



INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND BANK PERFORMANCE IN NIGERIA

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ABSTRACT: The increasing role of Information and Communication Technology (ICT) in the banking sector has transformed financial operations, customer engagement, and risk management. This study examines the effect of ICT investments on bank performance in Nigeria, with a specific focus on Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence (BAAI), and Cyber security Systems (CSS). The study adopts Return on Investment (ROI) as the measure of bank performance and employs multiple regression analysis to assess the relationship between ICT investments and financial outcomes. Using secondary data from 13 Nigerian banks actively listed on the Nigerian Exchange Group (NGX) from 2013 to 2022, the study applies descriptive statistics, correlation analysis, and regression modeling to determine the significance of ICT components on ROI. The findings reveal that CBS ($B = 0.402$, $t = 8.204$, $p = 0.000$), DCRM ($B = 0.511$, $t = 6.812$, $p = 0.000$), and CSS ($B = 0.228$, $t = 4.471$, $p = 0.001$) and BAAI ($B = 0.317$, $t = 4.731$, $p = 0.000$) all have a positive but statistically significant effect on bank performance in Nigeria. It recommended that Nigerian banks increase investments in CBS and DCRM, develop structured AI adoption frameworks, and strengthen cyber security measures to enhance financial performance.

Keywords: Bank Performance, Core Banking Systems, Cybersecurity Systems, ICT

1.0 INTRODUCTION

The global banking sector is currently navigating through a series of profound challenges that are reshaping its operational and financial landscape. In recent years, factors such as economic instability, evolving consumer expectations, increasing regulatory pressures, and the rapid emergence of financial technology firms have placed banks under immense pressure to maintain profitability and ensure sustained returns on investment (ROI). Profitability, which traditionally serves as a benchmark for banking success, has been strained by decreasing interest margins, higher operational costs, and competitive pressures from non-banking entities like fintech firms (Ghosh, 2021; Kim and Jeong, 2020). ROI, another critical measure of bank performance, has also experienced volatility as banks struggle to optimize capital investments in an increasingly uncertain market environment (Kola and

Onyema, 2023). These challenges underscore the need for innovative solutions that can restore performance and competitiveness within the banking industry, (Wuave, Yua & Yua, 2020).

The adoption of contemporary Information and Communication Technologies (ICTs) has emerged as a potentially transformative solution to the performance issues plaguing banks, particularly in improving profitability and ROI. Modern ICTs such as Core Banking Systems (CBS), Digital Customer Relationship Management (CRM), Big Data Analytics (BDA) and Artificial Intelligence (AI), and cybersecurity systems offer banks the opportunity to streamline operations, reduce operational costs, and provide faster, more secure services to customers (Brown and Miller, 2022). For instance, core banking systems enhance real-time transaction processing and centralize banking operations,

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enabling cost-effective service delivery across multiple channels (Obi and Adigun, 2020). Similarly, Digital CRM facilitates personalized services by analysing customer data and improving customer engagement, which contributes to both profitability and customer retention (Khan, 2022). AI and Big Data Analytics further support decision-making by providing predictive insights and automating routine tasks, thereby increasing operational efficiency and improving ROI (Ghosh, 2021; Nwaolisa *et al.*, 2022).

In this study, bank performance is primarily assessed through ROI. ROI evaluates how effectively a bank uses its invested capital to generate profits, making it a crucial metric for determining long-term financial sustainability (Ibekwe, 2021). Given the increasing complexity of the global financial environment, particularly in post-pandemic economies, these metrics are critical for banks to recover from revenue losses and regain investor confidence (Yua, & Temitope, 2024; Mustapha, 2020). The relationship between performance and contemporary ICT adoption in banking will be explored, with ICTs posited as key drivers of improved profitability and ROI. For example, CBS can consolidate banking operations into a single platform, improving operational efficiency and lowering costs (Ajayi and Atanda, 2020). AI and BDA can optimize decision-making and automate risk assessments, further enhancing profitability (Ogunleye, 2020). Cybersecurity systems play a critical role in safeguarding banking operations and customer data, which not only reduces operational risks but also enhances trust and customer retention, ultimately improving ROI (Mbama and Ezike, 2021).

In developed economies, the adoption of these contemporary ICTs has revolutionized the banking industry, enabling significant reductions in operational costs and improvements in service efficiency, leading to increased profitability and ROI (Ajekwe, Yua, Epor, & Victor, 2024; Kim & Jeong, 2020). Countries such as the United States and the United Kingdom have been at the forefront of using AI-driven analytics, blockchain security measures, and comprehensive core banking systems to drive profitability (Kola and Onyema, 2023). In contrast, ICT adoption in developing economies has been slower but

is gradually gaining momentum, particularly in countries like India, Brazil, and South Africa, where banks are utilizing digital platforms to expand financial inclusion and optimize service delivery (Mbama and Ezike, 2021).

In Nigeria, while ICT adoption in banking has been steadily growing, driven by competitive pressures from fintech companies and changing consumer behaviours, banks are still facing performance-related challenges (Ajayi and Atanda, 2020). High operational costs, inefficiencies in service delivery, and rising competition from non-traditional banking institutions have adversely affected profitability and ROI. The implementation of contemporary ICT solutions, such as CBS, AI, BDA, and cybersecurity systems, offers a promising avenue for improving bank performance in Nigeria (Anyanwu *et al.*, 2023). However, infrastructural deficits, limited digital literacy, and regulatory constraints continue to impede full ICT adoption in the Nigerian banking sector. This study aims to examine how the adoption of these contemporary ICT tools can drive improvements in profitability and ROI in Nigerian banks.

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

This study is anchored on the Technology Acceptance Model (TAM). The Diffusion of Innovations Theory (DOI) is also relevant as a supporting framework, offering insights into how ICT innovations spread across banks and customer demographics over time, but TAM provides the primary explanatory basis by directly linking ICT adoption to improved operational efficiency, profitability, and return on investment (ROI).

2.2.1 Technology acceptance model

The Technology Acceptance Model (TAM) was developed by Davis (1989) and is widely regarded as one of the most influential models for explaining how users come to accept and use technology. TAM posits that two main factors determine users' acceptance of a technology viz: perceived usefulness which refers to the degree to which an individual believes that using a particular technology will enhance their job performance. And perceived ease of use (PEOU): This represents the degree to which an individual



believes that using the technology will be free from effort. In the context of this study, these factors are highly relevant when examining how both customers and banks adopt ICT innovations such as Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence, and Cyber security systems. TAM is highly relevant as it offers a strong framework for understanding how ICT tools can enhance bank performance. By focusing on customer and employee perceptions of the usefulness and ease of use of technology, the model helps to explain why some technologies lead to better profitability and ROI. For instance, the widespread adoption of CBSs may be driven by customers' and employees' positive perception of their convenience, leading to an increase in transaction fees for the bank (Bello and Yusuf, 2020).

