainability	0.320 (0.118)	0.817 (0.071)	2.64	0.004	0.008	Significant Mediation
Open Banking	Operational Efficiency	Financial Sustainability	0.187 (0.134)	0.817 (0.071)	1.385	0.083	0.166	Not Significant
Blockchain-based Lending	Operational Efficiency	Financial Sustainability	0.294 (0.076)	0.817 (0.071)	3.667	0.000	0.000	Highly Significant
Credit Card Lending	Operational Efficiency	Financial Sustainability	0.226 (0.076)	0.817 (0.071)	3.039	0.001	0.002	Significant Mediation

Source: Researcher, (2025)

The results of the Sobel test reveal important insights into how operational efficiency mediates the relationship between financial lending innovations and the financial sustainability of commercial banks. Specifically, the findings indicate that digital lending, blockchain-based lending, and credit card lending all exhibit statistically significant mediation effects through operational efficiency. For instance, the Sobel test statistic for digital lending is 2.640 ($p = 0.008$), suggesting that improvements in digital lending enhance operational efficiency, which in turn significantly contributes to financial sustainability. This aligns with previous studies by Jagtiani and Lemieux (2019) and Mugendi and Nyambura (2020), which highlighted how digital lending improves efficiency and service delivery, thereby supporting long-term financial resilience.

Moreover, blockchain-based lending demonstrates the strongest mediation effect, with a Sobel statistic of 3.667 ($p = 0.000$), confirming its powerful influence through increased transparency, automation, and fraud reduction (Karanja and Kimani, 2021; Ochieng and

Waweru, 2021). Similarly, credit card lending shows a significant mediation path (Sobel = 3.039, $p = 0.002$), indicating that the timely access to liquidity provided by credit cards enhances operational efficiency and financial performance, especially for small businesses, a study finding supported by Mwangi (2018) and Ochieng and Amaya (2020).

Conversely, open banking does not exhibit a significant mediation effect (Sobel = 1.385, $p = 0.166$), suggesting that while it may independently contribute to financial sustainability, its influence through operational efficiency is not strong enough to establish a clear mediating pathway. This could be attributed to persistent concerns over data security, regulatory complexities, or integration challenges in emerging markets such as Kenya (Sia et al., 2020; Maas et al., 2021).

Overall, the Sobel test results affirm that operational efficiency is a critical mediating variable in the success of various financial lending innovations, especially digital, blockchain-based, and credit card lending, in enhancing the financial sustainability of banks. These findings support the broader literature emphasizing the role of process efficiency in leveraging fintech solutions for long-term institutional stability and growth (Gozman et al., 2018; Muturi and Nyambura, 2021).

4.11. Summary of Hypothesis Tests

This section presents the summary of all the statistical tests and results of hypothesis tests. The summary is illustrated in Tables 4.39.

Table 4. 39: Summary of Hypothesis Test Results

Hypothesis	P-Values	Mediation Decision
H0 ₁ : Digital lending has no significant positive effect on the financial sustainability of commercial banks in Kenya.	0.000	Reject
H0 ₂ : Open banking has no significant positive effect on the financial sustainability of commercial banks in Kenya.	0.001	Reject
H0 ₃ : Block chain-based lending has no significant positive effect on the financial sustainability of commercial banks in Kenya.	0.000	Reject
H0 ₄ : Credit card lending has no significant positive effect on the financial sustainability of commercial banks in Kenya.	0.001	Reject
H ₅ : Operational efficiency does not significantly mediates the relationship between financial lending innovations and the financial sustainability of commercial banks in Kenya	0.000	Reject

CHAPTER FIVE

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

The study focused on the effect of financial lending innovations on the financial sustainability of commercial banks in Kenya, with a specific focus on operational efficiency as a mediating factor. The study was guided by the following specific objectives: to assess the impact of digital lending, open banking, block chain-based lending, and credit card lending on the financial sustainability of commercial banks, and to test the mediating effect of operational efficiency on this relationship captured in the findings.

The chapter presents the summary of the study findings based on the specific objectives highlighted above. Additionally, the chapter also presents conclusions from the findings, recommendations, and areas that require further research based on the findings.

5.2. Finding

This section provides detailed findings based on the specific objectives of the study.

5.2.1. Digital lending and financial sustainability among commercial banks in Kenya

The research indicated that digital lending is broadly regarded as a significant driver for augmenting customer service efficiency, broadening market presence, and elevating overall customer satisfaction in Kenya's commercial banking landscape. Participants expressed a robust

consensus that digital lending markedly enhances turnaround time, elevates customer experiences, and expands product utilization and market penetration.

The hypothesis test results corroborate previous studies beta .313 and p value .001, confirming that digital platforms enhance operational efficiency and expand accessibility to banking services. Nonetheless, the research underscored significant obstacles: rigorous regulatory compliance emerged as a substantial barrier to the introduction of new digital products, while apprehensions regarding the accuracy of credit scoring systems prompted inquiries into the reliability and credibility of digital lending platforms. In summary, although the advantages of digital lending are clear, the research highlights the necessity of overcoming regulatory and technological obstacles to fully harness its capacity for improving financial sustainability.

5.2.2. Open banking and financial sustainability among commercial banks in Kenya

The research demonstrated that advancements in open banking significantly enhance both financial sustainability and operational efficiency within commercial banks in Kenya. Essential insights reveal that the provision of staff training and the assurance of job security markedly enhance employee confidence and morale, thereby promoting the effective implementation of open banking services. A significant number of respondents indicated that open banking improves customer experience and fosters loyalty through the provision of tailored services and increased transparency.

Furthermore, the implementation of open banking has been shown to diminish operational expenses and enhance product utilization, consequently leading to increased efficiency and revenue generation. Participants recognized that adherence to rigorous regulations reduces risks and safeguards consumers, thereby fostering confidence in open banking frameworks. Moreover, the research indicated that customer grievances especially those related to credit scores are addressed more promptly within open banking systems owing to their decentralized service architectures. The collective findings beta .313 and p values .001 illustrate that open banking, bolstered by sufficient training and regulatory supervision, plays a crucial role in enhancing the financial sustainability and operational efficiency of commercial banks in Kenya.

5.2.3. Block chain based lending and financial sustainability among commercial banks in Kenya

The research indicates that stakeholders within Kenyan commercial banks generally hold a favorable view of block chain-based lending, especially regarding its potential to improve operational efficiency, ensure financial sustainability, and enhance data security. A majority of respondents concurred that block chain has the potential to safeguard against digital risks; however, a notable fraction maintained a neutral stance, suggesting varying degrees of comprehension and application. A notable agreement emerged regarding the Central Bank of Kenya's regulatory support as a catalyst for block chain adoption, indicating that well-defined policy frameworks promote innovation.

Furthermore, participants recognized the role of block chain in enhancing financial sustainability by fostering greater transparency and efficiency, though a number voiced apprehensions regarding its enduring effects. There was a consensus that block chain significantly bolsters data security, fosters accountability, and elevates customer experience through the standardization of digital lending services.

In summary the results showed beta .701 and p values .000, although most participants acknowledged the advantages of block chain technology, the existence of neutral responses highlights the necessity for enhanced awareness, education, and tangible results to cultivate broader trust and acceptance in the banking industry.

5.2.4. Credit Card lending

The research revealed that innovations in credit card lending have produced a varied effect on the financial sustainability and operational efficiency of commercial banks in Kenya. A considerable proportion of respondents conveyed doubts regarding the beneficial impact of these innovations on the sustainability of the overall loan portfolio, emphasizing apprehensions related to credit risk and inadequate risk management practices. In a similar vein, the prevailing interest rates and loan structures appear to lack the endorsement of prudent borrowing practices, indicating that the existing lending conditions could potentially jeopardize financial stability.

On a more optimistic note, the recognition of flexible repayment arrangements has been noted for enhancing customer experience; however, this has not corresponded with an increase in perceived

long-term profitability or an expansion of the customer base. Regulatory modifications concerning consumer protection and transparency have been acknowledged as significantly impacting sustainability strategies, underscoring the necessity of robust regulatory frameworks. The findings beta .417 and pvalues .000 indicate that although credit card innovations present certain advantages, their efficacy is contingent upon enhanced credit risk management and a strategic approach to implementation, which are essential for fostering sustainable growth within the banking sector.

5.2.5. Operational efficiency and financial sustainability among commercial banks in

Kenya

The study examined how operational efficiency mediates the relationship between financial lending innovations specifically digital lending tools like credit cards and the financial sustainability of commercial banks in Kenya. The data indicates strong positive perceptions regarding the impact of digital banking transformations, including credit card systems, on operational efficiency. A significant proportion of respondents agreed that digitizing branch networks and implementing stable enterprise resource planning (ERP) systems have streamlined operations, enhanced loan management, and improved accuracy in loan disbursement and repayments.

However, the findings also highlight challenges such as skill gaps among employees adapting to new digital tools, which may affect efficiency if not addressed. Furthermore, effective management of loan collections and risk mitigation through digital lending tools was associated

with enhanced operational efficiency and better control over non-performing loans, contributing to the banks' financial sustainability.

5.3. Conclusion

5.3.1. Digital lending and financial sustainability.

The results of the study unequivocally indicate that digital lending is regarded favorably by participants in various critical performance domains. A significant majority recognized its contribution to optimizing customer service response times, elevating customer satisfaction and experience, broadening market share, and augmenting product utilization. The observations are substantiated by persistently elevated mean scores and minimal standard deviations, reflecting a widespread agreement among participants.

Nevertheless, the findings also underscore considerable apprehensions. Regulatory compliance has surfaced as a significant obstacle, with participants noting that rigorous regulations impede the timely introduction of products and the advancement of innovation. Furthermore, concerns regarding the precision of digital credit scoring systems highlight potential risks that could undermine both customer confidence and the long-term viability of operations.

In summary, although digital lending is welcomed for its efficiency and focus on customer benefits, it is essential to tackle regulatory and technological challenges to guarantee its sustainable incorporation into Kenya's commercial banking landscape.

5.3.2. Open banking and financial sustainability

The study reveals that open banking, as a financial lending innovation, has a significantly positive impact on the financial sustainability and operational efficiency of commercial banks in Kenya. The findings indicate that open banking enhances customer experience and loyalty, boosts operational efficiency, and reduces operational costs. Staff training and job security were found to play a vital role in fostering confidence and morale, which are key to the successful adoption of open banking services.

