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- III. Keywords (3-5)
- IV. Introduction
- V. Literature Review
- VI. Methodology
- VII. Results and Discussion
- VIII. Conclusion and Recommendations
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## EFFECT OF FORENSIC TECHNOLOGICAL TOOLS ON FINANCIAL CRIME INVESTIGATION EFFICIENCY AMONG LISTED DEPOSIT MONEY BANKS IN NIGERIA

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### ABSTRACT

*This study investigated the effect of forensic technological tools on financial crime investigation efficiency among listed deposit money banks in Nigeria. The dependent variable was financial crime investigation efficiency, while the independent variables included forensic accounting software usage, artificial intelligence tools, electronic transaction monitoring systems, and cybersecurity infrastructure. A survey research design was adopted, with a population of 452 and a sample size of 233 respondents. Data were analyzed using multiple regression techniques. Findings revealed that all four technological tools significantly enhance the efficiency of financial crime investigations. Forensic accounting software aid in evidence recovery and data analysis; artificial intelligence tools improve detection through predictive analytics; electronic transaction monitoring systems, having the strongest influence, enable real-time identification of suspicious activities; and cybersecurity infrastructure secures digital environments and supports traceable investigations. All variables were statistically significant at the 1% level. Based on these findings, the study recommends that deposit money banks should invest in advanced forensic technologies, integrate artificial intelligence into their investigative systems, expand electronic monitoring capacities, and strengthen cybersecurity infrastructure to enhance their ability to detect and combat financial crimes efficiently.*

**Key terms: Digital Forensic, Artificial Intelligence, Electronic Transaction Monitoring Systems, and Cybersecurity Infrastructure**

### 1.0 Introduction

Financial crime investigation plays a pivotal role in enhancing transparency, accountability, and trust in the global financial system, particularly among listed deposit money banks. These institutions are often primary targets for complex financial crimes such as money laundering, cyber fraud, and terrorist financing due to their expansive operations and digital integration. Globally, listed banks are expected to implement proactive investigative measures to trace, detect, and prevent illicit financial activities, aligning with standards set by international bodies like the Financial Action Task Force (FATF, 2022). According to Levi and Reuter (2020), effective financial crime

investigation contributes to the deterrence of organized crime and reduces the systemic risk posed by financial fraud. Furthermore, the adoption of technological tools in crime investigations enhances precision and speeds up the detection of fraudulent schemes (Arner, et al., 2020). Ultimately, effective crime investigations contribute to a safer financial ecosystem and reinforce investor confidence in the banking sector.

Forensic technological tools play a crucial role in modern financial crime investigation by enabling the efficient collection, analysis, and interpretation of



digital evidence. These tools, such as forensic imaging software, blockchain analytics, and AI-driven anomaly detectors, help investigators uncover hidden transactions, trace illicit financial flows, and authenticate digital records (Alshgari et al., 2021). They enhance the accuracy and speed of investigations, minimizing human error and improving decision-making. According to Okere et al. (2022), forensic tools also support proactive fraud detection through real-time monitoring and predictive modeling. Furthermore, they strengthen compliance with regulatory standards by documenting evidence trails and maintaining data integrity. As financial crimes become increasingly sophisticated, forensic technologies provide the analytical power necessary to counter these evolving threats. The integration of forensic technological tools such as Forensic accounting software usage, artificial intelligence tools, electronic transaction monitoring systems and cybersecurity infrastructure into audit and investigation processes is now a global best practice for financial institutions.

Forensic accounting software are vital in uncovering digital evidence related to financial crimes, especially in banking operations. They assist in retrieving deleted files, analyzing computer logs, and reconstructing transaction histories, thereby exposing fraudulent activities (Akinbowale et al., 2020). These tools provide structured methods for investigating cyber-enabled financial crimes and preserving the integrity of digital evidence. Their application ensures that findings are admissible in court and support regulatory compliance.

Artificial Intelligence (AI) tools play a transformative role in financial crime investigation by enabling predictive analytics and real-time fraud detection. AI can detect unusual patterns across large volumes of transaction data, helping banks proactively identify suspicious behaviors (Brennen & Kreiss, 2021). Machine learning algorithms adapt over time, increasing the precision of investigations and reducing false positives. These tools significantly reduce investigation time and enhance operational efficiency.

Electronic transaction monitoring systems enable continuous surveillance of customer activities to detect red flags in financial transactions. These systems are designed to flag anomalies such as unusual deposits, rapid fund transfers, or transactions in high-risk regions (Omar et al., 2022). Such monitoring helps banks fulfill regulatory obligations, such as anti-money laundering (AML) compliance. They allow investigators to quickly isolate suspicious activities for further scrutiny.