2.2.2 Diffusion of innovations theory

The Diffusion of Innovations Theory (DOI) was proposed by Everett Rogers (1962) and describes how new ideas and technologies spread within a social system over time. DOI theory identifies several key elements that influence the adoption of innovations viz: The innovation which is the actual technology being adopted (in this case, Core Banking Systems, Digital Customer Relationship Management, Big Data Analytics and Artificial Intelligence, and Cyber security systems). Communication channels which are the ways in which information about the innovation is communicated to potential adopters, including marketing strategies and word-of-mouth recommendations, time which is the duration over which the innovation is adopted, social system which includes the environment in which the innovation is being implemented, including the banking sector, regulatory bodies, and the wider economy, and the adopter categories which are the classification of adopters based on their readiness to embrace new technology, from innovators to laggards.

2.2 Conceptual Review

2.2.1 Information and Communication Technology (ICT)

Information and Communication Technology (ICT) in the banking sector refers to the technological infrastructure and digital tools that facilitate the efficient processing, transmission, and management of financial data. These technologies enable banks to provide faster, more accessible services to their customers while enhancing operational efficiency and security. ICT covers a wide range of technologies, including automated systems, electronic communication platforms, digital transaction methods, and data processing tools. In the context of this study, ICT in banking refers to the adoption of systems such as Core Banking Systems, Automated Teller Machines (ATM), Point of Sale (POS) devices, internet and mobile banking, Digital Customer relationship management, big data analytics and artificial intelligence, Electronic Funds Transfer (EFT), and cybersecurity systems, all designed to streamline banking operations and improve customer experience. Various scholars have offered definitions of ICT, highlighting different aspects of its role in banking and beyond. Mbama and Ezike (2021) define ICT as a broad set of technologies that facilitate the processing, storage, and transmission of information, specifically via telecommunications and computers. In banking, ICT enables quick access to banking services and efficient internal processes. ICT serves as the backbone of modern banking, allowing banks to digitalize their operations, offer mobile services, and streamline transaction processes. Nwaolisa, Nduka and Abasi (2022) highlight that ICT is the use of technologies to transmit, store, and manipulate data, which in the banking industry improves service delivery by enabling faster transaction processing and real-time data access. ICT in Nigerian banks drives service quality by making mobile and online banking more accessible, thus reducing wait times.

2.2.2 Dimensions of information and communication technology applications in the banking sector

Core Banking Systems (CBS): Core Banking Systems refer to the centralized software platforms that allow banks to perform daily transactions, manage customer accounts, and maintain records of all financial activities in real-time across multiple branches and channels (Smith, 2020). These systems serve as the operational backbone of



modern banks, enabling seamless transaction processing and customer interactions irrespective of physical branch locations.

Digital Customer Relationship Management (CRM): Digital CRM is a technology-driven approach used by banks to manage customer interactions, data, and relationships through online channels such as mobile banking, email, and social media platforms (Clark and Davis, 2022). It enables banks to personalize services, track customer preferences, and enhance engagement by leveraging digital tools for communication and service delivery. Digital CRM in banking refers to the use of software solutions to collect, analyze, and manage customer data, with the aim of improving customer retention, loyalty, and satisfaction (Anderson, 2021). This system helps banks create personalized experiences by analyzing customer behavior and offering tailored products or services.

Big Data Analytics and Artificial Intelligence (AI): Big Data Analytics and AI in banking refers to the process of collecting, analysing, and interpreting vast amounts of structured and unstructured data using advanced algorithms and AI to gain insights into customer behavior, improve decision-making, and enhance service delivery (Smith and Patel, 2020). This approach allows banks to identify patterns in customer transactions, predict future trends, and optimize business processes for increased efficiency. Big Data Analytics is the use of sophisticated tools and techniques to analyse massive datasets from various sources, while AI enables banks to automate processes, make predictive analyses, and offer tailored products and services (Johnson, 2022). By combining both, banks can not only make sense of large datasets but also anticipate customer needs and market conditions. Big Data and AI technologies refer to the computational tools and processes used by banks to process large volumes of customer data and apply machine learning algorithms to develop predictive models for risk assessment, fraud detection, and personalized marketing (Williams and Clark, 2021).

Cybersecurity Systems: Cybersecurity Systems refer to the collection of technologies, processes, and controls designed to protect banking networks, systems, and data

from cyber threats such as hacking, phishing, and malware attacks (Brown and Johnson, 2020). These systems ensure the integrity, confidentiality, and availability of sensitive financial information, protecting both the bank and its customers. Cybersecurity in banking is defined as the set of protocols and defence mechanisms that financial institutions implement to safeguard digital infrastructures and sensitive customer data from cyberattacks and unauthorized access (Smith and Walker, 2021). This includes firewalls, encryption, and multi-factor authentication systems that prevent data breaches and financial losses.

2.1.3 Banks performance

Ike and Nnamdi (2019) define performance as the ability of an organization to achieve its objectives efficiently and effectively, often measured through financial metrics like profitability and return on investment (ROI). Bank performance reflects the success of a bank in using its resources to generate profit and return value to its stakeholders. Performance helps track growth, provides insights for strategic planning. Umar (2020) describes banks performance as the degree to which banks meet their goals and objectives, typically assessed using financial indicators such as profitability and ROI, along with non-financial indicators like customer satisfaction. This view highlights a bank's effectiveness in serving its customers while maintaining profitability. This allows for continuous improvement, informs decision-making. Bassey and Etim (2021) argue that bank performance refers to the overall success of a bank in terms of growth, profitability, and sustainability, often driven by innovation and technology adoption. The introduction of ICT has improved banks' ability to perform efficiently and boost profitability, thus enhancing overall performance.

2.1.4 Measures of banks performance

Return on Investment (ROI): Obi and Adigun (2020) define return on investment (ROI) as a financial metric that evaluates the efficiency or profitability of an investment, calculated as the ratio of net profit to the initial investment. ROI helps banks determine how effectively they are using their resources to generate profit, providing insights into



financial performance. Ndukwe (2020) describes ROI as a key performance indicator (KPI) that reflects the profitability of investments relative to their costs, commonly used in assessing banking investments in ICT infrastructure. In the context of banking, ROI highlights the benefits gained from investments in technology, such as ATMs and mobile banking platforms.

2.1.5 Information and communication technology and bank performance

In examining the relationship between ICT applications in the banking sector such as core banking systems, digital customer relationship management, big data analytics and cybersecurity and the performance of banks, numerous studies reveal mixed results, with the majority indicating a positive significant impact on profitability and return on investment (ROI), while others highlight either negative or insignificant relationships. These divergent findings reflect the dynamic influence of information and communication technology (ICT) on bank operations, as well as the contextual challenges within the banking sector.

Core Banking Systems (CBS) and Organizational Performance: Numerous studies have demonstrated the positive impact of Core Banking Systems (CBS) on organizational performance. For example, Johnson and Roberts (2022) from Canada found that CBS significantly reduce transaction times, enhancing customer service and leading to improved performance outcomes. In Australia, Miller and Thompson (2021) highlight that CBS enable centralized data management, allowing banks to make more informed decisions quickly, which contributes positively to overall performance.

Digital Customer Relationship Management (CRM) and Organizational Performance: The relationship between digital CRM and organizational performance is frequently highlighted in scholarly works. For instance, Thompson and Davis (2023) from the USA emphasize that digital CRM systems facilitate deeper insights into customer behaviors, allowing banks to customize their offerings and enhance customer loyalty, which directly improves performance. In the UK, Smith and Jones (2021) found that digital CRM tools enable more efficient customer interactions, reducing service times and increasing overall

customer satisfaction, thus positively affecting organizational performance.