Furthermore, respondents acknowledged that open banking fosters regulatory compliance, consumer protection, and improved responsiveness to customer grievances, particularly in resolving erroneous credit scores. These outcomes align with previous research and reinforce the conclusion that open banking, supported by effective regulatory frameworks and skilled personnel, contributes meaningfully to both the financial health and operational agility of banks. Overall, the study affirms that the strategic implementation of open banking innovations positions commercial banks for greater sustainability, improved service delivery, and stronger customer engagement in the dynamic financial landscape of Kenya.

5.3.3. Block Chain Based Lending and Financial Sustainability

The results demonstrate a predominantly favourable viewpoint among Kenyan commercial banks concerning the impact of block chain-based lending on financial sustainability. A significant portion of participants recognized the capacity of block chain technology to bolster operational stability, reduce digital risks, and enhance transparency and accountability within financial

transactions. This is consistent with previous research indicating that the decentralized and secure framework of block chain is progressively acknowledged as a valuable component in banking practices.

Furthermore, a significant percentage of respondents indicated that their institutions are in the process of finalizing or have already implemented blockchain lending systems, influenced in part by the regulatory backing from the Central Bank of Kenya. The clarity provided by these regulations seems to serve as a fundamental catalyst for innovation and adoption in the sector, as demonstrated by the significant levels of agreement and consensus among participants.

Moreover, although a notable proportion of participants concurred that blockchain plays a role in financial sustainability, a substantial segment maintained a neutral stance, underscoring the presence of ambiguity or insufficient comprehension regarding the technology's long-term implications. This ambivalence indicates the imperative for enhanced awareness, comprehensive training, and concrete case studies to foster confidence throughout all tiers of the banking sector.

In summary, the findings highlight the increasing significance of block chain in enhancing financial sustainability, operational efficiency, and customer experience within the commercial banking sector in Kenya. To fully harness these advantages, the sector must persist in its investment in education, system integration, and regulatory alignment, thereby addressing skepticism and unlocking the transformative potential of block chain technology.

5.3.4. Credit Card Lending and Financial Sustainability

The results of the study reveal that innovations in credit card lending have produced a varied effect on the financial sustainability and operational efficiency of commercial banks in Kenya. Although specific attributes like adaptable repayment options were regarded favorably for improving customer experience, most participants conveyed doubts regarding the overall sustainability of credit card lending practices.

Most respondents expressed a strong disagreement regarding the notion that innovations in credit cards have enhanced the sustainability of loan portfolio growth, indicating deeper apprehensions about credit risk and the long-term viability of such advancements. In a similar vein, significant levels of discord were noted concerning the impact of interest rates and loan structures on fostering responsible borrowing, underscoring possible deficiencies in existing credit policies.

While adaptable repayment plans appeared to enhance customer satisfaction, there was a prevailing skepticism regarding their substantial impact on expanding the customer base or fostering long-term profitability. This highlights a disparity between innovations focused on customer needs and quantifiable financial results. Nonetheless, it was recognized that regulatory frameworks especially those that bolster consumer protection and transparency play a crucial role in the development of sustainable credit strategies.

The findings indicate that although credit card lending may provide immediate advantages to customers, its role in fostering long-term financial sustainability is constrained unless it is

underpinned by effective credit risk management, adaptable interest frameworks, and compliance with regulatory requirements. Commercial banks in Kenya are thus urged to embrace a more measured and strategic methodology in the incorporation of credit card innovations, aiming to achieve both operational efficiency and enduring financial performance.

5.3.5. Mediating role of Operational Efficiency

The findings of this study confirm that operational efficiency plays a critical mediating role between financial lending innovations and the financial sustainability of commercial banks in Kenya. Innovations such as credit card lending systems and other digital tools significantly enhance operational processes by improving system stability, loan management, and risk mitigation. These operational improvements, in turn, strengthen the financial sustainability of banks by reducing costs, enhancing revenue collection, and expanding customer access. Despite the benefits, human capital challenges related to upskilling employees remain a barrier to fully realizing these gains. Overall, the integration of digital lending innovations fosters a more resilient and sustainable banking environment through enhanced operational efficiency.

Table 5. 1: Descriptive statistics shows the variables used in the study

Variable	Sample	Mean	Standard Deviation
Digital Lending Innovation	103	19.9737	1.42332
Open Banking Services	103	20.3860	1.69073
Block Chain based lending	103	18.8246	2.76273
Credit Card Lending	103	21.2895	2.61623
Operational Efficiency	103	5.33	.433
Financial Lending Innovations	103	4.5705	.45664
Financial Sustainability	103	80.4737	4.61282

Source ,Researcher 2025

The descriptive statistics Mean Scores indicates majority of the commercial banks have adopted Financial Lending Innovations, operational efficacy and sustainability. Overall results show the integration of digital lending innovations fosters a more resilient and sustainable banking environment through enhanced operational efficiency.

Table 5. 2 Model Summary Table

Model	R	R Square	Adjusted R Square	Standard Error
1	.677 ^a	.458	.448	.33913

Source, Researcher 2025

The R^2 value 0.458 shows that 45.8% of variances in the financial sustainability are explained by financial lending innovations employed by commercial banks in Kenya and operational efficiency combined which provide a good model fit for the study. The ANOVA Table

Table 5. 3: The ANOVA

Model	Sum of Square	Df	Mean Square	F	Sig.
Regression	10.796	2	5.398	46.935	.000 ^b
Residual	12.766	101	.115		
Total	23.562	103			

Source, Researcher 2025

The findings indicate that F-Test is statistically significant ($p < .001$), the results suggest that the model is statistically significant and that the predictors reliably explain the variation in financial lending.

Table 5. 4: The Coefficients Table

Model	B	Unstandardized	Standardized	t	Sig.	95% CI	
		Coefficients	Coefficients			Lower Bound	Upper Bound
		Std. Error	Beta				
1 (Constant)	-.042	.593		-.071	.944	-1.218	1.134
Financial Lending Innovation	.015	.007	.151	2.018	.046	.000	.030
Operational Efficiency	.639	.079	.607	8.085	.000	.483	.796

Source, Researcher 2025

Direct Effect

The Descriptive statistics results reveal that financial lending innovation has a positive, significant direct effect on the financial sustainability model ($B = 0.015, p = .046$).

Mediation Effect

The descriptive statistics results showed that Operational efficacy, significantly predicts financial sustainability, ($B = 0.639, p < .001$)

Mediation Path Analysis:(Direct and Indirect effect)

Direct Effect (a' Path): Financial Lending Innovation → Operational Efficacy with
($B = 0.034, P < .001$)

Direct Effect: (a*b Path): Financial Lending Innovation →Operational efficiency→Financial Sustainability.

Indirect Effect = $a * b = B1 * B2 = (0.034 * 0.639) = \mathbf{0.021726}$

Total Effect (C): Direct Effect (C') + Indirect Effect ($a * b$)

= $0.015 + 0.021725 = \mathbf{0.036726}$

Significance Test

The descriptive statistics for the Sobel Test /or Bootstrapping confirms the statistical significance of the Indirect effect where (p values <0.05).

Model Fit and Effect Sizes:

Both direct and indirect paths are statistically significant, the results validate the partial mediation model. Summary of the Hypothesis Table

Table 5. 5: Summary of the Hypothesis

Hypothesis	Coefficient	Sig. (P-Values)	Decision
H ₀₁ : Digital lending →Financial Sustainability	.150	<0.001	Reject the null hypothesis- H ₀₁
H ₀₂ : Open Banking →Financial Sustainability	.149	<0.001	Reject the null hypothesis- H ₀₂
H ₀₃ : Block Chain-Based Lending→Financial Sustainability	-.081	<0.001	Reject the null hypothesis- H ₀₃
H ₀₄ : Credit Card Lending →Financial Sustainability	.098	<0.001	Reject the null hypothesis- H ₀₄
Financial Lending Innovation →Financial Sustainability	.037	<0.001	Reject the null hypothesis
Financial Lending Innovation→Operational Efficiency	.034	<0.001	Reject the null hypothesis
H ₀₅ : Financial Lending Innovation→Operational Efficiency→Financial Sustainability (Indirect Mediation effect)	.0217	<0.001	Reject the null hypothesis- H ₀₅

Source, Researcher, 2025

The results indicate that financial lending innovation significantly improves financial sustainability using both the direct and indirect mediation process through operational efficiency.

The result therefore confirms that financial lending innovations directly enhances financial

performances, it also enhanced when banks embrace operational efficiency. Lastly the mediation effects show that operational efficiency is a critical path that complements other underlying lending innovations which boost financial sustainability of banks.

5.4. Recommendations

Based on the key findings of objective one, the study recommends that stakeholders in the digital lending sector should advocate for regulatory frameworks that balance innovation with consumer protection. Easing restrictive regulations can encourage the development of new products while safeguarding users. Additionally, improving the accuracy and transparency of digital credit scoring through advanced data analytics is vital for maintaining customer trust and ensuring long-term viability. Emphasis should also be placed on enhancing customer service and user experience, as these factors are central to user satisfaction and market growth. Addressing these regulatory and technological challenges will support the sustainable integration of digital lending into Kenya's commercial banking landscape.

Based on the key findings, the study recommends that commercial banks in Kenya strategically adopt open banking innovations to enhance operational efficiency and financial sustainability. Banks should invest in building robust digital infrastructure and foster a culture of continuous professional development to equip staff with the necessary skills for effective implementation. Ensuring job security during technological transitions is also vital for boosting employee morale and commitment. Additionally, the study urges financial institutions to work closely with regulatory bodies to strengthen consumer protection, uphold compliance, and address issues such

as credit scoring errors. These measures collectively aim to improve customer experience, build loyalty, and enhance the banks' competitiveness in an evolving financial landscape.

Based on the key findings of objective three, it is recommended that Kenyan commercial banks continue adopting and expanding block chain-based lending systems to enhance operational efficiency, transparency, and financial stability. To support this shift, banks should invest in continuous staff training to address knowledge gaps and reinforce the long-term relevance of block chain technology. Additionally, regulatory bodies such as the Central Bank of Kenya should establish clear, adaptable policies that promote innovation while safeguarding financial stability and consumer rights. Finally, commercial banks are encouraged to document and share real-world success stories to build industry-wide confidence and accelerate the responsible integration of block chain solutions.

Based on the key findings of fourth objective, it is recommended that commercial banks in Kenya adopt a more strategic, risk-conscious approach when implementing innovations in credit card lending. While customer-friendly features like flexible repayment plans can enhance satisfaction, they must be balanced with robust credit risk management to ensure long-term financial stability. Banks should also reassess their interest rate structures and lending terms to encourage responsible borrowing and safeguard portfolio quality. Additionally, aligning product innovations with regulatory requirements and enhancing consumer protection measures will help build trust and transparency in the credit market. Overall, integrating customer-centric

innovation with financial prudence is essential for enhancing operational performance and sustaining the growth of credit card services in Kenya.