Cybersecurity infrastructure protects financial data from unauthorized access, ensuring the

confidentiality, integrity, and availability of sensitive information. Firewalls, encryption protocols, and intrusion detection systems prevent cybercriminals from exploiting system vulnerabilities (Khan et al., 2021). By securing digital systems, cybersecurity measures reduce the risk of data breaches that could compromise financial investigations. They also support forensic readiness by ensuring that digital logs and evidence are preserved and traceable.

Listed deposit money banks contribute significantly to the Nigerian economy by serving as financial intermediaries, mobilizing savings from the public and channeling them into productive investments (Sanusi, 2012). They play a crucial role in capital formation and support the growth of key sectors such as agriculture, manufacturing, and infrastructure through credit extension (CBN, 2021). These banks also aid in the implementation of monetary policy by facilitating the transmission of interest rates and liquidity controls as directed by the Central Bank of Nigeria. In terms of employment, listed banks contribute both directly through job creation within the sector and indirectly by financing businesses that generate additional employment (Adeleke, 2020). Their status as publicly listed entities enhances transparency, investor confidence, and adherence to corporate governance practices (SEC Nigeria, 2022). It is against this background that this study investigated the effect of forensic technological tools on financial crime investigation efficiency among listed deposit money banks in Nigeria.

### Statement of the Problem

Despite the increasing sophistication of financial crimes in Nigeria's banking sector, the effectiveness of forensic technological tools in combating these crimes among listed deposit money banks remains inadequately explored. Although forensic tools such as digital imaging, data mining, AI-based analytics, and transaction monitoring systems are globally recognized for enhancing financial investigations (Akinbowale et al., 2020; Okere et al., 2022), there is limited empirical evidence assessing their collective impact within Nigeria's financial ecosystem. Many prior studies, such as those by Ogundana et al. (2021) and Alshgari et al. (2021), focused on traditional forensic accounting techniques without integrating the role of emerging technologies. This presents a variable gap, as modern digital tools are rarely isolated and examined for their direct contribution to crime detection outcomes. Theoretical gaps also persist, as few studies apply robust investigative or criminological theories such as Fraud Diamond Theory in modeling the relationship between forensic tools and crime detection. Methodologically, past research often relied on descriptive surveys or qualitative designs (e.g., interviews with auditors), lacking inferential analyses that establish causality or predictive value. Furthermore, most Nigerian studies

have focused broadly on fraud control in commercial or microfinance banks (Omodero & Ogbonnaya, 2022), thereby introducing a geographical and sectoral scope gap with little attention to the listed deposit money banks regulated by the Nigerian Exchange Group. Finally, the evidence gap is widened by the absence of recent studies that incorporate current technological advancements in AI and blockchain in financial investigation efficiencies, limiting the relevance of older findings. Hence, there is a pressing need for a focused, theory-driven, and empirically grounded study that evaluates the effect of forensic technological tools on financial crime investigation efficiency within this crucial segment of Nigeria's banking industry. The following research questions were raised in the course of the study.

### Research Questions

The following research questions were raised in the course of the study

- i. What is the effect of forensic accounting software on financial crime investigation efficiency of listed deposit money banks in Nigeria?
- ii. How does artificial intelligence tools affect the financial crime investigation efficiency of listed deposit money banks in Nigeria?
- iii. What is the effect of electronic transaction monitoring systems on the financial crime investigation efficiency of listed deposit money banks in Nigeria?
- iv. How does cybersecurity infrastructure affect the financial crime investigation efficiency of listed deposit money banks in Nigeria?

### 1.4 Objectives of the Study

The main objective of the study is to examine the effect of digital technological tools on financial crime investigation efficiency of listed deposit money banks in Nigeria. Specifically, the study sought to:

- i. assess the effect of forensic accounting software on the financial crime investigation efficiency of listed deposit money banks in Nigeria;
- ii. evaluate the effect of artificial intelligence tools on the financial crime investigation efficiency of listed deposit money banks in Nigeria;
- iii. determine the effect of electronic transaction monitoring systems on the financial crime investigation efficiency of listed deposit money banks in Nigeria;
- iv. ascertain how cybersecurity infrastructure affect the financial crime investigation efficiency of listed deposit money banks in Nigeria;

In order to achieve the objective of the study, the following hypotheses were raised in null forms

**H<sub>01</sub>:** Forensic accounting software has no significant effect on financial crime investigation efficiency among listed deposit money banks in Nigeria.