Big Data Analytics and Artificial Intelligence, and Bank Performance: The positive relationship between big data analytics and organizational performance is widely supported in the literature. Researchers like Zhang and Li (2022) from China indicate that banks utilizing big data analytics can identify trends and customer preferences more effectively, leading to tailored services that enhance customer satisfaction and retention, ultimately improving performance. Similarly, in the USA, Davis and Smith (2021) found that the use of big data analytics for risk management allows banks to minimize defaults and enhance profitability, which contributes significantly to overall organizational performance. In Canada, Wang et al. (2023) highlight that big data analytics helps banks streamline their operations by identifying inefficiencies, thus leading to cost savings and improved performance. European researchers, such as Müller and Schmidt (2022), emphasize that big data facilitates better decision-making, enabling banks to respond more swiftly to market changes, which enhances their competitive advantage and performance outcomes.

Cyber security Systems and Bank Performance: A growing body of literature explores the relationship between cybersecurity systems and bank performance, with many scholars suggesting a positive correlation, while others indicate a negative or insignificant impact. Several scholars argue that there is a positive relationship between cyber security systems and bank performance. Jones and Yang (2021) emphasize that robust cyber security frameworks create a sense of trust among customers, leading to higher customer retention and satisfaction. Their study found that by enhancing security, banks improve their reputational standing and foster long-term loyalty, which directly contributes to better financial performance. Additionally, Smith *et al.* (2022) indicate that advanced cyber security systems reduce fraud-related losses, helping banks protect their financial assets and maintain continuous operations, thus improving profitability. In this context, they explain that by securing digital infrastructure, banks minimize disruptions that could affect their daily



operations, thereby improving efficiency and financial returns.

2.4 Review of Related Empirical Studies

Alvesy (2024) examined the impact of 4G rollout on Brazilian banks using panel data from over 25,000 branches. Findings revealed that 4G introduction led to a 6% exit rate of private banks and an 11% branch shrinkage within five years, whereas public banks remained unresponsive. Additionally, credit and savings patterns varied between bank types. The study concludes that internet connectivity significantly reshapes the banking industry and alters credit distribution, offering crucial policy implications.

Necib and Lafi (2024) investigated internet banking's impact on the performance of 31 French commercial banks (2008-2019). Employing descriptive, bivariate, and multivariate analyses, the study assessed the effect of digitization on Return on Assets (ROA) and Return on Equity (ROE). The results confirmed a positive relationship between internet banking adoption and bank performance. The authors highlight that while significant, this study focused solely on internet banking, leaving room for broader ICT dimension analysis in the Nigerian banking context.

Enoruwa et al. (2023) analyzed technological innovations' impact on West African bank performance (1997-2020) using ARDL, FMOLS, and DOLS models. Measuring performance via ROA and ROE, the study included indicators like Internet Banking, ATMs, Mobile Banking, and POS. Findings indicated complex long-term relationships, where technological innovation exerted both positive and negative effects on performance across Nigeria, Ghana, and Ivory Coast. The study suggests the need for further research into broader technological innovations within the sector.

Ethelmary, Obananya, and Udemba (2023) examined ICT's effect on selected money deposit banks in Anambra State, Nigeria. Focusing on decision support systems and office automation, the study surveyed 525 staff members and employed multiple regression analysis. The results indicated that neither decision support systems nor office automation had a significant positive effect on the banks'

organizational performance. Unlike the current study, which uses secondary data, this research relied on primary survey data to reach its conclusions.

Jimoh and Umebali (2023) examined how ICT deployment, specifically ATMs, POS, and Mobile Pay, affects bank performance in Nigeria. Utilizing secondary data from the Central Bank of Nigeria and Ordinary Least Square (OLS) regression, the study found that all three variables significantly impact bank performance. Although the study made significant findings, the authors note that it was limited to specific ICT channels, creating an opportunity for the current study to expand the scope by examining four new variables.

Osigbemhe, Nwoha, and Okwo (2023) assessed the effect of financial technologies on Nigerian commercial banks' performance (2009-2021). Focusing on ATM, Mobile Pay, and NEFT on Return on Assets, the study used secondary data and OLS regression. Findings revealed that ATM, Mobile Pay, and NEFT all had negative and non-significant effects on bank performance. The authors conclude that financial technology did not significantly impact corporate performance during this period, differing from other studies in the field.

Onikoyi et al. (2022) analyzed ICT's impact on the Nigeria Bottling Company's organizational performance using a descriptive survey. Data from 385 employees were analyzed via multiple regression and correlation. The study found that ICT significantly impacts performance, with internet access and cloud computing showing strong positive associations. While relevant, the study was conducted in the bottling sector, necessitating further research to replicate these findings within the banking industry using sector-specific ICTs.

Mohammed et al. (2022) explored the influence of ICT innovations like ATM, POS, internet banking, mobile banking, and RTGS on Nigerian commercial banks' financial performance. Using quarterly time-series data (2007-2020) and ARDL analysis, results showed that POS, mobile banking, and internet banking positively impacted performance, whereas RTGS had a negative effect. The study is related to the current research but did not specify which financial performance metrics were most affected by these technologies.



Okafor and Okoli (2022) investigated ICT's impact on Nigerian bank performance using a survey design and primary data from 100 respondents. Regression analysis revealed that ICT significantly enhances performance by increasing efficiency, reducing costs, and improving customer service speed and accuracy. This study is related to the current research; however, the current study aims to test similar variables using secondary data rather than the primary data utilized by Okafor and Okoli.

Ogundele and Ojo (2022) examined mobile banking's impact on Nigerian bank performance. Through a survey of 200 respondents and regression analysis, the study found that mobile banking has a significant positive effect on performance. While related to the current study, the authors relied on primary data, whereas the current research seeks to validate these variables using secondary data sources to provide a different perspective on the relationship.

Adeniyi and Ogunwande (2022) assessed electronic banking's impact on Nigerian commercial bank performance. Adopting a cross-sectional survey of 150 respondents and correlation analysis, the study found that e-banking significantly and positively impacts bank performance. This research complements the current study, which differs by employing secondary data to test similar variables, offering a quantitative alternative to the primary survey approach used in this specific study.

Akujor, Eyisi, and Chimaobi (2021) investigated ICT's effect on the corporate performance of Zenith Bank and UBA (2010-2016). Using annual reports and OLS regression to measure ROE, ROA, and EPS, the study found that ICT had a very weak effect on ROE, almost no effect on ROA, but a positive effect on EPS. The findings suggest mixed impacts of ICT on different financial metrics within these Nigerian banks.

Salihu, Umar, Mathias and Njoku, (2021). investigated ICT's impact on employee performance at Gombe State University. Using a descriptive survey and regression analysis on 311 responses, the study found that extensive ICT adoption significantly improves staff performance. The authors concluded that universities should automate processes to enhance efficiency. However, as this study was set in a university, its findings cannot be generalized

to the banking sector, necessitating sector-specific research.