To enhance operational efficiency and financial sustainability, banks should invest in workforce development by prioritizing training and upskilling programs to address skill gaps related to managing digital lending innovations such as credit card systems. Additionally, ongoing investment in stable and reliable digital infrastructure, including ERP and credit card processing systems, is crucial to support efficient lending services. Strengthening loan management through automated, technology-driven approaches will help maintain control over loan collections and non-performing loans, improving financial outcomes. Integrating credit card lending into broader risk management strategies can diversify credit offerings and enhance operational resilience. Finally, continuous monitoring and evaluation of these innovations' impact on efficiency and sustainability will enable banks to identify improvements and adapt their strategies effectively.

5.5. Study Implications

5.5.1. Theoretical Implications

The findings related to digital lending have significant theoretical implications, particularly when examined through the lens of Financial Intermediation Theory and Transaction Cost Theory. From the perspective of Financial Intermediation Theory, the results affirm that digital lending enhances the intermediary role of banks by reducing information asymmetry and increasing access to credit. Digital lending platforms facilitate faster credit appraisal and service delivery, enabling banks to reach previously underserved markets, thus reinforcing their financial intermediary function.

Furthermore, Transaction Cost Theory is reflected in the observed reduction in turnaround times and operational expenses. By automating credit processes and leveraging digital technologies, commercial banks are able to lower the costs of processing, monitoring, and enforcing loan agreements. However, the highlighted concerns about regulatory compliance and the reliability of credit scoring systems point to challenges in reducing transaction risks, underscoring the necessity for enhanced regulatory frameworks and technological robustness. These challenges suggest that while digital lending acts as a disruptive innovation, its full potential can only be realized through regulatory support and improved algorithmic transparency, aligning with the Disruptive Innovation Theory's emphasis on institutional adaptation for sustainable transformation.

The findings on open banking innovations can be interpreted within all three guiding theories. Financial Intermediation Theory is supported by the observed improvements in tailored service delivery and customer loyalty, which enhance the banks' intermediary role through greater personalization and transparency. Open banking facilitates seamless data sharing among financial entities, thereby enabling more informed credit decisions and fostering deeper customer relationships. From the perspective of Transaction Cost Theory, the reduction in operational costs and enhanced efficiency through decentralized service provision align with the theory's assertion that innovations lower the costs associated with financial transactions. Furthermore, the emphasis on staff training and regulatory compliance reflects the importance of minimizing internal resistance and maintaining institutional legitimacy, which are crucial in reducing coordination and enforcement costs.

Disruptive Innovation Theory is also strongly evident here: open banking represents a shift from traditional, siloed banking systems to more agile, customer-centric models. This disruption necessitates not only technological transformation but also cultural and regulatory shifts within banks. The successful implementation of open banking depends on an ecosystem that supports innovation while safeguarding stakeholders an insight that reinforces the theory's claim that institutions must evolve structurally and behaviorally to remain sustainable.

The findings concerning block chain-based lending offer profound theoretical contributions, especially in the context of Disruptive Innovation Theory and Transaction Cost Theory. Block chain technology fundamentally redefines traditional banking infrastructure by decentralizing data management and increasing transparency, thereby embodying a classic disruptive innovation. The participants' recognition of block chain's potential to improve data security and accountability reflects its capacity to shift industry norms, consistent with the disruptive model.

The mixed understanding among stakeholders further supports the theory's premise that disruptive technologies often face initial resistance or low comprehension before their full value is realized. Transaction Cost Theory is also affirmed as block chain minimizes verification, monitoring, and enforcement costs by automating and recording transactions on tamper-proof ledgers. This reduces the reliance on intermediaries and significantly lowers the risks associated with trust and fraud. Additionally, regulatory backing from the Central Bank of Kenya reinforces the need for institutional support to mainstream such innovations. The theoretical implication is that block chain can serve as both an enabler and accelerator of financial sustainability provided

there is strategic investment in stakeholder education, regulatory clarity, and technical infrastructure to close the knowledge and trust gaps.

The results of the study carry substantial theoretical significance, especially concerning Financial Intermediation Theory and Transaction Cost Theory. Although credit card lending continues to be a conventional method of financial intermediation, advancements in this domain seem to have a minimal effect on improving financial sustainability. This indicates a waning effectiveness of banks as intermediaries, attributed to heightened credit risks and inadequately designed loan products. Insufficient risk management and unwise lending practices could result in elevated default rates, thereby compromising the effectiveness of capital allocation.

Examining the nuances of Transaction Cost Theory reveals that the inefficiencies associated with default recovery, enforcement, and borrower monitoring are significantly exacerbated in the absence of effective pricing strategies and adequate borrower education. Moreover, the results suggest that innovations in credit cards do not conform to the tenets of Disruptive Innovation Theory, as they do not possess the transformative potential to alter the landscape of traditional banking. The findings of the study indicate that, in the absence of substantial reforms in credit risk management and regulatory oversight, advancements in credit card lending are likely to be limited and will not provide enduring, sustainable value.

5.5.2. Policy Implications

The findings on digital lending underscore the need for targeted policy interventions aimed at enhancing the regulatory and technological environment in which commercial banks operate. Policymakers, particularly the Central Bank of Kenya and the Communications Authority, should streamline and harmonize regulatory frameworks to reduce barriers to innovation while maintaining financial system integrity. Regulatory sandboxes and innovation hubs can facilitate experimentation with digital products under controlled conditions, allowing for gradual scalability.

Additionally, policies should prioritize the development of robust digital infrastructure and promote public-private partnerships to enhance system integration and data accuracy especially in credit scoring mechanisms. These efforts will ensure that digital lending continues to serve as a key driver of operational efficiency and financial sustainability across Kenya's banking sector.

The research findings on open banking point to significant opportunities for regulatory bodies to reinforce employee capacity and customer trust through supportive policy measures.

The Central Bank of Kenya and other relevant authorities should consider mandating open banking frameworks through standardized APIs, interoperability requirements, and strict data protection policies to safeguard consumers and institutions alike. Moreover, national policy should advocate for ongoing training and capacity-building programs to equip bank employees with the necessary skills to adapt to open banking systems. Incentivizing innovation through tax credits or grants for institutions implementing secure and inclusive open banking solutions could enhance

sector-wide adoption. These policy actions will collectively contribute to a more transparent, efficient, and customer-centric financial ecosystem, ultimately reinforcing financial sustainability.

Given the favourable yet cautious stance towards block chain-based lending, there is a pressing need for policy initiatives that enhance awareness, regulation, and infrastructure support. The Central Bank of Kenya, in collaboration with ICT ministries and academic institutions, should develop national awareness campaigns and pilot projects that showcase block chain's value in lending. Regulatory bodies should also formulate a comprehensive block chain policy framework that ensures compliance, standardization, and risk mitigation, while promoting innovation and market inclusivity. Special attention should be given to promoting education and technical skills in block chain technologies among financial professionals. Such measures will not only enhance adoption but also improve operational efficiency, data security, and financial sustainability across the sector.

The mixed findings regarding credit card lending innovations suggest that policymakers must revisit and strengthen the regulatory framework governing credit risk assessment, interest rate caps, and consumer protection. Financial regulators should enforce more stringent guidelines around credit card issuance, interest rate disclosures, and debt recovery practices to prevent over-indebtedness and maintain the health of banks' loan portfolios. Additionally, regulatory support should focus on improving credit education for consumers to encourage prudent borrowing practices. Banks should be incentivized to adopt advanced credit risk analytics and flexible yet responsible lending models that balance customer experience with long-term

profitability. These policies are essential for ensuring that credit card lending contributes positively to financial sustainability without undermining systemic stability.

5.6. Recommendations for further studies

The study recommends further studies on areas;

1. Future studies should explore additional mediating factors, such as digital infrastructure, customer satisfaction, and employee competence to gain a deeper insights and understanding of how financial lending innovations impact the financial sustainability of commercial banks.
2. It is recommended that future research adopt a longitudinal approach to evaluate the long-term effects of financial lending innovations on financial sustainability, more so distinguish between short-term and long-term benefit extending to different sectors.
3. Further research is recommended to test and analyze secondary data on lending innovations, such as digital lending platforms, credit card lending, and block chain credit scoring algorithms to assess their impact on operational efficiency and financial sustainability outcomes.
4. Future research should investigate the role of regulatory policies and institutional frameworks in shaping the effectiveness of financial lending innovations in promoting sustainability, particularly within non-financial institutions in Kenya. Such studies can provide critical insights for policymakers and industry stakeholders on creating enabling environments for innovation-driven sustainability firms.

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APPENDICES
APPENDIX I: INTRODUCTION LETTER

Dear Respondent,

I **Imbalo Patrick Kivale** postgraduate student **Reg No.PBA/H/01-70595/2021** enrolled at **Masinde Muliro University of Science and Technology**, will be conducting a study on **“Financial Lending Innovations and Financial Sustainability of Commercial Banks in Kenya”** as part of a broader academic research effort am required to do a study in partial fulfillment of requirements for award of Degree in Doctor of philosophy in Business Administration Finance and Accounting.

The study aims to investigate the impact of financial lending innovations like digital lending, open banking, block chain-based lending, and credit card lending on the financial sustainability and operational efficiency of Kenyan commercial banks.

Politely your Participation in this study is important for understanding banking sector dynamics and identifying sustainability strategies. Please note your identity, responses will be confidential, voluntary and will not appear in final report, and you can skip questions or withdraw at any time without consequences.

The questionnaires will take approximately 10-15 minutes of your valuable time to complete. Your thoughtful and honest responses are highly valued. If you have any questions or need further clarification regarding this study. Please feel free to contact me through the **Mobile number +254 725 594 424, email patkivale@gmail.com**

Thank you for your valuable input in my academic research, which is crucial for the advancement of knowledge in this field and capital development.

Yours faithfully,

Patrick Imbalo Kivale
Masinde Muliro University of Science and Technology
Department of Accounting and Finance

APPENDIX II: QUESTIONNAIRE

The questionnaire seeks to establish the effect of financial lending innovations on financial sustainability in Commercial Banks of Kenya, while assessing the Mediating effect of Operational efficiency on financial sustainability of banks.