**H<sub>02</sub>:** Artificial intelligence tools have no significant effect on financial crime investigation efficiency among listed deposit money banks in Nigeria.

**H<sub>03</sub>:** Electronic transaction monitoring systems have no significant effect on financial crime investigation efficiency among listed deposit money banks in Nigeria.

**H<sub>04</sub>:** Cybersecurity infrastructure has no significant effect on financial crime investigation efficiency among listed deposit money banks in Nigeria.

## 2.0 Literature Review

### Conceptual Reviews

This study has reviewed important concepts that are germane to the study such as concepts of financial crime investigation, financial crime investigation efficiency, forensic accounting software usage, artificial intelligence tools, electronic transaction monitoring systems, and cybersecurity infrastructure.

### Financial crime investigation

According to Levi and Reuter (2020), financial crime investigation involves the systematic identification, tracing, and examination of unlawful financial activities such as fraud, embezzlement, and money laundering, using legal and technological methods to collect admissible evidence. It aims to uncover how financial crimes are perpetrated, who is responsible, and how illicit gains are concealed or laundered. Similarly, FATF (2022) describes financial crime investigation as a multidisciplinary process combining forensic accounting, auditing, intelligence analysis, and law enforcement procedures to detect and prosecute financial wrongdoing. These investigations often rely on collaboration between banks, regulatory bodies, and investigative agencies to ensure transparency and legal compliance. The process not only deters future crimes but also strengthens public trust in financial institutions. Financial crime investigations are often complex due to evolving criminal tactics and the global movement of illicit funds. While these definitions emphasize legal and analytical rigor, they understate the challenges posed by cross-border jurisdictions and the limited technological capacity in some developing economies like Nigeria.

### Financial crime investigation efficiency

Financial Crime Investigation Efficiency (FCIE), as described by Ajagbe et al. (2025), refers to the strategic ability of investigative agencies to detect, analyze, and resolve financial crimes in a timely, cost-effective, and resource-optimized manner while ensuring accuracy and evidential integrity. The first perspective focuses on internal investigative processes, where efficiency is achieved through the integration of skilled personnel, digital forensic tools, artificial intelligence analytics, and effective case management systems (Ajagbe et al., 2025). It

emphasizes reducing investigation cycle time, improving detection-to-conviction ratios, maximizing asset recovery rates, and fostering inter-agency collaboration and data sharing. Key performance indicators such as alert-to-case conversion rates, time-to-first-action, and successful prosecution ratios serve as benchmarks for measuring success.

Also, FATF (2024) views FCIE as an ecosystem-wide capacity that depends on coordinated governance structures, interoperable systems, and legally compliant information sharing between public and private stakeholders. It underscores the role of regulatory frameworks, mutual legal assistance treaties, and joint operational task forces in accelerating investigative timelines and resolving complex cross-border cases. Efficiency indicators here include subpoena turnaround times, the usefulness of Suspicious Activity Reports, and the proportion of international cases successfully closed. This perspective stresses risk-based allocation of resources and the use of AI-powered transaction monitoring, balanced with strong governance and legal safeguards. While the first view may overemphasize technological and performance metrics, and the second may risk diluting accountability among actors, both approaches affirm that FCIE relies on strategic resource deployment, measurable outcomes, and compliance with legal and ethical standards.

### **Forensic accounting software**

Forensic accounting software are specialized technologies used to extract, preserve, and analyze digital evidence from electronic devices during an investigation. Akinbowale et al. (2020) define them as automated systems and software such as FTK, EnCase, or X-Ways that support investigators in collecting, analyzing, and presenting data from digital storage systems. In a similar vein, Alshgari et al. (2021) note that Forensic accounting software enhance the accuracy and reliability of financial crime detection by enabling the recovery of hidden or deleted digital footprints and transaction records. These tools play a crucial role in uncovering cyber-enabled crimes in banking systems. They help maintain the chain of custody and integrity of evidence for judicial admissibility. Although these tools are praised for their effectiveness, their successful use depends heavily on skilled personnel, which may be lacking in many Nigerian banking environments.