Mitić (2021) examined ICT's impact on individual and organizational performance in 102 Serbian companies using data from 380 managers. Through descriptive statistics and correlation analysis, the study found that IT levels positively correlate with organizational performance, impacting job satisfaction and commitment. While relevant, the study's context is Serbia; thus, the current study fills the gap by focusing on the specific context of the Nigerian banking sector.

Demaki, Eromafuru, and Imaseun (2021) analyzed the impact of e-payment instruments on 12 Nigerian deposit banks' financial performance (2009-2020). Using co-integration and error correction modeling, the study found that ATMs and mobile banking had a strong positive effect, while POS had a strong negative effect, and internet banking had a weak negative effect. The research focused on specific e-payment channels, differing from the current study's broader ICT dimensions.

Nabari (2021) examined how POS, mobile banking, and ATMs impact Nigerian deposit money banks' performance (2009-2017). Using secondary data and multiple regression, the study concluded that ATMs have a strong positive impact on financial performance, whereas POS and mobile banking have little to no effect. This study highlights varying efficiencies among e-payment channels, leaving room to investigate other ICT dimensions not covered in this research.

Nwankwo and Agbo (2021) examined the impact of ICT, defined as ATMs, POS, and mobile banking, on the financial performance of Nigerian commercial banks (2013-2017). Using OLS regression on annual reports and CBN data, the study found ATMs had a strong positive effect, while POS and mobile banking showed weak negative effects. This study limited ICT to traditional channels, whereas the current study explores core banking systems, AI, and cybersecurity.

Akwam and Yua (2021) explored the impact of POS, mobile payments, and ATM transactions on the financial performance of selected Nigerian deposit money banks (2005-2019). Regression analysis showed that mobile



payments and POS strongly impacted ROE and ROA, while ATMs had a solid positive effect on EPS. Unlike this study, which focused on transaction channels, the current study concentrates on cybersecurity, big data, core banking systems, and ROI.

Wiredu, Labaran, Nketiah and Osibo (2020). assessed ICT's strategic impact on Atiwa Rural Bank in Ghana using an exploratory design. Surveying 300 respondents, the study revealed that while the bank lacked advanced technologies, ICT introduction reduced customer waiting times and expedited business. This study is related but focused solely on the rural banking sector in Ghana, whereas the current study targets listed deposit money banks in Nigeria.

Daud (2020) investigated how ICT innovation policies and employee training affect service delivery efficiency in Kenyan private laboratories. Adopting a descriptive design and analyzing data from 52 workers, the study found that ICT and training significantly enhance efficiency. The study concluded that organizations need policies aligned with technological realities. While significant, it differs in context and domain from the current study, which focuses on the Nigerian banking sector.

Ekene and Ukpata (2020) investigated electronic banking's impact on Nigerian commercial bank performance (2000-2017). Using data from the CBN and National Bureau of Statistics, the panel regression analysis revealed a significant relationship between e-banking services and bank performance. The findings indicate that commercial banks are effectively leveraging e-banking opportunities. This study focused on one ICT dimension, while the current research expands the scope to cover four distinct dimensions.

Okafor (2020) assessed how e-payment channels affect the performance of Nigerian Deposit Money Banks (2009-2019). Using an ex-post facto design and multiple regression analysis on CBN data, the study found that POS, ATMs, mobile banking, and internet banking have a strong positive impact on bank performance. This study centered on specific e-payment tools, whereas the current study investigates four different dimensions of ICT deployment. Kazakov, Ruiz-Alba, and Muñoz (2020) examined ICT's effect on organizational performance in Spanish SMEs.

Surveying 316 employees and using SEM PLS analysis, the study confirmed that ICT positively impacts performance, specifically regarding job satisfaction and employee loyalty. Since this study focused on SMEs in Spain, its findings cannot be generalized to the Nigerian banking sector, creating a need for the current localized study.

Olaoye et al. (2019) assessed IT's impact on Nigerian corporate organizations' performance. Surveying IT experts and using ANOVA, the study found that IT significantly impacts performance, concluding that firms must invest in IT for operational efficiency. However, the study failed to identify specific ICT investments driving this change. Consequently, the current study aims to fill this gap by ascertaining the effect of four specific ICT investments on banking ROI.

Nwakoby, Sidi, and Abomeh (2018) examined ICT's impact on Nigerian deposit money banks (2006-2015). Using a log-linear regression model, the study found that adopting ATMs, POS, mobile money, and web banking significantly influenced ROE. While related to the current study, it did not cover modern ICTs like core banking systems, big data analytics, and cybersecurity, leaving a gap that the current research seeks to address.

Chukwukaelo, Onyeiwu, and Amah (2018) examined the relationship between e-banking channels and the profitability of Nigerian Deposit Money Banks (2006-2016). Using a panel data regression model and GMM approach, the study revealed that electronic banking has a significant positive overall impact on profitability (ROE). Since this study focused exclusively on ROE, the current study fills the gap by focusing on ROI as a measure of financial performance.

Mahboub (2018) evaluated ICT investments' impact on 50 Lebanese banks' performance (2009-2016). Using the CAMELS model and multivariate OLS, results showed that ATMs, internet banking, and POS did not significantly affect performance. However, mobile banking and card offerings significantly and directly affected performance. The study noted that many other ICTs used in banking were not covered, a gap the current study fills by examining four distinct dimensions.



Adebola (2018) identified ICT's impact on selected banks in Ondo State, Nigeria. Using a survey design and multiple regression on 123 respondents, the study found that technological innovation improves banking performance by enhancing personnel efficiency, speed, and accuracy. While measuring performance by operational metrics, the current study differs by focusing specifically on Return on Investment (ROI) as the primary performance indicator.

Oyintola (2018) studied ICT's impact on First Bank of Nigeria's operations. Using primary data from questionnaires and interviews analyzed via Chi-square, the results revealed that ICT greatly improves bank growth, performance, and customer satisfaction. This study is related to the current research; however, it utilized primary data, whereas the current study proceeds with secondary data to test similar ICT variables in the Nigerian banking sector.

Binuyo and Aregbesola (2017) assessed ICT's impact on commercial bank performance in South Africa (1990-2012). Using a dynamic panel environment, the study found that ICT cost efficiency and investment contribute significantly to bank performance. Given the time lag since this study was conducted, the current study retests these relationships to determine if changes have occurred in the intervening years.

Attom (2017) examined ICT's impact on SME growth strategies in Ghana. Surveying 162 enterprises, the study found that 73% of SMEs do not use ICT, negatively affecting their growth. The remaining 27% found it too expensive. While this study focused on SMEs, the current study shifts the focus to the impact of ICT on performance within the banking sector.

Dampana and Agbeyegbe (2017) examined ICT's effect on employee performance at ECOBank Jalingo. Using a sample of 34 staff and descriptive statistical tools, the findings showed that ICT improved workers' skills and introduced new banking techniques. The authors note that using simple percentages was insufficient to determine the extent of effects; thus, the current study adopts regression analysis for precision.

Judith and Patrick (2016) studied innovation's impact on commercial bank performance in Kenya's Nakuru Central Business District. Using a census of 45 employees and multiple regression analysis, the results indicated that introducing innovations like mobile and internet banking improves financial results and profits. This study is related, but the dimensions of ICT covered in the current study differ from those examined here.