PART 1: DEMOGRAPHIC INFORMATION

The 'Demographics' section below collects basic information about your personal background, such as gender, age, education level, and your experience, to help the researcher understand the characteristics of the respondents. Kindly select one that applies to you.

What is the Name of your Bank

1) What is your gender?.*

a) Male

b) Female

2) What is your age group?*.

a) 18 – 25

b) 30 – 35

c) 35 – 40

d) 40 – 45

e) 45– 50

f) 50– and Above

3) What is your highest level of education attained?.*

a) Secondary Level

b) Certificate/ Diploma Level

c) Undergraduate Level

- d) Graduate Level
- e) Post-graduate Level

4) Which Category or Tier does your Bank fall under?. *

- a) Tier 1 (Large established banks)
- b) Tier 2 (Medium-sized banks)
- c) Tier 3 (Small banks)

5) What is your level of work experience in the banking sector?.*

- a) 0-3 years
- b) 4 – 7 years
- c) 8 – 10 years
- d) Over ten years

6) Which department do you work in the Bank?*

- a) Customer Relations /Experience / Support
- b) Business Development
- c) Operations management
- d) Compliance and Reporting
- e) Marketing and client Relations management
- f) Information Technology and Security (IT)
- g) Finance Reporting
- h) Digital Channels department
- i) Products Development
- j) Bank Audit and Risk Management
- k) Bank Credit and Lending Services
- l) Others :

PART 2: INFORMATION ON BANK LENDING INNOVATIONS, PRODUCTS, MARKET SEGMENT AND SERVICES.

SECTION 1: Bank Lending Services and Staff Level of Preparedness of lending innovations implemented in the bank

a) What is your bank major lending market segment?

- (i) Digital client customer
- (ii) Retail Client Customer
- (iii) MSMEs
- (iv) Corporate Client

b) The bank lending services and practice are either; fully digital, manual or both manual and digital, please Tick the boxes for applicable process in your assisted lending (branches?)

- (i) Full Digital process
- (ii) Manual and Digital blended process
- (iii) Manual Lending processing

d) Kindly indicate the extend of your agreement with the following statements on the bank level of preparedness to adopt financial lending innovation and financial sustainability in box 1, 2, 3, 4, or 5,

Where 1=strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=strongly agree

A. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank.*

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Digital lending					
Open Banking Services					
Block chain Technology					
Credit Card Lending					
B. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service.					
	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Digital lending					
Open Banking Services					
Block chain Technology					
Credit Card Lending					
C. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. *					
	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Digital lending					
Open Banking Services					
Block chain Technology					
Credit Card Lending					
D. Financial Lending Innovations.					
	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
System fraud					
System breakdown					
Erroneous digital credit score					
High customer Default					

E. The bank’s strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services. *

Which of the following recovery process are practiced by your bank.

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Digital demand recovery					
Credit discount/Negotiated					
Cash payment recovery					
Auctioneers enforcements					

F. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below*

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Digital lending					
Open Banking Services					
Block chain Technology					
Credit Card Lending					

SECTION 2: My Bank has implemented and adopted listed Technological infrastructures and services to support the lending services.

S/No	Lending Innovations/Services	Applicable to Bank	Not Applicable
A.	Digital lending	<input type="checkbox"/> Digital E-wallet <input type="checkbox"/> Mobile-Banking <input type="checkbox"/> Agent Banking Solutions <input type="checkbox"/> Digital Credit score	
B.	Open Banking Services	<input type="checkbox"/> Open-end- credit score <input type="checkbox"/> Open banking applications (APIs) <input type="checkbox"/> Personalized Banking <input type="checkbox"/> Open banking collaboration(Fintech)	
C.	Block Chain Lending Services	<input type="checkbox"/> Accountable Data System <input type="checkbox"/> Data Immutability(Secured) <input type="checkbox"/> Digital Ledger <input type="checkbox"/> Digital currency	
D.	Credit Card Lending	<input type="checkbox"/> Cash back reward credit <input type="checkbox"/> Customer Payments Visa systems <input type="checkbox"/> Secured credit card <input type="checkbox"/> Unsecured credit card	

PART 3: FINANCIAL LENDING INNOVATIONS –DATA INSTRUMENT ITEMS

Kindly indicate your level of agreement with the following statements which seek to determine the effect of financial lending innovation adoption on financial sustainability in your bank in box 1, 2, 3, 4, or 5, where 1=Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree

Section A. Digital Lending Innovation

To a scale of 1 – 5 where 1=Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree,, what’s your comment in response to digital lending innovations practices in your bank based on the following?.

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Digital lending improve customer service Turnaround Time					
Digital lending increase satisfaction level, Customer base and Experience in the bank services					
Digital Lending increase market shares and products usage					
Stringent Bank regulation compliance prevent product launch					
Digital services may generate erroneous credit score					

Section B. Open banking Lending.

To a scale of 1 – 5 where 1=Strongly disagree, 2= Disagree, 3= Neutral, 4=Agree, 5=Strongly agree,, what’s your comment in response to open banking innovations practices in your bank based on the following?.

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Training and job security of Staff has increased confidence level, moral, the face to face disruption has widened open banking services to customers					
Customers have embraced open banking services in the bank boosting customer Experience and loyalty					
Open banking have reduced bank operational costs and increased value chain and products usage					
Stringent Bank regulation compliance prevents risks and protects consumers using opened banking services.					
Customer complains on erroneous credit score are resolved faster using open bank policy and decentralized services					

Section C. Block Chain Based Lending

To a scale of 1 – 5 1 – Strongly agree, 2 – Agree, 3 – Neutral, 4 – Disagree and 5 – strongly disagree, what’s your comment in response to Block chain based lending innovations practices in the bank based on the following.

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
The block chain protects the bank against digital risks, hence stability in operations.					
The Central Bank of Kenya regulates licensing, approval to implement the global market block chain lending system, has the process is been finalized by your bank.					
Block chain technology if utilized in the lending operations and can contribute to financial sustainability of your bank?					
Use of block-chain technology support system security due to data mutability, accountability and transparency in capital allocation and sustainability of bank services.					
The block chain lending services and digital currency impact lending, as standardized digital services, currency, enhances customer experience (%).					

Section D. Credit Card Lending

To a scale of 1 – 5 1 – Strongly agree, 2 – Agree, 3 – Neutral, 4 – Disagree and 5 – strongly disagree, what’s your comment in response to Block chain based lending innovations practices in the bank based on the following?

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Has key innovation in credit card lending improved overall loan portfolio growth sustainability of your bank.					
Has the Bank's interest rates and loan structures conditions on credit cards encourage responsible borrowing, which contribute to financial sustainability of bank.					
There is notable improvement in customer experience after your bank introduced flexible repayment arrangement to customers with lower interest rates conditions depending on usage of card.					
Flexible repayment models as innovations has improved customer base growth, customer retention and long-term profitability of bank					
Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank’s credit card lending strategies and long-term sustainability					

Section E. Financial sustainability

To a scale of 1 – 5 1 – Strongly agree, 2 – Agree, 3 – Neutral, 4 – Disagree and 5 – strongly disagree, what’s your comment in response to the effect of financial lending innovations, operational efficiency on financial sustainability practices in the bank based on the following?

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
The introduction of lending innovations improved your bank target lending segment in the market and business Growth.					
The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs.					
The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contribute to the financial sustainability and profitability of your bank in Kenya					
Your bank has employed customer focused strategies to manage customer relation, experience and retention to which reduces bad credit, default and minimizes level of Non-performing loans?					
Your bank ensures financial sustainability by diversification of revenue streams product lines, Digital banking and prudent lending for long term stability					

Section F. Operational Efficiency

To a scale of 1 – 5 1 – Strongly agree, 2 – Agree, 3 – Neutral, 4 – Disagree and 5 – strongly disagree, what’s your comment in response on the effect of financial lending innovation of operational efficiency practices in the bank based on the following?

	1	2	3	4	5
	Strongly Disagree			Strongly Agree	
Has digitization of the branches networks impacted efficiency levels in the bank?.					
Enterprise resource planning systems in my banks are stable, up-to-date, and reliable and support bank lending services *.					
The bank uses negotiated approach and legal process to enforce loan collection of defaulted loans and Non-Performing loans.					
Staff Technological skill and experience has broadened bank product outreach to wider market					
The bank takes appropriate approaches to manage inherent internal system challenges and risks affecting lending innovations process.					

APPENDIX III: LIST OF COMMERCIAL BANKS IN KENYA

S/No.	Name of Bank	Remarks
1	African Banking Corporation Limited	
2	Bank of Africa Kenya Limited	
3	Bank of Baroda (K) Limited	
4	Bank of India	
5	ABSA Bank of Kenya Limited	
6	CFC Stanbic Bank Limited	
7	Citibank N.A Kenya	
8	NCBA Bank of Kenya Limited	
9	Consolidated Bank of Kenya Limited	
10	Co-operative Bank of Kenya Limited	
11	Credit Bank Limited	
12	Development Bank of Kenya Limited	
13	Diamond Trust Bank Kenya Limited	
14	Ecobank Kenya Limited	
15	Equatorial Commercial Bank Limited	
16	Equity Bank Kenya Limited	
17	Family Bank Limited	
18	Fidelity Commercial Bank Limited	
19	First Community Bank Limited	
20	Guaranty Trust Bank (K) Ltd	
21	Giro Commercial Bank Limited	
22	Guardian Bank Limited	
23	Gulf African Bank Limited	
24	Habib Bank A.G Zurich	
25	Habib Bank Limited	
26	I and M Bank Limited	
27	Jamii Bora Bank Limited	
28	KCB Bank Kenya Limited	
29	Middle East Bank (K) Limited	
30	National Bank of Kenya Limited	
31	NIC Bank Limited	
32	Oriental Commercial Bank Limited	
33	Paramount Bank Limited	
34	Prime Bank Limited	
35	Sidian Bank Limited	
36	Standard Chartered Bank Kenya Limited	
37	Trans-National Bank Limited	
38	UBA Kenya Bank Limited	
39	Victoria Commercial Bank Limited	

APPENDIX IV: PILOT SURVEY VALIDITY TEST ANALYSIS

A. Validity Tests

1. Construct Validity Test

In this study the construct validity is tested through **factor analysis** to confirm that the items measure the intended constructs (Hair et al., 2019).

In order to ascertain construct validity, the researcher will utilize the **Keiser –Meyer Olkin (KMO)** to measure adequacy of sampling to check for variance in the variables which might be because of underlying factors High values (close to 1.0) indicates that factor analysis may be useful in the data collected.