### **Artificial intelligence tools**

Artificial Intelligence (AI) tools refer to machine learning algorithms and automated systems that mimic human intelligence to analyze large volumes of data and detect anomalies. Brennen and Kreiss (2021) define AI tools in financial crime investigation as

predictive technologies capable of identifying suspicious patterns in real-time across complex financial networks. Likewise, Arner, et al. (2020) explain that AI enables proactive detection of potential fraud through pattern recognition, anomaly detection, and behavioral analytics. These tools are particularly effective in minimizing false positives and improving operational efficiency. Their adaptability over time allows for improved fraud detection accuracy. Despite their potential, AI tools are often costly to implement and require extensive datasets for training, which may not be readily available or standardized in developing countries like Nigeria.

### **Electronic transaction monitoring systems**

Electronic Transaction Monitoring Systems (ETMS) are automated programs used by financial institutions to track and evaluate transactions for signs of illicit activity. Omar et al. (2022) define them as real-time surveillance systems that flag unusual behavior based on pre-defined risk parameters such as transaction volume, frequency, or destination. These systems are essential in meeting Anti-Money Laundering (AML) compliance standards and in identifying suspicious activities. Similarly, Okere et al. (2022) emphasize that ETMS support investigative processes by providing real-time alerts and historical transaction patterns to forensic accountants and regulators. These tools are integral to risk management in modern banking. While effective in theory, ETMS may generate high volumes of false positives and require robust human oversight, which could delay investigations if improperly managed.

### **Cybersecurity infrastructure**

Cybersecurity infrastructure comprises the frameworks, technologies, and practices implemented to protect digital systems from cyber threats and unauthorized access. Khan et al. (2021) define it as an integrated set of tools such as firewalls, encryption, intrusion detection systems, and access controls designed to secure financial information systems. Similarly, KPMG (2022) notes that robust cybersecurity infrastructure not only protects data but also enhances forensic readiness by preserving digital evidence and preventing data tampering during financial investigations. In the context of banking, it ensures the integrity of financial records and systems under investigation. These definitions offer a comprehensive view of cybersecurity's preventive role, but they do not sufficiently address the lag in cybersecurity investment and enforcement in many developing banking sectors.

### **Empirical studies**

This study has conducted empirical reviews by stating the authors, problem investigated, methodology adopted, findings and recommendation on each of the independent variables.



### **Forensic accounting software and financial crime investigations efficiency**

Ogundana et al, (2021) investigated the impact of Forensic accounting software on the effectiveness of financial crime investigations in Nigerian listed deposit money banks. The study identified the rising use of digital platforms in banking as a facilitator of financial crimes and questioned whether banks' forensic capacities were sufficient to detect and trace such offenses. The study employed a survey research design with structured questionnaires administered to compliance officers and internal auditors of listed banks. The population consisted of staff from 13 listed deposit money banks, while a sample size of 130 respondents was selected using purposive sampling. Descriptive and inferential statistics, including multiple regression analysis, were used to analyze the data. The study found that the use of Forensic accounting software such as log tracking, file recovery software, and imaging tools significantly improved the banks' ability to investigate and resolve financial crime cases. The authors recommended increased investment in forensic technology and continuous training of bank staff on digital evidence handling. The study adopted a strong analytical framework but was limited by the non-probability sampling technique, which may affect the generalizability of the findings across the entire banking sector.

### **Artificial intelligence and financial crime investigations efficiency**

Okere et al. (2022) conducted a study to assess the combined effect of Artificial Intelligence (AI) tools and electronic transaction monitoring systems on financial crime investigation in Nigerian deposit money banks. The authors noted that the increasing sophistication of financial crimes necessitated advanced tools for real-time detection and decision-making. A quantitative research design was adopted, using structured questionnaires distributed among staff in compliance, IT, and risk management departments. The population covered employees from 10 major listed deposit money banks, and a sample size of 150 was drawn using stratified random sampling. Data were analyzed using Structural Equation Modeling (SEM) to test the relationships among the variables. The study revealed that AI tools and transaction monitoring systems significantly enhance fraud detection accuracy, reduce investigation time, and improve the overall success rate of criminal probes. It recommended integrating AI with transaction data analytics to optimize investigative efficiency. The use of SEM adds rigor and precision; however, the reliance on self-reported data introduces potential bias, as respondents may overstate the effectiveness of implemented technologies.