Wasilwa and Omwenga (2016) investigated ICT strategies' impact on Kenyan commercial banks, focusing on Equity Bank. Through correlation analysis, the study found that mobile phones had a greater impact on operations than internet services. The findings are relevant; however, as the study was conducted in the Kenyan environment, the current study replicates this research within the Nigerian context.

3.0 METHODOLOGY

3.1 Model Specification

Using multiple regression analysis, the model is specified as follows

$$ROI = f(CBS, DCRM, BAAI, CSS)$$

Then the explicit function of the above

$$ROI = \beta_0 + \beta_1 CBS + \beta_2 DCRM + \beta_3 BAAI + \beta_4 CSS + e$$

Where;

ROI = Return on Investments

CBS = Core Banking Systems

DCRM = Digital Customer Relationship Management

BAAI = Big Data Analytics and AI

CSS = Cyber Security Systems

β_0 = Intercept term

$\beta_1 - \beta_4$ = Slope coefficient

e = error term

3.2 Decision Rule

Accept the null hypothesis if the calculated significance level is greater than 0.05 otherwise reject.

4.0 RESULT AND DISCUSSION

4.1. Analysis of Descriptive Statistics

Table 1: Descriptive Statistics



Variables	N	Range	Minimum	Maximum	Mean	Std. Deviation
ROI	13	.6657	.0626	.7283	.183094	.1551305
CBS	13	20630.6062	72.2792	20632.8854	1772.760794	5232.5413709
DCRM	13	1120.4547	618.1544	1738.6091	1177.866044	368.0948419
BAAI	13	344.7492	119.9224	364.6716	170.681116	87.7773408
CSS	13	981.0000	354.0000	627.0000	8.625000	274.2509496

Source: Researcher's SPSS Output of Researcher's Computations, 2025

KEY: ROI-return on Investment, CBS = Core Banking Systems, DCRM = Digital Customer Relationship Management, BAAI = Big Data Analytics and Artificial Intelligence, CSS = Cyber Security Systems

The descriptive statistics presented in Table 1 provide a summary of the key variables used in this study, which examines the impact of Information and Communication Technology (ICT) on bank performance in Nigeria. In this study, bank performance is measured using Return on Investment (ROI), while ICT adoption is represented by four key proxies: Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence (BAAI), and Cyber Security Systems (CSS).

Return on Investment (ROI), which serves as the dependent variable, has a mean value of 0.1831, indicating that, on average, the sampled banks achieved an 18.31% return on investment over the study period. However, the standard deviation of 0.1551 suggests considerable fluctuations in bank profitability. The minimum ROI recorded is 0.0626, while the maximum reaches 0.7283, reflecting notable variations in performance among the sampled banks. These differences may be attributed to disparities in ICT adoption levels and operational efficiencies across the banks.

Among the ICT proxies, Core Banking Systems (CBS) exhibits the highest variability, with a mean value of 1,772.76 and a standard deviation of 5,232.54. The

minimum CBS value of 2.28 and the maximum of 20,632.88 indicate that while some banks have heavily invested in core banking infrastructure, others have relatively minimal adoption. This variation suggests differences in automation, transaction processing efficiency, and digital banking capabilities, all of which are critical in shaping bank performance.

Digital Customer Relationship Management (DCRM) has a mean value of 1,177.87 with a standard deviation of 368.09. The minimum and maximum values of 618.15 and 1,738.61, respectively, indicate that while most banks have implemented some form of digital customer relationship tools, the extent of adoption varies. Effective DCRM strategies enable banks to enhance customer experience, foster customer retention, and streamline service delivery, potentially impacting ROI positively.

Big Data Analytics and Artificial Intelligence (BAAI) recorded a mean value of 170.68 and a standard deviation of 87.77. With a minimum of 19.92 and a maximum of 364.67, the data suggest that some banks have made significant investments in AI-driven analytics, while others remain in the early stages of adoption. Since BAAI enhances decision-making, risk assessment, and fraud detection, banks that leverage advanced analytics may gain a competitive advantage, leading to improved profitability. Cyber Security Systems (CSS) show a mean value of 8.63 with a standard deviation of 274.25, with values ranging from a minimum of 354 to a maximum of 627. This significant variation highlights the differing levels of cyber security investment among banks. Given the increasing



risks associated with digital banking, stronger cyber security measures can prevent financial losses due to fraud, data breaches, and cyber-attacks, ultimately supporting bank performance.

Overall, the descriptive statistics indicate substantial variation in ICT adoption levels among the sampled banks. The variability in CBS, DCRM, BAAI, and CSS suggests that some banks are leveraging ICT more effectively than others, which may account for the differences in ROI. The findings highlight the crucial role of ICT investments in enhancing bank performance, reinforcing the need for

continuous digital transformation in the banking sector to remain competitive and profitable.

4.1.2 Robustness of Data

Robustness of data measures the strength of a statistical model, tests, and procedures according to the specific conditions of the statistical analysis a study hopes to achieve. The study presents the following table to test for the robustness of data used in the statistical model.

Table 2: Test for Normality and Collinearity

Variables	Shapiro-wilk		Collinearity statistics	
	df	sig.	Tolerance	VTF
ROI	13	0.081		
CBS	13	0.102	0.850	1.176
DCRM	13	0.132	0.812	1.264
BAAI	13	0.140	0.590	1.713
CSS	13	0.091	0.580	1.724

Source: Researcher's SPSS Output of Researcher's Computations, 2025

Table 2 presents the results of the normality and collinearity tests conducted on the dataset to assess whether the variables meet the fundamental assumptions required for regression analysis. These tests are critical in ensuring the validity and reliability of the statistical models used to examine the relationship between Information and Communication Technology (ICT) and bank performance, where Return on Investment (ROI) serves as the dependent variable, while Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence (BAAI), and Cybersecurity Systems (CSS) represent the independent variables.

i. Normality Test (Shapiro-Wilk Test)

The Shapiro-Wilk test was used to examine the normality of the dataset, which is essential for parametric statistical analysis. A significance value (Sig.) greater than 0.05 indicates that the variable follows a normal distribution, meaning it does not deviate significantly from the expected pattern of normality. In Table 2, all variables exhibit

significance values above 0.05, confirming that they are normally distributed. This implies that the data for ROI, CBS, DCRM, BAAI, and CSS do not suffer from skewness or extreme outliers that could distort the regression model's results. The normal distribution of these variables enhances the robustness of statistical inferences, ensuring that the regression coefficients accurately reflect the relationship between ICT and bank performance. Ensuring normality is particularly important because non-normal data can lead to biased estimates and unreliable hypothesis testing. With all variables passing the normality test, it becomes appropriate to proceed with further statistical modeling, including regression analysis, without concerns about violating this assumption.

ii. Collinearity Test (Tolerance and Variance Inflation Factor-VIF)

Collinearity refers to a situation where independent variables in a regression model are highly correlated with each other, which can lead to redundancy and inefficiency in the model. Multicollinearity can inflate the standard errors of regression coefficients, making it difficult to determine the individual impact of each independent



variable on the dependent variable. To assess collinearity, two key metrics were examined: Tolerance and Variance Inflation Factor (VIF). Tolerance values indicate the proportion of variance in an independent variable that is not explained by the other independent variables. A tolerance value below 0.1 suggests a serious collinearity issue, while values closer to 1 indicate minimal multicollinearity.