Factor analysis will help identify the main components or factors underlying the questionnaire items and assess how well these factors align with the theoretical framework of financial sustainability in commercial banks.

Table 3: Construct Validity

Variable	Initial	Extraction
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Digital lending]	1.000	.981
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Open Banking Services]	1.000	.972
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Block chain Technology]	1.000	.986
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Credit Card Lending]	1.000	.995
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Digital lending]	1.000	.990

Variable	Initial	Extraction
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Open Banking Services]	1.000	.999
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Block chain Technology]	1.000	.977
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Credit Card Lending]	1.000	.996
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Digital lending]	1.000	.984
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Open Banking Services]	1.000	.999
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Block chain Technology]	1.000	.884
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Credit Card Lending]	1.000	.986
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System fraud]	1.000	.999
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System breakdown]	1.000	.997
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [Erroneous digital credit score]	1.000	.843
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [High customer Default]	1.000	.967
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services.	1.000	.979

Variable	Initial	Extraction
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services.	1.000	.975
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services.	1.000	1.000
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services.	1.000	.930
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Digital lending]	1.000	.992
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Open Banking Services]	1.000	.991
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Block chain Technology]	1.000	.968
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Credit Card Lending]	1.000	.953
A. Digital Lending Innovation [Digital lending improve customer service Turnaround Time]	1.000	.994
A. Digital Lending Innovation [Digital lending increase satisfaction level, Customer base and Experience in the bank services]	1.000	.998
A. Digital Lending Innovation [Digital Lending increase market shares and products usage]	1.000	.998
A. Digital Lending Innovation [Stringent Bank regulation compliance prevent product launch]	1.000	.995
A. Digital Lending Innovation [Digital services may generate erroneous credit score]	1.000	.981

Variable	Initial	Extraction
B. Open banking Lending [Training and job security of Staff has increased confidence level, moral, the face to face disruption has widened open banking services to customers.]	1.000	.942
B. Open banking Lending [Customers have embraced open banking services in the bank boosting customer Experience and loyalty.]	1.000	.994
B. Open banking Lending [Open banking have reduced bank operational costs and increased value chain and products usage]	1.000	.887
B. Open banking Lending [Stringent Bank regulation compliance prevents risks and protects consumers using opened banking services.]	1.000	.968
B. Open banking Lending [Customer complains on erroneous credit score are resolved faster using open bank policy and decentralized services]	1.000	.980
C. Block Chain Based Lending [The block chain protects the bank against digital risks, hence stability in operations.]	1.000	.964
C. Block Chain Based Lending [The Central Bank of Kenya regulates licensing, approval to implement the global market block chain lending system, has the process is been finalized by your bank.]	1.000	.976
C. Block Chain Based Lending [Block chain technology if utilized in the lending operations and can contribute to financial sustainability of your bank?.]	1.000	.985
C. Block Chain Based Lending [Use of block-chain technology support system security due to data mutability, accountability and transparency in capital allocation and sustainability of bank services.]	1.000	.994
C. Block Chain Based Lending [The block chain lending services and digital currency impact lending, as standardized digital services, currency, enhances customer experience (%).]	1.000	.904
D. Credit Card Lending [Has key innovation in credit card lending improved overall loan portfolio growth sustainability of your bank.]	1.000	.901
D. Credit Card Lending [Has the Bank's interest rates and loan structures conditions on credit cards encourage responsible borrowing, which contribute to financial sustainability of bank.]	1.000	.997

Variable	Initial	Extraction
D. Credit Card Lending [There is notable improvement in customer experience after your bank introduced flexible repayment arrangement to customers with lower interest rates conditions depending on usage of card.]	1.000	.976
D. Credit Card Lending [Flexible repayment models as innovations has improved customer base growth, customer retention and long-term profitability of bank]	1.000	.879
D. Credit Card Lending [Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and long-term sustainability]	1.000	.936
E. Financial sustainability [The introduction of lending innovations improved your bank target lending segment in the market and business Growth.]	1.000	.975
E. Financial sustainability [The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs.]	1.000	.970
E. Financial sustainability [The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contribute to the financial sustainability and profitability of your bank in Kenya]	1.000	.976
E. Financial sustainability [Your bank has employed customer focused strategies to manage customer relation, experience and retention to which reduces bad credit, default and minimizes level of Non-performing loans?]	1.000	.999
E. Financial sustainability [Your bank ensures financial sustainability by diversification of revenue streams product lines, Digital banking and prudent lending for long term stability]	1.000	.992
A. Digital lending [Digital E-wallet]	1.000	.791
A. Digital lending [Mobile-Banking]	1.000	.984
A. Digital lending [Agent Banking Solutions]	1.000	.823
A. Digital lending [Digital Credit score]	1.000	.998
B: Open Banking services [Open-end- credit score]	1.000	.984
B: Open Banking services [Open banking applications (APIs)]	1.000	.994
B: Open Banking services [Personalized Banking]	1.000	.995
B: Open Banking services [Open banking collaboration (Fintech)]	1.000	.994
C: Block Chain Lending Services [Accountable Data System]	1.000	.976
C: Block Chain Lending Services [Data Immutability (Secured)]	1.000	.994
C: Block Chain Lending Services [Digital Ledger]	1.000	.994

Variable	Initial	Extraction
C: Block Chain Lending Services [Digital currency]	1.000	.987
D: Credit card Lending [Cash back reward credit]	1.000	.995
D: Credit card Lending [Customer Payments Visa systems]	1.000	.995
D: Credit card Lending [Secured credit card]	1.000	.995
D: Credit card Lending [Unsecured credit card]	1.000	.948
F. Operational Efficiency [Has digitization of the branch's networks impacted efficiency levels in the bank?]	1.000	.996
F. Operational Efficiency [Enterprise resource planning systems in my banks are stable, up-to-date, and reliable and support bank lending services *.]	1.000	.988
F. Operational Efficiency [Has the Bank operational shift toward digital banking has affected the skills required from bank employee; the skill gap may affect efficiency and work performance.]	1.000	.994
F. Operational Efficiency [The bank uses negotiated approach and legal process to enforce loan collection of defaulted loans and Non-Performing loans.]	1.000	.992
F. Operational Efficiency [Staff Technological skill and experience has broadened bank product outreach to wider market]	1.000	.975
F. Operational Efficiency [The bank takes appropriate approaches to manage inherent internal system challenges and risks affecting lending innovations process.]	1.000	.996
F. Operational Efficiency [Technology has played a role in improving the operational efficiency of your bank]	1.000	.999

Extraction Method: Principal Component Analysis.

The findings show that; Almost all extraction values are very high, ranging from about 0.79 to 1.000, indicating that the components extracted from Principal Component Analysis (PCA) explain a large portion of the variance in each item.

The items with particularly high communalities (≥ 0.99) include those related to:

- i) Investment in technology infrastructure
- ii) Risk assessment for fraud/system breakdown
- iii) Open banking policy and regulatory compliance
- iv) Operational efficiency due to digitization

The items with relatively lower communalities (but still acceptable):

- i) Digital lending via Digital E-wallet (.791)
- ii) Agent Banking Solutions (.823)
- iii) Erroneous digital credit score risk assessment (.843)
- iv) Open banking product usage (.887)
- v) Some credit card innovations (.879, .901, etc.)

The PCA model does a very good explanation on most of the variance in responses. The lower communalities in some technology sub-items might suggest they are either, less central to the underlying factor structure, or represent more nuanced or divergent views among respondents.

2. Content Validity Test

The content validity test is based on Lawshes method content validity ratio for assessing content validity.

Table 4: The Content Validity

Variable	Total Agreement	I-CVI
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Digital lending]	13	1.0000
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Open Banking Services]	12	0.9231
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Block chain Technology]	12	0.9231
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees transition to adopted Financial Lending Innovations in bank. [Credit Card Lending]	13	1.0000
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for	13	1.0000

Variable	Total Agreement	I-CVI
implementing and adoption of financial lending service. [Digital lending]		
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Open Banking Services]	13	1.0000
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Block chain Technology]	12	0.9231
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Credit Card Lending]	13	1.0000
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Digital lending]	12	0.9231
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Open Banking Services]	11	0.8462
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Block chain Technology]	11	0.8462
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Credit Card Lending]	12	0.9231
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System fraud]	13	1.0000
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System breakdown]	13	1.0000
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [Erroneous digital credit score]	11	0.8462
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [High customer Default]	13	1.0000
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	13	1.0000
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate	12	0.9231

Variable	Total Agreement	I-CVI
support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services		
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	12	0.9231
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	12	0.9231
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Digital lending]	13	1.0000
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Open Banking Services]	12	0.9231
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Block chain Technology]	12	0.9231
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Credit Card Lending]	12	0.9231
A. Digital Lending Innovation [Digital lending improve customer service Turnaround Time]	13	1.0000
A. Digital Lending Innovation [Digital lending increase satisfaction level, Customer base and Experience in the bank services]	13	1.0000
A. Digital Lending Innovation [Digital Lending increase market shares and products usage]	13	1.0000
A. Digital Lending Innovation [Stringent Bank regulation compliance prevent product launch]	12	0.9231
A. Digital Lending Innovation [Digital services may generate erroneous credit score]	12	0.9231
B. Open banking Lending [Training and job security of Staff has increased confidence level, moral, the face to face disruption has widened open banking services to customers.]	13	1.0000
B. Open banking Lending [Customers have embraced open	13	1.0000

Variable	Total Agreement	I-CVI
banking services in the bank boosting customer Experience and loyalty.]		
B. Open banking Lending [Open banking have reduced bank operational costs and increased value chain and products usage]	13	1.0000
B. Open banking Lending [Stringent Bank regulation compliance prevents risks and protects consumers using opened banking services.]	13	1.0000
B. Open banking Lending [Customer complains on erroneous credit score are resolved faster using open bank policy and decentralized services]	12	0.9231
C. Block Chain Based Lending [The block chain protects the bank against digital risks, hence stability in operations.]	12	0.9231
C. Block Chain Based Lending [The Central Bank of Kenya regulates licensing, approval to implement the global market block chain lending system, has the process is been finalized by your bank.]	13	1.0000
C. Block Chain Based Lending [Block chain technology if utilized in the lending operations and can contribute to financial sustainability of your bank?.]	13	1.0000
C. Block Chain Based Lending [Use of block-chain technology support system security due to data mutability, accountability and transparency in capital allocation and sustainability of bank services.]	13	1.0000
C. Block Chain Based Lending [The block chain lending services and digital currency impact lending, as standardized digital services, currency, enhances customer experience (%).]	13	1.0000
D. Credit Card Lending [Has key innovation in credit card lending improved overall loan portfolio growth sustainability of your bank.]	12	0.9231
D. Credit Card Lending [Has the Bank's interest rates and loan structures conditions on credit cards encourage responsible borrowing, which contribute to financial sustainability of bank.]	13	1.0000
D. Credit Card Lending [There is notable improvement in customer experience after your bank introduced flexible repayment arrangement to customers with lower interest rates conditions depending on usage of card.]	13	1.0000
D. Credit Card Lending [Flexible repayment models as innovations has improved customer base growth, customer retention and long-term profitability of bank]	12	0.9231
D. Credit Card Lending [Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and	12	0.9231