### **Electronic Transaction Monitoring Systems and financial crime investigations efficiency**

Adebayo and Ogunleye (2023) conducted a study on the impact of Electronic Transaction Monitoring Systems (ETMS) on financial crime investigation efficiency among listed deposit money banks in Nigeria. The problem identified in their study was the increasing sophistication of financial crimes such as fraudulent wire transfers and unauthorized electronic withdrawals, which have challenged the traditional investigative tools used by financial institutions. The study aimed to determine whether the adoption of ETMS has enhanced the timeliness and effectiveness of financial crime detection and investigation. The researchers employed a descriptive survey design using structured questionnaires administered to compliance officers, IT specialists, and fraud detection personnel across 10 listed deposit money banks. The population consisted of 850 personnel from these banks, from which a stratified random sample of 270 respondents was selected. Data were analyzed using regression analysis and correlation statistics. The findings revealed a significant positive relationship between the deployment of ETMS and the prompt detection of suspicious transactions, as well as a reduction in time taken to resolve fraud cases. The study recommended that banks should increase investment in real-time monitoring technologies and regularly train staff to respond to emerging digital fraud tactics. While the use of stratified random sampling improved the representativeness of the study, reliance solely on self-reported data through questionnaires may have introduced response bias. Also, the study could have been enhanced by including secondary data on actual fraud cases before and after ETMS adoption to provide stronger empirical backing.

Nwankwo and Bello (2024) explored the effectiveness of Electronic Transaction Monitoring Systems in combating financial crimes among listed deposit money banks in Nigeria. The study focused on the persistent challenges Nigerian banks face in detecting complex financial crimes due to the rapid evolution of digital banking. The research utilized a mixed-method approach, combining quantitative analysis of bank-reported fraud cases with qualitative interviews. The population included all 22 listed deposit money banks, with a purposive sample of 12 banks selected based on their level of digital infrastructure. From each bank, 5 senior compliance and fraud investigation officers were selected, totaling a sample size of 60 respondents. Quantitative data were analyzed using Structural Equation Modeling (SEM), while thematic analysis was applied to qualitative interview data. Results showed that banks with robust ETMS recorded lower incidences of undetected fraud and demonstrated quicker investigative response times. Interview responses also highlighted that integration with artificial intelligence features significantly enhanced detection accuracy. The authors recommended the integration of machine

learning algorithms in ETMS and stronger collaboration with regulatory authorities for real-time data sharing. The mixed-method approach enriched the findings, offering both statistical trends and contextual insights. However, the purposive sampling may have introduced selection bias, limiting the generalizability of the findings to banks with lower technological capabilities.

### **Cybersecurity infrastructure and financial crime investigations efficiency**

Omodero and Ogbonnaya (2022) explored how cybersecurity infrastructure supports financial crime investigations within Nigeria's listed banking institutions. The study recognized the frequent compromise of digital evidence and data breaches as significant barriers to successful investigations. The researchers applied a mixed-method approach, combining both quantitative surveys and key informant interviews. The study population included IT security professionals and forensic auditors in 12 listed banks, and a sample size of 120 respondents was selected through convenience sampling. Quantitative data were analyzed using ANOVA and regression, while qualitative responses were coded thematically. Findings showed that strong cybersecurity measures such as real-time network monitoring, secure data encryption, and intrusion detection facilitated better preservation and retrieval of financial data during investigations. The authors recommended a policy framework that mandates minimum cybersecurity standards across all listed banks. The mixed-method design enriches the study's insights, yet the use of convenience sampling reduces the study's external validity and makes replication in other contexts less feasible.

Omar et al. (2022) conducted a study to evaluate the effectiveness of electronic transaction monitoring systems in enhancing financial crime investigations and anti-money laundering (AML) compliance among listed deposit money banks in Nigeria. The study was prompted by persistent challenges in delayed suspicious transaction reporting, ineffective monitoring systems, and non-compliance with AML regulations. Using a quantitative survey research design, the researchers distributed structured questionnaires to compliance officers, IT staff, and AML personnel. The population included staff members from 10 listed deposit money banks, and a sample of 140 respondents was selected through purposive sampling. Data were analyzed using multiple regression analysis to determine the extent to which features of ETMS such as real-time alerts, transaction pattern detection, and report generation enhanced the effectiveness of financial crime investigations. The findings revealed that ETMS significantly improved the speed, precision, and outcome of investigations by allowing early detection and timely suspicious activity reporting. The study

recommended continuous technological upgrades, staff training, and regulatory facilitation for cross-border data tracking. However, a major methodological limitation was its use of purposive sampling, which may introduce selection bias and limit the generalizability of findings across all Nigerian listed banks.