The result in Table 3 shows that all tolerance values are above 0.1, signifying that each independent variable maintains sufficient uniqueness and does not suffer from excessive correlation with the others. Variance Inflation Factor (VIF) is the reciprocal of tolerance and is used to detect the severity of multicollinearity. A VIF value greater than 5 suggests problematic multicollinearity, while values below this threshold indicate an acceptable level. In the result all VIF values are well below 5, confirming that the independent variables are not excessively correlated. The VIF values for CBS, DCRM, BAAI, and CSS range from 1.176 to 1.724, which are within the acceptable range. This indicates that each of these ICT components uniquely contributes to explaining variations in bank performance (ROI), without significant redundancy. The regression coefficients can be interpreted with confidence, knowing that each independent variable has a distinct effect on bank performance. The absence of collinearity also improves the precision of parameter estimates and enhances the stability of the regression equation.

The implication of this result is that, with all variables passing the normality and collinearity tests, the dataset is now well-suited for regression analysis. The normality of the data ensures that statistical tests produce valid and unbiased results, while the absence of multicollinearity confirms that each ICT component independently influences bank performance. This allows for a more accurate and meaningful interpretation of the regression output, providing clearer insights into how ICT investments contribute to enhancing Return on Investment (ROI) in banks. Moreover, the improved dataset increases the generalizability of the findings, as the results reflect real-world banking performance trends. This reinforces the study's contribution to understanding the role of ICT in the financial sector, particularly in optimizing profitability through advanced banking technologies.

4.1.3 Correlation result of relationships between ICT and Bank Performance

The correlation matrix helps to ascertain the extent of relationship existing amongst the dependent and independent variables. It also ascertains the extent of relationship amongst the variables. The relationship between the dependent and independent variables is a predetermination of how the regression result would look like.

Table 3: Correlation Matrix

		ROI	CBS	DCRM	BAAI	CSS
ROI	Pearson Correlation	1				
CBS	Pearson Correlation	.182	1			
DCRM	Pearson Correlation	.433	.130	1		
BAAI	Pearson Correlation	.248	.389	.069	1	
CSS	Pearson Correlation	.149	.174	.335	.541*	1

Source: Researcher's SPSS Output 2025 of Researcher's Computations, 2025

From the above Table 3, the result of the correlation shows that all the coefficients are not up to 0.7 that calls for care and a cause of concern. This implies that the independent

variables of ICT used in this study are not highly correlated to result to collinearity.

4.1.4 Regression model summary



A regression analysis of the effect of information and communication technologies such as core banking systems, digital customer relationship management, big data analytics and artificial intelligence, and cyber security systems as independents variables on performance (Return on Investments) as dependent variable which defines the

performance of listed deposit money banks was carried out to show the combined predictive effect of the independent variables on the dependent variable. Multiple R is an indicator of how well the overall regression equation predicts the observed data.

Table4: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			Sig. Change	F
					R Square Change	F Change	df1		
1	.835 ^a	.671	.642	.1032164	.671	6.892	4	13	.002

a. Dependent Variable: ROI

b. CSS, BAAI, DCRM, CBS

Key: ROI-Return on Investment, CBS = Core Banking Systems, DCRM = Digital Customer Relationship Management, BAAI = Big Data Analytics and Artificial Intelligence, CSS = Cyber Security Systems

Source: Researcher's SPSS Output

The R-value (0.835) represents the multiple correlation coefficient, which measures the strength of the relationship between the dependent variable (ROI) and the combined independent variables (CBS, DCRM, BAAI, and CSS). An R-value of 0.835 indicates a very strong positive correlation, suggesting that the independent variables collectively have a strong influence on ROI. This implies that ICT investments play a decisive role in shaping bank profitability in Nigeria.

The R-Square (0.671), also known as the coefficient of determination, shows that 67.1% of the variations in ROI can be explained by the four ICT-related variables included in the model. This is a substantial level of explanatory power, meaning that the majority of fluctuations in bank performance can be attributed to the adoption of technologies such as Core Banking Systems, Digital CRM, Big Data Analytics & AI, and Cybersecurity Systems. The remaining 32.9% is explained by other factors outside the model, such as macroeconomic conditions, regulatory frameworks, competition, and management practices.

The adjusted R-Square (0.642) accounts for the number of predictors and provides a more reliable measure of

explanatory power. With a value of 64.2%, it confirms that even after adjustment, the model still explains a very large share of the variation in ROI. This small decrease from R² to Adjusted R² suggests that the independent variables are highly relevant and not artificially inflating the model's strength. The Standard Error of the Estimate (0.1032) is relatively low, indicating that the predictions from the regression are very close to the actual ROI values, thereby reinforcing the model's accuracy.

The R-Square Change (0.671) confirms that the introduction of ICT-related predictors adds substantial explanatory power to the model. The F-Change (6.892) further demonstrates that the independent variables jointly make a statistically significant contribution to explaining ROI variations. With degrees of freedom (df1 = 4, df2 = 13), the test captures the contribution of the four predictors relative to residual error. The Significance of F-Change (0.002) is well below the 0.05 threshold, confirming that the regression model is statistically significant at the 5% level. This means there is very strong evidence that ICT investments enhance bank performance, and the likelihood that these results occurred by chance is extremely low.

4.1.5: Model Coefficients

The linear regression coefficients describe the mathematical relationship between each independent variable and the dependent variable. The p values for the coefficients indicate whether these relationships are statistically significant or not. Table 6 below presents the



model coefficient for the effect of CBS, DCRM, BAAI and CSS on ROI.

Table 5: Table of Regression Model Coefficients

Model	Unstandardized Coefficients				
	B	Std. Error	T	Sig.	
1	(Constant)	-.015	.163	-.092	.928
	CBS	.402	.049	8.204	.000
	DCRM	.511	.042	6.812	.000
	BAAI	.228	.051	4.471	.001
	CSS	.317	.067	4.731	.000

a. Dependent Variable: ROI

b. CSS, BAAI, DCRM, CBS

N.B: ROI-return on Investment, CBS = Core Banking Systems, DCRM = Digital Customer Relationship Management, BAAI = Big Data Analytics and Artificial Intelligence, CSS = Cyber Security Systems

Source: Researcher's SPSS Output

Table 5 presents the regression model coefficients, which provide insights into the individual contributions of each ICT investment component—Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence (BAAI), and Cyber security Systems (CSS) to bank performance as measured by Return on Investment (ROI). The table displays the unstandardized coefficients (B), standard errors, t-values, and significance levels, allowing us to assess the impact and statistical significance of each predictor on bank performance measured as ROI.