Variable	Total Agreement	I-CVI
long-term sustainability]		
E. Financial sustainability [The introduction of lending innovations improved your bank target lending segment in the market and business Growth.]	11	0.8462
E. Financial sustainability [The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs.]	10	0.7692
E. Financial sustainability [The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contribute to the financial sustainability and profitability of your bank in Kenya]	11	0.8462
E. Financial sustainability [Your bank has employed customer focused strategies to manage customer relation, experience and retention to which reduces bad credit, default and minimizes level of Non-performing loans?]	11	0.8462
E. Financial sustainability [Your bank ensures financial sustainability by diversification of revenue streams product lines, Digital banking and prudent lending for long term stability]	11	0.8462
F. Operational Efficiency [Has digitization of the branches networks impacted efficiency levels in the bank?.]	11	0.8462
F. Operational Efficiency [Enterprise resource planning systems in my banks are stable, up-to-date, and reliable and support bank lending services *.]	10	0.7692
F. Operational Efficiency [Has the Bank operational shift toward digital banking has affected the skills required from bank employee; the skill gap may affect efficiency and work performance.]	11	0.8462
F. Operational Efficiency [The bank uses negotiated approach and legal process to enforce loan collection of defaulted loans and Non-Performing loans.]	11	0.8462
F. Operational Efficiency [Staff Technological skill and experience has broadened bank product outreach to wider market]	11	0.8462
F. Operational Efficiency [The bank takes appropriate approaches to manage inherent internal system challenges and risks affecting lending innovations process.]	11	0.8462
F. Operational Efficiency [Technology has played a role in improving the operational efficiency of your bank]	11	0.8462

The findings indicate that on the average Scale-CVI is 0.931. This is the average proportion of items rated as content valid across all experts. The value is above 0.90 and

therefore considered excellent, meaning strong overall agreement among experts about the relevance of the items.

The Universal Agreement value is 0.411. This is the proportion of items that all experts rated as relevant. A value of 0.41 indicates moderate universal agreement, which is not ideal. Typically, a value ≥ 0.80 is preferred, but it's common for Universal Agreement to be lower than average Scale-CVI. Moderate UA indicates that there's room for improvement in universal agreement.

The Total Agreement is 23. This refers to the number of items for which there was total agreement among raters (i.e., all raters considered the item valid). In validating a questionnaire, the average score suggests it's acceptable, but individual item review might be needed.

3. Criterion validity

Criterion validity evaluates the extent to which the research instrument accurately predicts or correlates with an external criterion or gold standard. In this study, criterion validity could be assessed by comparing the results obtained from the research instrument (e.g., questionnaire responses or financial metrics) with an established measure of financial sustainability, such as credit ratings or financial performance indicators (Trochim and Donnelly, 2008).

Table 5: Criterion Validity Test

Variable		Total
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Digital lending]	Pearson	.586*
	Correlation	
	Sig. (2-tailed)	.035
	N	13
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Open Banking Services]	Pearson	.740**
	Correlation	
	Sig. (2-tailed)	.004
	N	13
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Block chain Technology]	Pearson	.319
	Correlation	
	Sig. (2-tailed)	.288
	N	13
10. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Credit Card Lending]	Pearson	.787**
	Correlation	
	Sig. (2-tailed)	.001
	N	13
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Digital lending]	Pearson	.706**
	Correlation	
	Sig. (2-tailed)	.007
	N	13
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Open Banking Services]	Pearson	.892**
	Correlation	
	Sig. (2-tailed)	.000
	N	13
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Block chain Technology]	Pearson	.543
	Correlation	
	Sig. (2-tailed)	.055
	N	13
11. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Credit Card Lending]	Pearson	.797**
	Correlation	
	Sig. (2-tailed)	.001
	N	13
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Digital lending]	Pearson	.635*
	Correlation	
	Sig. (2-tailed)	.020
	N	13
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Open Banking Services]	Pearson	.763**
	Correlation	
	Sig. (2-tailed)	.002
	N	13
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Block chain Technology]	Pearson	.440
	Correlation	
	Sig. (2-tailed)	.132
	N	13

Variable		Total
12. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Credit Card Lending]	Pearson	.603*
	Correlation	.029
	Sig. (2-tailed)	.13
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System fraud]	N	13
	Pearson	.458
	Correlation	.116
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System breakdown]	Sig. (2-tailed)	.13
	Pearson	.732**
	Correlation	.004
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [Erroneous digital credit score]	Sig. (2-tailed)	.13
	Pearson	.305
	Correlation	.311
13. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [High customer Default]	Sig. (2-tailed)	.13
	Pearson	.211
	Correlation	.489
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	Sig. (2-tailed)	.13
	Pearson	.691**
	Correlation	.009
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	N	13
	Pearson	.600*
	Correlation	.030
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	Sig. (2-tailed)	.13
	Pearson	.718**
	Correlation	.006
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services	Sig. (2-tailed)	.13
	Pearson	.256
	Correlation	.398
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Digital lending]	Sig. (2-tailed)	.13
	Pearson	.482
	Correlation	.095
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Open Banking Services]	Sig. (2-tailed)	.13
	Pearson	.715**
	Correlation	.006
	N	13

Variable		Total
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Block chain Technology]	Pearson	.200
	Correlation	
	Sig. (2-tailed)	.512
	N	13
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Credit Card Lending]	Pearson	.574*
	Correlation	
	Sig. (2-tailed)	.040
	N	13
A. Digital Lending Innovation [Digital lending improve customer service Turnaround Time]	Pearson	.610*
	Correlation	
	Sig. (2-tailed)	.027
	N	13
A. Digital Lending Innovation [Digital lending increase satisfaction level, Customer base and Experience in the bank services]	Pearson	.721**
	Correlation	
	Sig. (2-tailed)	.005
	N	13
A. Digital Lending Innovation [Digital Lending increase market shares and products usage]	Pearson	.721**
	Correlation	
	Sig. (2-tailed)	.005
	N	13
A. Digital Lending Innovation [Stringent Bank regulation compliance prevent product launch]	Pearson	.294
	Correlation	
	Sig. (2-tailed)	.330
	N	13
A. Digital Lending Innovation [Digital services may generate erroneous credit score]	Pearson	.057
	Correlation	
	Sig. (2-tailed)	.854
	N	13
B. Open banking Lending [Training and job security of Staff has increased confidence level, moral, the face to face disruption has widened open banking services to customers.]	Pearson	.667*
	Correlation	
	Sig. (2-tailed)	.013
	N	13
B. Open banking Lending [Customers have embraced open banking services in the bank boosting customer Experience and loyalty.]	Pearson	.787**
	Correlation	
	Sig. (2-tailed)	.001
	N	13
B. Open banking Lending [Open banking have reduced bank operational costs and increased value chain and products usage]	Pearson	.567*
	Correlation	
	Sig. (2-tailed)	.043
	N	13
B. Open banking Lending [Stringent Bank regulation compliance prevents risks and protects consumers using opened banking services.]	Pearson	.572*
	Correlation	
	Sig. (2-tailed)	.041
	N	13
B. Open banking Lending [Customer complains on erroneous	Pearson	.718**

Variable		Total
credit score are resolved faster using open bank policy and decentralized services]	Correlation	
	Sig. (2-tailed)	.006
	N	13
C. Block Chain Based Lending [The block chain protects the bank against digital risks, hence stability in operations.]	Pearson	.736**
	Correlation	
	Sig. (2-tailed)	.004
C. Block Chain Based Lending [The Central Bank of Kenya regulates licensing, approval to implement the global market block chain lending system, has the process is been finalized by your bank.]	N	13
	Pearson	.480
	Correlation	
C. Block Chain Based Lending [The Central Bank of Kenya regulates licensing, approval to implement the global market block chain lending system, has the process is been finalized by your bank.]	Sig. (2-tailed)	.097
	N	13
	Pearson	.488
C. Block Chain Based Lending [Block chain technology if utilized in the lending operations and can contribute to financial sustainability of your bank?.]	Correlation	
	Sig. (2-tailed)	.091
	N	13
C. Block Chain Based Lending [Use of block-chain technology support system security due to data mutability, accountability and transparency in capital allocation and sustainability of bank services.]	Pearson	.426
	Correlation	
	Sig. (2-tailed)	.147
C. Block Chain Based Lending [The block chain lending services and digital currency impact lending, as standardized digital services, currency, enhances customer experience (%).]	N	13
	Pearson	.008
	Correlation	
D. Credit Card Lending [Has key innovation in credit card lending improved overall loan portfolio growth sustainability of your bank.]	Sig. (2-tailed)	.980
	N	13
	Pearson	.463
D. Credit Card Lending [Has the Bank's interest rates and loan structures conditions on credit cards encourage responsible borrowing, which contribute to financial sustainability of bank.]	Correlation	
	Sig. (2-tailed)	.111
	N	13
D. Credit Card Lending [There is notable improvement in customer experience after your bank introduced flexible repayment arrangement to customers with lower interest rates conditions depending on usage of card.]	Pearson	-.032
	Correlation	
	Sig. (2-tailed)	.916
D. Credit Card Lending [Flexible repayment models as innovations has improved customer base growth, customer retention and long-term profitability of bank]	N	13
	Pearson	.419
	Correlation	
D. Credit Card Lending [Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and long-term sustainability]	Sig. (2-tailed)	.154
	N	13
	Pearson	.484
D. Credit Card Lending [Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and long-term sustainability]	Correlation	
	Sig. (2-tailed)	.094
	N	13
D. Credit Card Lending [Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and long-term sustainability]	Pearson	.363
	Correlation	
	Sig. (2-tailed)	.223
D. Credit Card Lending [Regulatory changes around consumer protection, transparency, and interest rate caps have impacted your bank's credit card lending strategies and long-term sustainability]	N	13