Adewuyi and Akinyemi (2021) explored the impact of real-time electronic transaction monitoring systems on the detection and investigation of financial fraud in Nigeria's listed deposit money banks. Motivated by rising incidents of undetected internal fraud and operational lapses in fraud detection systems, the researchers adopted a survey research design, using standardized questionnaires administered to staff in risk management, internal control, and fraud investigation departments. The study population included employees in 12 listed deposit money banks, and a sample size of 156 respondents was selected using simple random sampling. The collected data were analyzed using descriptive statistics and Pearson correlation to examine the relationship between the level of ETMS implementation and the effectiveness of financial crime detection. The study found a strong positive correlation between the functionality of ETMS and the timely identification of fraudulent transactions. It was observed that banks with more advanced transaction monitoring frameworks responded more effectively to financial crime threats. The researchers recommended the integration of artificial intelligence with ETMS and the establishment of centralized fraud analytics departments. While the use of random sampling enhanced the representativeness of the data, the methodological shortcoming lies in the exclusive use of correlation analysis, which limits the study's ability to infer causality or assess the influence of other control variables.

### **Theoretical Reviews**

The theory that anchored this study is the Fraud Pentagon Theory, the theory which was developed by Crowe LLP (2011), expands earlier fraud models by identifying five drivers of fraud: pressure, opportunity, rationalization, competence, and arrogance. It posits that fraud is influenced not only by external conditions but also by the fraudster's skills and mindset (Crowe, 2011). In relation to forensic technological tools in Nigerian listed deposit money banks, the theory helps explain how these tools reduce fraud risks. Forensic accounting software address opportunity by uncovering hidden digital evidence, while Artificial Intelligence Tools detect complex patterns, limiting the effect of competence. Electronic Transaction Monitoring Systems reduce concealment chances through real-time alerts, and Cybersecurity Infrastructure prevents unauthorized access and data breaches (Okere et al., 2022). However, its limitation lies in the challenge of empirically measuring traits

like arrogance and competence (Omar et al., 2022). Overall, the theory remains applicable in guiding efforts to strengthen financial crime investigations using advanced technology.

### 3.0 Methodology

The study adopted survey research design and the population of this study is all the Four Hundred and fifty two (452) staff in Corporate Headquarters of

thirteen (13) listed deposit money banks in Nigeria, comprising of cyber security analysts, forensic accountants, accountants and IT specialists in charge of information and security, and risk managers because these workers are more directly in charge cybercrime detection in the banks as at 30<sup>th</sup> of April 2025 ((Human Resources Units, 2025). The population and sample size of the banks are tabulated below.

**Table 1 population and sample size distribution**

Bank Name	Population	Proportion	Sample increase	Sample
Access BankPlc	43	43/452*212	20*1.1	22
FBN Holdings Plc	48	48/452*212	23*1.1	25
FCMB Group Plc	39	39/452*212	18*1.1	20
Fidelity Bank Plc	34	37/452*212	16*1.1	18
Guaranty Trust	43	43/452*212	20*1.1	22
Stanbic IBTC	35	35/452*212	16*1.1	18
Sterling bank	30	30/452*212	14*1.1	15
Ecobank	29	29/452*212	14*1.1	15
UBA	19	19/452*212	9*1.1	10
Wema Bank Plc	30	30/452*212	14*1.1	15
Zenith Bank Plc	46	46/452*212	22*1.1	24
Unity Bank	29	29/452*212	14*1.1	15
Polaris Bank	27	27/452*212	13*1.1	14
Total	452	452/452*212	212*1.1	233

**Source: Human Resources Units of the banks and author's computations**

Using Yamane sample size determination formula ( $n = N / 1 + N(e^2)$ ,  $n = 452 / 1 + 452(0.05^2) = 213$ . therefore 452/2.13=212. From the population, the sample size of 212 was arrived and stratified proportionate sampling technique was adopted by the study because of differences in population. Consequently, the sample size of the study based on stratified random sampling technique after attrition rate of 10% was considered gave a final sample size of 233.

A 25 items structured questionnaire (five questions for each independent variable and 5 questions also, for dependent variable) was used to collect data and the independent variables of the study were forensic accounting software, artificial intelligence tools, electronic transaction monitoring systems and cybersecurity infrastructure. The reliability of the

constructs were tested using Cronbach alpha with results of 0.79, 0.82, 0.76 and 0.74, respectively. The dependent variable was financial crime investigation efficiency with a Cronbach alpha results of 0.77 which indicated that they were all reliable enough for the study, because they exceeded benchmark of 0.7.