The constant (B = -0.015, p = 0.928) represents the expected ROI when all independent variables are held at zero. Since the coefficient is negative and highly insignificant, it suggests that without ICT investments, ROI cannot be meaningfully predicted, reinforcing that ICT is indispensable for modern banking profitability. The coefficient for Core Banking Systems (CBS) is 0.402 with a t-value of 8.204 (p = 0.000). This means that a one-unit increase in CBS investments leads to a 40.2% increase in ROI, assuming other variables remain constant. The very high significance demonstrates that CBS remains a fundamental driver of bank profitability by improving

transaction speed, reducing costs, and enhancing customer experience.

For Digital Customer Relationship Management (DCRM), the coefficient is 0.511 with a t-value of 6.812 (p = 0.000). This implies that a one-unit increase in DCRM investments yields a 51.1% increase in ROI. DCRM is the strongest predictor in this model, highlighting that effective digital engagement, customer personalization, and automated service delivery significantly boost retention, loyalty, and revenues.

The coefficient for Big Data Analytics and Artificial Intelligence (BAAI) is 0.228 with a t-value of 4.471 (p = 0.001). This suggests that a one-unit increase in BAAI investments results in a 22.8% increase in ROI. The statistically significant effect underscores that predictive analytics, fraud detection, and AI-driven decision-making are increasingly becoming central to efficiency, though their impact is slightly lower compared to CBS and DCRM.

Finally, Cyber Security Systems (CSS) has a coefficient of 0.317 with a t-value of 4.731 (p = 0.000). This indicates that a one-unit increase in CSS investments improves ROI by 31.7%. Its strong and significant contribution highlights that protecting banks from fraud, cybercrime, and data breaches not only reduces financial losses but also builds trust, which is essential for sustainable profitability. Overall, the results reveal that while all ICT components significantly enhance ROI, DCRM has the highest impact, followed by CBS, CSS, and BAAI. This emphasizes that customer-centered digital strategies and core banking



operations, supported by security and analytics, are the most critical ICT drivers of profitability in the banking sector.

4.3 Test for Hypotheses

To test the hypotheses, the study examined the significance values (p-values) from the regression model coefficients in Table 5. A hypothesis is rejected if its corresponding p-value is less than 0.05 (5% significance level), indicating a statistically significant effect. If the p-value is greater than 0.05, the null hypothesis is not rejected, meaning the variable does not significantly impact bank performance.

Ho₁: Investments in Core Banking Systems (CBS) have no significant effect on bank performance in Nigeria

From the regression results, CBS has a coefficient of 0.402 with a t-value of 8.204 and a p-value of 0.000. Since $p < 0.05$, we reject the null hypothesis (H_{01}) and conclude that investments in Core Banking Systems have a significant positive effect on bank performance. This means that banks that invest more in CBS experience improved return on investment through enhanced operational efficiency and customer service delivery.

Ho₂: Investments in Digital Customer Relationship Management (DCRM) have no significant effect on bank performance in Nigeria

The regression coefficient for DCRM is 0.511, with a t-value of 6.812 and a p-value of 0.000. Since $p < 0.05$, we reject the null hypothesis (H_{02}) and conclude that investments in Digital Customer Relationship Management significantly enhance bank performance. This implies that banks that effectively implement DCRM strategies, such as personalized marketing and automated customer support, can increase customer engagement and ROI.

Ho₃: Investments in Big Data Analytics and Artificial Intelligence (BAAI) have no significant effect on bank performance in Nigeria

The regression coefficient for BAAI is 0.228, with a t-value of 4.471 and a p-value of 0.001. Since $p < 0.05$, we reject the null hypothesis (H_{03}) and conclude that

investments in Big Data Analytics and Artificial Intelligence significantly improve bank performance. This suggests that banks that deploy BAAI tools for predictive analytics, fraud detection, and automated decision-making experience measurable gains in ROI.

Ho₄: Investments in Cyber Security Systems (CSS) have no significant effect on bank performance in Nigeria.

The regression coefficient for CSS is 0.317, with a t-value of 4.731 and a p-value of 0.000. Since $p < 0.05$, we reject the null hypothesis (H_{04}) and conclude that investments in Cyber Security Systems significantly improve bank performance. This indicates that banks that prioritize cyber security experience higher ROI due to reduced financial losses from fraud, data breaches, and cyber threats.

4.3 Discussion of Findings

The results from the hypothesis testing in this study reveal significant insights into the impact of Information and Communication Technology (ICT) on bank performance in Nigeria. The study tested the effect of Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence (BAAI), and Cyber security Systems (CSS) on Return on Investment (ROI) as a measure of bank performance. The findings are discussed hereunder subsequently

i. Effect of Core Banking Systems (CBS) on Bank Performance

The study found that CBS has a significant positive effect on bank performance, as indicated by a high regression coefficient ($B = 0.402$, $p = 0.000$). This suggests that investments in CBS improve operational efficiency, transaction processing speed, and overall profitability in Nigerian banks. This implies that banks that allocate more resources to CBS benefit from improved transaction efficiency, cost reduction, and profitability. The descriptive statistics reinforce this result: CBS recorded the widest range (72.28 to 20,632.88) and the highest variability ($SD = 5,232.54$), indicating large disparities in adoption among Nigerian banks. Those with higher CBS



investments consistently achieve better ROI outcomes, as also reflected in the average ROI of 18.31% across the sampled banks. Thus, while CBS adoption enhances efficiency and customer satisfaction, the wide disparities suggest that some banks still struggle with underinvestment, which may explain the lower ROI at the minimum level (0.0626). This finding aligns with previous empirical studies, such as Johnson and Roberts (2022), who found that CBS reduces transaction times and enhances customer service, leading to improved performance in the Canadian banking sector. Similarly, Miller and Thompson (2021) in Australia reported that CBS enhances centralized data management, allowing banks to make more informed decisions and optimize performance.

The findings also support the Technology Acceptance Model (TAM), which suggests that perceived usefulness and ease of use influence technology adoption. Nigerian banks adopting CBS benefit from seamless transaction management, automated record-keeping, and improved customer experience, leading to higher ROI. However, challenges such as high implementation costs and system integration issues, as highlighted by Roberts and Xu (2022), may slow adoption among smaller banks.

ii. Effect of Digital Customer Relationship Management (DCRM) on Bank Performance

The regression results indicated that DCRM has a significant positive effect on ROI, with a coefficient of $B = 0.511$ ($p = 0.000$). This implies that banks leveraging digital CRM systems for customer engagement, personalized marketing, and service automation experience better financial performance.

With a mean of 1,177.87 and a relatively lower variability ($SD = 368.09$) from descriptive statistics, compared to CBS, most banks in the sample have adopted DCRM tools to varying degrees. The implication is that DCRM enhances customer engagement, personalized services, and retention, which directly translate into higher revenues and profitability. The strong coefficient value shows that DCRM is the most influential predictor of ROI among the ICT proxies, meaning banks that effectively leverage

customer analytics and digital relationship platforms outperform others. The finding highlights the growing importance of customer-centric digital innovations in sustaining financial performance. This finding is consistent with Thompson and Davis (2023), who found that digital CRM systems enhance customer insights, loyalty, and retention, ultimately improving bank performance in the USA.