Variable		Total
E. Financial sustainability [The introduction of lending innovations improved your bank target lending segment in the market and business Growth.]	Pearson	.680*
	Correlation	
	Sig. (2-tailed)	.011
	N	13
E. Financial sustainability [The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs.]	Pearson	.715**
	Correlation	
	Sig. (2-tailed)	.006
	N	13
E. Financial sustainability [The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contribute to the financial sustainability and profitability of your bank in Kenya]	Pearson	.556*
	Correlation	
	Sig. (2-tailed)	.048
	N	13
E. Financial sustainability [Your bank has employed customer focused strategies to manage customer relation, experience and retention to which reduces bad credit, default and minimizes level of Non-performing loans?]	Pearson	.660*
	Correlation	
	Sig. (2-tailed)	.014
	N	13
E. Financial sustainability [Your bank ensures financial sustainability by diversification of revenue streams product lines, Digital banking and prudent lending for long term stability]	Pearson	.755**
	Correlation	
	Sig. (2-tailed)	.003
	N	13
A. Digital lending [Digital E-wallet]	Pearson	.434
	Correlation	
	Sig. (2-tailed)	.138
	N	13
A. Digital lending [Mobile-Banking]	Pearson	.399
	Correlation	
	Sig. (2-tailed)	.177
	N	13
A. Digital lending [Agent Banking Solutions]	Pearson	.560*
	Correlation	
	Sig. (2-tailed)	.047
	N	13
A. Digital lending [Digital Credit score]	Pearson	.580*
	Correlation	
	Sig. (2-tailed)	.038
	N	13
B: Open Banking services [Open-end- credit score]	Pearson	.399
	Correlation	
	Sig. (2-tailed)	.177
	N	13
B: Open Banking services [Open banking applications (APIs)]	Pearson	.610*
	Correlation	
	Sig. (2-tailed)	.027
	N	13
B: Open Banking services [Personalized Banking]	Pearson	.283

Variable		Total
	Correlation	
	Sig. (2-tailed)	.348
	N	13
B: Open Banking services [Open banking collaboration (Fintech)]	Pearson Correlation	.610*
	Sig. (2-tailed)	.027
	N	13
C: Block Chain Lending Services [Accountable Data System]	Pearson Correlation	.543
	Sig. (2-tailed)	.055
	N	13
C: Block Chain Lending Services [Data Immutability (Secured)]	Pearson Correlation	.610*
	Sig. (2-tailed)	.027
	N	13
C: Block Chain Lending Services [Digital Ledger]	Pearson Correlation	.610*
	Sig. (2-tailed)	.027
	N	13
C: Block Chain Lending Services [Digital currency]	Pearson Correlation	-.056
	Sig. (2-tailed)	.855
	N	13
D: Credit card Lending [Cash back reward credit]	Pearson Correlation	.283
	Sig. (2-tailed)	.348
	N	13
D: Credit card Lending [Customer Payments Visa systems]	Pearson Correlation	.283
	Sig. (2-tailed)	.348
	N	13
D: Credit card Lending [Secured credit card]	Pearson Correlation	.283
	Sig. (2-tailed)	.348
	N	13
D: Credit card Lending [Unsecured credit card]	Pearson Correlation	-.274
	Sig. (2-tailed)	.366
	N	13
F. Operational Efficiency [Has digitization of the branches networks impacted efficiency levels in the bank?.]	Pearson Correlation	.726**
	Sig. (2-tailed)	.005
	N	13
F. Operational Efficiency [Enterprise resource planning systems in my banks are stable, up-to-date, and reliable and support bank	Pearson Correlation	.612*

Variable		Total
lending services *.]	Sig. (2-tailed)	.026
	N	13
F. Operational Efficiency [Has the Bank operational shift toward digital banking has affected the skills required from bank employee; the skill gap may affect efficiency and work performance.]	Pearson	.635*
	Correlation	
	Sig. (2-tailed)	.020
	N	13
F. Operational Efficiency [The bank uses negotiated approach and legal process to enforce loan collection of defaulted loans and Non-Performing loans.]	Pearson	.654*
	Correlation	
	Sig. (2-tailed)	.015
	N	13
F. Operational Efficiency [Staff Technological skill and experience has broadened bank product outreach to wider market]	Pearson	.620*
	Correlation	
	Sig. (2-tailed)	.024
	N	13
F. Operational Efficiency [The bank takes appropriate approaches to manage inherent internal system challenges and risks affecting lending innovations process.]	Pearson	.607*
	Correlation	
	Sig. (2-tailed)	.028
	N	13
F. Operational Efficiency [Technology has played a role in improving the operational efficiency of your bank]	Pearson	.681*
	Correlation	
	Sig. (2-tailed)	.010
	N	13

In criterion tests, correlation coefficients indicate the strength and direction of the relationship between a test and a criterion variable. A positive correlation suggests that higher scores on the test are associated with higher scores on the criterion, indicating good concurrent or predictive validity. Conversely, a negative correlation or no correlation suggests poor validity, meaning the test doesn't accurately measure the intended construct.

A positive correlation (e.g., $r = 0.80$) indicates that as scores on the test increase, scores on the criterion variable also tend to increase. This suggests that the test is valid, as it accurately reflects the construct being measured.

A negative correlation (e.g., $r = -0.50$) indicates that as scores on the test increase, scores on the criterion variable tend to decrease. This suggests that the test may not be

measuring the intended construct or that there's a reverse relationship between the test and the criterion.

The following variables had significant relationship with the scores on the criterion.

1. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Digital lending]
2. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Open Banking Services]
3. The bank has made flexible programs and allocate adequate training time and financial resources to support bank employees' transition to adopted Financial Lending Innovations in bank. [Credit Card Lending]
4. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Digital lending]
5. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Open Banking Services]
6. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Block chain Technology]
7. The bank has committed more resources and invested heavily in modern Technology infrastructure critical for implementing and adoption of financial lending service. [Credit Card Lending]
8. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Digital lending]
9. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Open Banking Services]

10. The bank has a well-established open door policy on data sharing information for streamlining operations and managing of risks in lending services. [Credit Card Lending]
11. My bank takes reasonable risk assessment to mitigate, detect and prevent potential threats to financial lending innovations. [System breakdown]
12. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services
13. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services
14. The bank's strategic goals on loan recovery process are clear to staff in lending department, the bank ensures adequate support when integrating the technology infrastructure to facilitate loans recovery to ensure sustainability of bank services
15. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Open Banking Services]
16. I have access to a wide range of bank new technologies like cloud, mobile, open banking, and big data and digital reports on credit score in all bank lending services below. [Credit Card Lending]
17. A. Digital Lending Innovation [Digital lending improve customer service Turnaround Time]
18. A. Digital Lending Innovation [Digital lending increase satisfaction level, Customer base and Experience in the bank services].
19. A. Digital Lending Innovation [Digital Lending increase market shares and products usage]
20. B. Open banking Lending [Training and job security of Staff has increased confidence level, moral, the face to face disruption has widened open banking services to customers.]
21. B. Open banking Lending [Customers have embraced open banking services in the bank boosting customer Experience and loyalty.]

22. B. Open banking Lending [Open banking have reduced bank operational costs and increased value chain and products usage]
23. B. Open banking Lending [Stringent Bank regulation compliance prevents risks and protects consumers using opened banking services.]
24. B. Open banking Lending [Customer complains on erroneous credit score are resolved faster using open bank policy and decentralized services]
25. C. Block Chain Based Lending [The block chain protects the bank against digital risks, hence stability in operations.]
26. E. Financial sustainability [The introduction of lending innovations improved your bank target lending segment in the market and business Growth.]
27. E. Financial sustainability [The bank performance and income growth rate has increased as a result of lending innovations and reduction in costs.]
28. E. Financial sustainability [The regulatory compliance, capital adequacy, risk management frameworks, digital transformation contribute to the financial sustainability and profitability of your bank in Kenya]
29. E. Financial sustainability [Your bank has employed customer focused strategies to manage customer relation, experience and retention to which reduces bad credit, default and minimizes level of non-performing loans?]
30. E. Financial sustainability [Your bank ensures financial sustainability by diversification of revenue streams product lines, Digital banking and prudent lending for long term stability]
31. Digital lending [Agent Banking Solutions]
32. Digital lending [Digital Credit score]
33. B: Open Banking services [Open banking applications (APIs)]
34. B: Open Banking services [Open banking collaboration (Fintech)]
35. C: Block Chain Lending Services [Data Immutability (Secured)]
36. C: Block Chain Lending Services [Digital Ledger]

A. Operational Efficiency [Has digitization of the branch's networks impacted efficiency levels in the bank?]

37. F. Operational Efficiency [Enterprise resource planning systems in my banks are stable, up-to-date, and reliable and support bank lending services *.]

38. F. Operational Efficiency [Has the Bank operational shift toward digital banking has affected the skills required from bank employee; the skill gap may affect efficiency and work performance.]
39. F. Operational Efficiency [The bank uses negotiated approach and legal process to enforce loan collection of defaulted loans and non-Performing loans.]
40. F. Operational Efficiency [Staff Technological skill and experience has broadened bank product outreach to wider market]
41. F. Operational Efficiency [The bank takes appropriate approaches to manage inherent internal system challenges and risks affecting lending innovations process.]
42. F. Operational Efficiency [Technology has played a role in improving the operational efficiency of your bank]

APPENDIX V: THESIS RESEARCH DEVELOPMENT WORK PLAN

Activity	Month 1-2	Month 3-4	Month 5-6	Month 7-8	Month 9-10	Month 11	Month 12
1. Proposal Development	Ongoing						
- Literature Review	X						
- Development of Research Questions and Objectives	X						
- Methodology Design	X						
2. Ethics Approval		X					
- Submission of Proposal to Ethics Committee		X					
- Incorporate Feedback and Finalize Approval		X					
3. Instrument Design and Piloting		X					
- Development of Questionnaire		X					
- Pilot Testing and Refinement		X					
4. Data Collection			X				
- Distribution of Questionnaires			X				
- Data Collection and Follow-up			X				
5. Data Cleaning and Preparation				X			
- Data Entry and Cleaning				X			
- Data Validation and Preparation				X			
6. Data Analysis				X	X		
- Testing CLRM Assumptions				X			
- Regression Analysis and Mediating Effects					X		
7. Report Writing					X	X	
- Drafting the Findings and Discussion Sections					X		
- Drafting Conclusion and Recommendations						X	
8. Presentation and						X	

Activity	Month 1-2	Month 3-4	Month 5-6	Month 7-8	Month 9-10	Month 11	Month 12
Review of Findings							
- Internal Review and Revisions						X	
- Presentation of Findings to Stakeholders						X	
9. Final Report Submission							X
- Submission of the Final Report							X