The modified five- point Likert response scale of Strongly Disagree, Disagree, Undecided, Agree and Strongly Agree was used and were awarded scores ranging from 1, 2, 3 4 and 5 respectively. The data collected was analyzed using different statistical procedures. The null hypotheses were tested using multiple regression through the aid of SPSS (Version) 23 software to find the strength of the relationship between financial crime investigation efficiency as the dependent variable and forensic accounting software,

artificial intelligence tools, electronic transaction monitoring systems and cybersecurity infrastructure as independent variables of the study. The functional relationship of the multiple regression is given as follows.

$$FCIE = f (FACS, ARIT, ETMS, CSIF) \dots \dots \dots (1)$$

With the aid of this equation the study arrived at a model which is mathematically presented as follows:

$$FCIE = \beta_0 + \beta_1 DFTU + \beta_2 ARIT + \beta_3 ETMS + \beta_4 CSIF + U, \dots \dots \dots (2)$$

Where, FCIE=Financial Crime investigation efficiency as measured by response from questionnaires. FACS=Forensic accounting software as measured by response from questionnaires.

ARIT=Artificial Intelligence as measured by response from questionnaires,

ETMS = Electronic transfer monitoring system as measured by response from questionnaires.

CSIF=Cybersecurity Infrastructures as measured by

response from questionnaires

Bo is the intercept while B1-4 is the coefficient of the independent variables.

A Priori expectation is that all the independent variables will have positive effect on financial crime investigation efficiency

#### 4.0 Data Analysis, Results and Discussion of findings

Table 2 provides a detailed summary of the descriptive statistics for the key variables examined in the study, which focuses on the role of forensic technological tools in financial crime investigation efficiency (FCIE) among listed deposit money banks in Nigeria. The variables include forensic accounting software usage, artificial intelligence tools, electronic transaction monitoring systems and cybersecurity infrastructure, based on a total of 219 responses received from 233 administered questionnaires representing 94% return of copies of questionnaire.

**Table 2. Descriptive statistics of variables**

Variables	Obs	Minimum	Maximum	Mean	St Deviation
FCIE	219	2.00	5.00	4.1361	.68585
FACS	219	2.80	5.00	4.3881	.41269
ARIT	219	2.60	5.00	3.9826	.55411
ETMS	219	2.00	5.00	3.9196	.81439
CSIF	219	2.40	5.00	4.2219	.59745

**Source: SPSS Outputs 2025.**

This variable represents how effectively listed deposit money banks in Nigeria are able to investigate financial crimes. Based on 219 observations, the minimum score was 2.00 while the maximum was 5.00 on a 5-point Likert scale. The mean score of 4.1361 indicates that, on average, respondents perceived the financial crime investigation efficiency to be relatively high. The standard deviation of 0.68585 suggests moderate variability in the responses, indicating that while many banks are performing well in this area, there are some that lag behind in investigative capacity. This measure serves as the outcome variable in understanding how digital technologies and infrastructure may influence investigative effectiveness.

Forensic accounting software (FACS) shows a strong presence across the listed deposit money banks, with a mean of 4.3881 on a scale of 2.80 to 5.00. This high average suggests that most banks have integrated Forensic Accounting Software into their systems to support crime detection, evidence recovery, and investigation processes. The low standard deviation of 0.41269 indicates consistency in the level of adoption across the banks. Given the strength and uniformity of

its usage, this variable likely plays a critical role in enhancing the efficiency of financial crime investigations, potentially by enabling faster and more accurate data analysis.

Artificial intelligence tools (ARIT) are also widely used among listed deposit money banks, with a mean score of 3.9826 and a range of 2.60 to 5.00. This average suggests that while AI tools are moderately integrated into operations, there is still room for expansion in their deployment for investigative purposes. The standard deviation of 0.55411 reflects a moderate level of variability among banks, implying that some institutions are more advanced than others in leveraging AI for fraud detection, predictive analysis, or anomaly detection. As an independent variable, AI tools may influence investigation efficiency by enhancing automation and reducing investigative time.

The use of electronic transaction monitoring systems (ETMS) among the banks is reflected in a mean of 3.9196, with scores ranging from 2.00 to 5.00. This shows that transaction monitoring is moderately embedded in financial operations and is an important



part of regulatory compliance and suspicious activity detection. However, the relatively high standard deviation of 0.81439 signals significant differences in the level of system sophistication and coverage across banks. This disparity may explain variations in investigative efficiency, as banks with more advanced transaction monitoring systems are likely to identify and act on fraudulent patterns more effectively.