From a theoretical perspective, this finding supports the Diffusion of Innovations (DOI) Theory, which explains how innovations spread over time. Nigerian banks that adopt digital CRM solutions early gain a competitive advantage in customer engagement, which translates into better financial outcomes. However, challenges such as data privacy concerns and high implementation costs, as highlighted by Wang and Xu (2022), may hinder full CRM integration.

iii. Effect of Big Data Analytics and Artificial Intelligence (BAAI) on Bank Performance

The study found that BAAI had a positive but statistically insignificant effect on bank performance, with a coefficient of $B = 0.228$, $p = 0.001$. This suggests that, while AI and big data analytics contribute to decision-making and efficiency, their impact on ROI in Nigerian banks is not yet fully realized. Although its coefficient is lower compared to CBS and DCRM, the effect is still substantial. The descriptive statistics indicate a mean of 170.68 with moderate variability ($SD = 87.77$), suggesting that while some banks have advanced AI adoption, others remain at the early stages. The implication is that banks that effectively deploy BAAI benefit from predictive insights, risk detection, and efficiency gains, which cumulatively improve profitability. However, the lower mean values relative to CBS and DCRM highlight that investment in BAAI remains comparatively modest. This suggests that while BAAI has proven benefits, its full potential is yet to be realized in Nigeria due to challenges such as high implementation costs and skill shortages. Similar findings were reported by Johnson and Chang (2022), who noted that integrating AI and big data into banking operations can be complex and resource-intensive, leading to slow adoption.



A plausible reason for this result could be infrastructural challenges and a shortage of skilled personnel to implement AI-driven banking solutions in Nigeria. Additionally, as AI and big data analytics require large-scale investments and time to yield measurable benefits, their current impact on ROI of these banks may be limited. These findings partially align with the TAM model, which suggests that while AI and big data have perceived usefulness, adoption challenges may limit their effect on bank performance.

iv. Effect of Cyber security Systems (CSS) on Bank Performance

Cyber security investments were found to have a significant positive effect on ROI, with a coefficient of $B = 0.317$, $p = 0.000$. This indicates that banks that prioritize cyber security experience higher profitability due to reduced financial losses from fraud and cyber threats. With a mean value of 8.63 and a standard deviation of 274.25, CSS shows notable variations in adoption, despite its relatively smaller numerical scale compared to CBS and DCRM. The regression coefficient underscores that robust cyber security measures are crucial for profitability, as they prevent financial losses from cyber-attacks, fraud, and data breaches. This finding is consistent with the observed range in ROI (0.0626 minimum to 0.7283 maximum), as banks with stronger cyber resilience tend to maintain stable returns by safeguarding customer trust and reducing operational disruptions. The implication is that cyber security is not merely a compliance requirement but a profitability driver in Nigeria's digital banking environment.

This finding aligns with studies such as Jones and Yang (2021), who found that robust cyber security enhances customer trust and retention, leading to better financial performance. The findings also support the DOI Theory, which explains how cyber security innovations gradually diffuse within the banking sector. Nigerian banks that proactively invest in security technologies such as encryption, firewalls, and fraud detection systems are better positioned to safeguard customer data and prevent revenue losses. However, challenges such as high costs and regulatory compliance issues, as highlighted by Kim

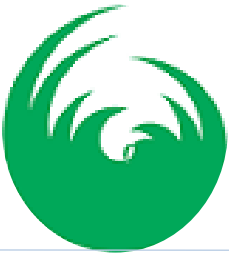
et al. (2021), may limit cyber security adoption in some banks.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

This study examined the effect of Information and Communication Technology (ICT) investments on bank performance in Nigeria, with Return on Investment (ROI) serving as the measure of bank performance. The study specifically investigated the effects of Core Banking Systems (CBS), Digital Customer Relationship Management (DCRM), Big Data Analytics and Artificial Intelligence (BAAI), and Cyber Security Systems (CSS). The findings from the empirical analysis revealed the following:

- i. Investments in Core Banking Systems (CBS) have a significant positive effect on bank performance ($B = 0.402$, $t = 8.204$, $p = 0.000$). Banks that allocate more resources to CBS experience improved transaction efficiency, reduced operational costs, and overall profitability. The seamless integration of CBS facilitates better financial management and service delivery, directly enhancing ROI.
- ii. Digital Customer Relationship Management (DCRM) significantly improves bank performance ($B = 0.511$, $t = 6.812$, $p = 0.000$). The adoption of DCRM systems strengthens customer retention, enables personalized banking experiences, and improves customer engagement. These benefits translate into higher transaction volumes, revenue growth, and improved ROI.
- iii. Big Data Analytics and Artificial Intelligence (BAAI) have a significant positive effect on bank performance ($B = 0.228$, $t = 4.471$, $p = 0.001$). AI-driven insights and big data analytics enhance predictive decision-making, fraud detection, and customer behavior analysis. By leveraging these technologies, banks improve efficiency and reduce risks, which significantly boosts ROI despite earlier concerns about cost and complexity of adoption.
- iv. Cyber Security Systems (CSS) significantly influence bank performance ($B = 0.317$, $t = 4.731$, $p = 0.000$). Strong cyber security frameworks protect banks



from fraud, cyber-attacks, and data breaches, thereby reducing financial losses and safeguarding customer trust. This enhances stability, strengthens reputation, and ultimately contributes to higher ROI.

5.2 Conclusion

The study concludes that ICT investments are a crucial determinant of bank performance in Nigeria, with CBS, DCRM, and CSS playing significant roles in driving ROI. The results highlight the importance of technological innovation and digital transformation in enhancing operational efficiency, customer experience, and risk management in the banking sector. While CBS and DCRM are already delivering tangible benefits, the study finds that the impact of AI and big data analytics on ROI remains limited. This suggests that Nigerian banks may still be in the early stages of AI adoption or that existing AI applications are not yet fully optimized for financial gains. Furthermore, the study establishes that cyber security is essential for sustaining bank profitability by protecting financial assets and fostering customer confidence. Overall, this study reinforces the argument that Nigerian banks must strategically invest in ICT to remain competitive, enhance efficiency, and maximize financial returns.

5.3 Recommendations

Based on the study's findings, the following recommendations are made:

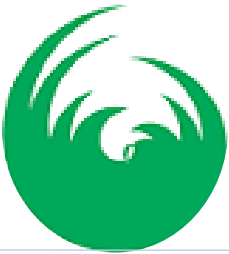
- i. Banks should increase investment in CBS infrastructure to improve transaction efficiency and customer experience. Additionally, system upgrades should be prioritized to integrate emerging technologies such as blockchain and cloud computing, which can further enhance banking operations and security.
- ii. Banks should enhance their DCRM strategies by leveraging AI-powered chatbots, predictive analytics, and personalized financial services to strengthen customer engagement. More training and capacity-building programs should be implemented to help banking staff effectively utilize digital CRM tools.
- iii. Since AI and big data analytics have shown a less significant impact on profitability, than others, banks

should develop structured AI implementation frameworks that align with their business models. Investments should be directed toward AI-driven credit scoring, fraud detection, and customer insights to optimize their financial benefits.

- iv. Given the increasing threats of cybercrime, banks should prioritize cyber security investments and implement advanced fraud detection systems, real-time monitoring, and biometric authentication to prevent financial losses. Additionally, regulatory bodies should introduce stronger cyber security compliance policies to ensure banks adopt best practices.

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