APPENDIX VI: SOBEL TEST PATH ANALYSIS

Path	Financial Lending Innovation	Coefficient (β)	p-value	Interpretation	Mediation Type
Path a (IV → M)	Digital Lending → Operational Efficiency	0.32	0.008	Significant positive effect	Mediating relationship supported
	Open Banking → Operational Efficiency	0.187	0.166	Not significant	No mediation
	Blockchain-Based Lending → Operational Efficiency	0.294	0.000	Strong positive effect	Mediating relationship supported
	Credit Card Lending → Operational Efficiency	0.226	0.028	Significant positive effect	Mediating relationship supported
Path b (M → DV)	Operational Efficiency → Financial Sustainability	0.817	0.000	Strong significant effect	Mediation possible for IVs significantly linked to M
Path c (Total Effect)	Digital Lending → Financial Sustainability	0.312	0.013	Significant total effect	Initial relationship present
	Open Banking → Financial Sustainability	0.345	0.015	Significant total effect	Initial relationship present
	Blockchain-Based Lending → Financial Sustainability	0.167	0.038	Significant total effect	Initial relationship present
	Credit Card Lending → Financial Sustainability	0.334	0.002	Significant total effect	Initial relationship present
Path c' (Direct Effect controlling for M)	Digital Lending → Financial Sustainability	0.207	0.093	Effect drops and becomes non-significant	Partial-to-Full Mediation
	Open Banking → Financial Sustainability	0.284	0.037	Effect slightly reduced but remains significant	Partial Mediation
	Blockchain-Based Lending → Financial Sustainability	0.07	0.392	Effect becomes non-significant	Full Mediation
	Credit Card Lending → Financial Sustainability	0.26	0.014	Effect drops but remains significant	Partial Mediation

Source: Reseacher, (2025)

APENDIX VII: THESIS RESEARCH BUDGET EXPENDITURE

The budget outlines researcher expenditure, associated research related activities and logistics costs.

Budget Item	Description	Estimated Cost (KES)
1. Proposal Development	Costs for printing, stationery, and initial meetings	50,000
2. Ethics Approval	Submission fees and revisions	30,000
3. Instrument Design and Piloting	Design of questionnaires, piloting costs	100,000
4. Data Collection	Travel, fieldwork allowances, and distribution costs	300,000
5. Data Cleaning and Preparation	Data entry personnel and software	100,000
6. Data Analysis	Statistical software (SPSS/Stata) and analyst fees	100,000
7. Report Writing	Editing, proofreading, and printing costs	200,000
8. Presentation of Findings	Venue hire, presentation materials	100,000
9. Miscellaneous	Unforeseen expenses	100,000
Total Estimated Cost		1,080,000

APPENDIX VIII: DIRECTORATE OF POST GRADUATE STUDIES LETTER



MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

Tel: 056-30870
Fax: 056-30153
E-mail: directordps@mmust.ac.ke
Website: www.mmust.ac.ke

P.O Box 190
Kakamega – 50100
Kenya

Directorate of Postgraduate Studies

Ref: MMU/COR: 509099

4th February 2025

Kivale Imbalo Patrick
PBA/H/01-70595/2021
P.O. Box 190-50100,
KAKAMEGA.

Dear Mr. Kivale

RE: APPROVAL OF PROPOSAL

I am pleased to inform you that the Directorate of Postgraduate Studies has considered and approved your PhD proposal entitled “*Financial Lending Innovation, Operation Efficiency and Financial Sustainability of Commercial Banks in Kenya*” and appointed the following as supervisors:

1. Prof. Charles Tibbs - SOBE, MMUST
2. Dr. Maniagi Musiega - SOBE, MMUST

You are required to submit through your supervisor(s) progress reports every three months to the Director Postgraduate Studies. Such reports should be copied to the following: Chairman, School of Business and Economics Graduate Studies Committee and Chairman, Business Administration and Management Sciences Department. Kindly adhere to research ethics consideration in conducting research.

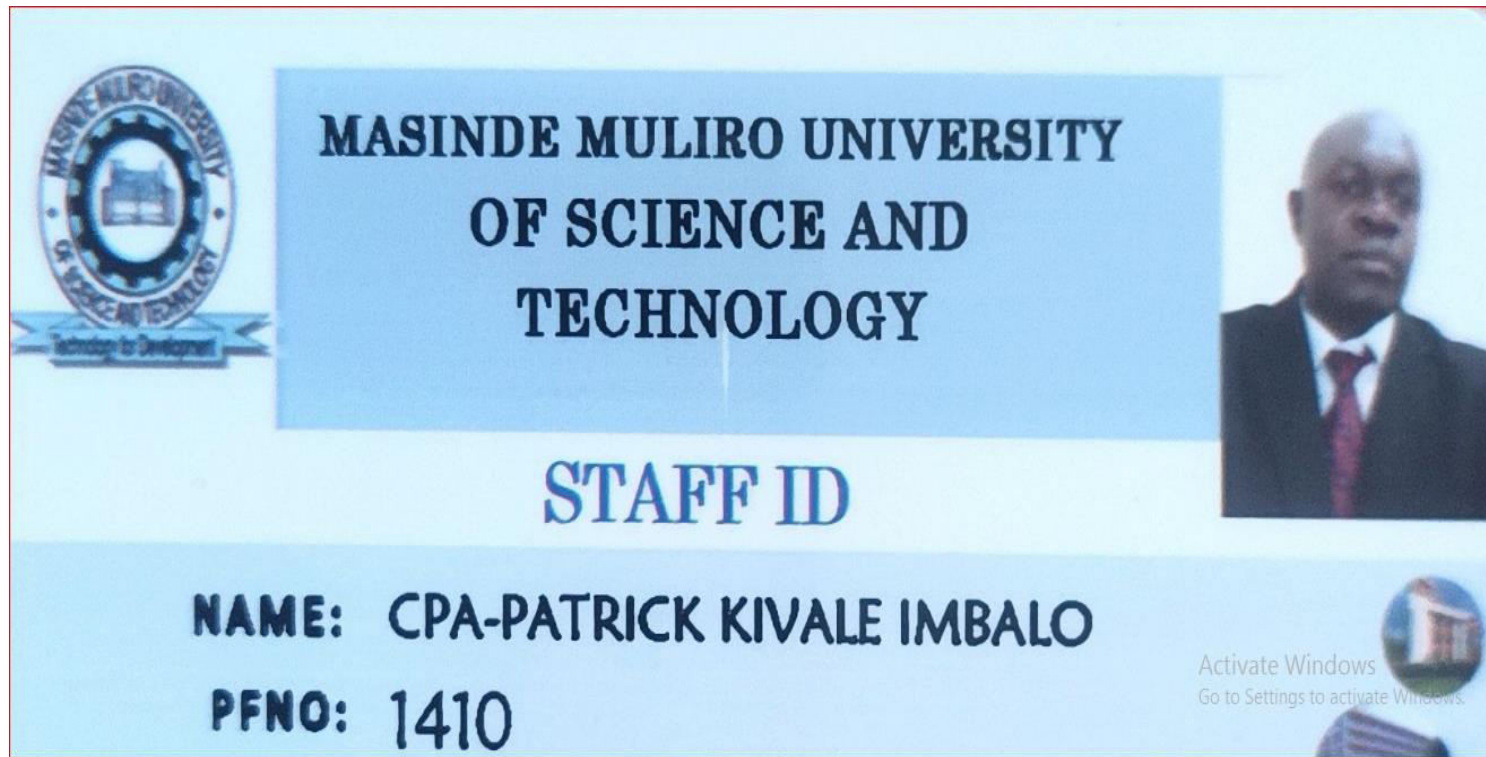
It is the policy and regulations of the University that you observe a deadline of three years from the date of registration to complete your PhD thesis. Do not hesitate to consult this office in case of any problem encountered in the course of your work.

We wish you the best in your research and hope the study will make original contribution to knowledge.

Yours Sincerely,


Prof. S. Odebero, PhD, FIEP
DIRECTOR, DIRECTORATE OF POSTGRADUATE STUDIES

APPENDIX IX: IDENTITY CARD



APPENDIX X: INSTITUTIONAL SCIENTIFIC AND ETHICS COMMITTEE LETTER

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

Tel: 056-31375

P. O. Box 190,

Fax: 056-30153

E-mail: ierc@mmust.ac.ke

Website: www.mmust.ac.ke

Institutional Scientific and Ethics Review Committee

REF: MMU/COR: 40312 Vol 6(01)

Date: February 20th, 2025

To: Mr. Kivale Imbalo

Dear Mr. Patrick Kivale



50100.

Kakamega,

KENYA

RE: FINANCIAL LENDING INNOVATION, OPERATIONAL EFFICIENCY AND FINANCIAL SUSTAINABILITY AMONG COMMERCIAL BANKS IN KENYA.

This is to inform you that the *Masinde Muliro University of Science and Technology Institutional Scientific and Ethics Review Committee (MMUST-ISERC)* has reviewed and approved your above research proposal. Your application approval number is **MMUST/ISERC/024/2025**. The approval covers for the period *February 20th, 2025 to February 20th, 2026*.

This approval is subject to compliance with the following requirements;

- i. Only approved documents including informed consents, study instruments, MTA will be used.
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by **MMUST-ISERC**.
- iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **MMUST-ISERC** within 72 hours of notification
- iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to **MMUST-ISERC** within 72 hours
- v. Clearance for export of biological specimens must be obtained from relevant institutions.
- vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
- vii. Submission of an executive summary report within 90 days upon completion of the study to **MMUST-ISERC**.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) <https://research-portal.nacosti.go.ke> and also obtain other clearances needed

Yours Sincerely,

Prof. Gordon Nguka (PhD),

Chairperson, Institutional Scientific and Ethics Review Committee

APPENDIX XI: NATIONAL RESEARCH FUND RESEARCHER LICENCE



REPUBLIC OF KENYA



NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 131522

Date of Issue: 14/February/2025

RESEARCH LICENSE



This is to Certify that Mr.. PATRICK IMBALO KIVALE of Masinde Muliro University of Science and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: FINANCIAL LENDING INNOVATION, OPERATIONAL EFFICIENCY AND FINANCIAL SUSTAINABILITY OF COMMERCIAL BANKS IN KENYA for the period ending : 14/February/2026.

License No: NACOSTI/P/25/415951

131522

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY &
INNOVATION

Verification QR Code



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