Cybersecurity infrastructure (CSIF) with a mean score of 4.2219 and a range of 2.40 to 5.00, shows a strong level of development across listed deposit money banks. This suggests that most banks are prioritizing secure digital environments, which is essential for preventing and investigating cyber-enabled financial crimes. The standard deviation of 0.59745 reveals moderate differences in the robustness of cybersecurity frameworks among

institutions. As a predictive factor, stronger cybersecurity infrastructure may contribute positively to investigation efficiency by minimizing data breaches, preserving evidence integrity, and supporting secure access to investigative tools.

The correlation matrix in Table 3 provides insight into the strength and direction of the relationships between financial crime investigation efficiency (the dependent variable) and four independent variables among listed deposit money banks in Nigeria. The values with "\*\*\*" indicate significance at the 0.01 level, suggesting strong statistical confidence. The Variance Inflation Factor (VIF) values also help assess multicollinearity among the predictors. The interpretation of each variable is provided below:

**Table 3 Correlation Matrix of Dependent and Independent variables**

Variables	FCIE	FACS	ARIT	ETMS	CSIF	VIF
FCIE	1.000	.	.			
FACS	.452**	1.000	.			1.260
ARIT	.581**	.505**	1.000			1.704
ETMS	.530**	.277**	.457**	1.000		1.560
CSIF	.522**	.222**	.529**	.463**	1.000	1.508

**Source: SPSS Outputs 2025.** \*\*= significant at 1% level of significance

This variable serves as the benchmark for measuring the effectiveness of tools and systems used in combating financial crimes within listed deposit money banks. As a dependent variable, it is examined in relation to various technological and infrastructural inputs to determine their impact on the investigation process. Since its correlation with itself is 1.000, no interpretation is required here.

Forensic accounting software (FACS) has a moderate positive correlation ( $r = .452$ ,  $p < 0.01$ ) with financial crime investigation efficiency. This suggests that as the use of Forensic Accounting Software increases, so does the efficiency in investigating financial crimes. These tools such as data recovery software and forensic analysis platforms are essential in collecting, analyzing, and presenting digital evidence. The correlation with other variables like artificial intelligence tools ( $r = .505$ ) and electronic transaction monitoring systems ( $r = .277$ ) indicates interdependence but with minimal risk of multicollinearity, confirmed by the VIF of 1.260, which is well below the acceptable threshold of 5.

Artificial intelligence tools (ARIT) show a strong positive correlation ( $r = .581$ ,  $p < 0.01$ ) with financial crime investigation efficiency, indicating that increased use of AI such as machine learning algorithms for anomaly detection significantly enhances investigative outcomes. AI tools also correlate positively with Forensic Accounting Software ( $r = .505$ ) and cybersecurity infrastructure ( $r = .529$ ), signifying technological integration. Despite

these correlations, the VIF value of 1.704 remains within acceptable limits, showing no severe multicollinearity concern.

Electronic transaction monitoring systems (ETMS) are strongly correlated with financial crime investigation efficiency ( $r = .530$ ,  $p < 0.01$ ), suggesting that real-time surveillance of electronic transactions contributes notably to prompt and accurate investigations. The variable also shows meaningful relationships with AI tools ( $r = .457$ ) and cybersecurity infrastructure ( $r = .463$ ), suggesting that the effectiveness of monitoring is enhanced when integrated with advanced technology. The VIF of 1.560 is comfortably below the critical limit, indicating a healthy level of independence from other predictors.

Cybersecurity infrastructure (CSIF) is strongly associated ( $r = .522$ ,  $p < 0.01$ ) with financial crime investigation efficiency, which indicates that robust cyber defenses like firewalls, encryption protocols, and secure networks significantly support crime detection and resolution. It also shares notable correlations with AI tools ( $r = .529$ ) and electronic monitoring systems ( $r = .463$ ), reflecting their mutual reinforcement in financial crime detection. All independent variables digital forensic tools, AI tools, electronic transaction monitoring systems, and cybersecurity infrastructure show statistically significant positive correlations with financial crime investigation efficiency, affirming their roles as key enablers of investigative performance. Furthermore,



low VIF values (ranging from 1.260 to 1.704) indicate that multicollinearity is not a concern, making all the predictors suitable for inclusion in a regression model. These findings support the assertion that technological adoption enhances investigative outcomes in Nigeria's banking sector.

The regression results presented in Table 4 assess the effect of forensic accounting software, artificial intelligence tools, electronic transaction monitoring

systems, and cybersecurity infrastructure on financial crime investigation efficiency among listed deposit money banks in Nigeria. The Ordinary Least Squares (OLS) regression analysis provides coefficient estimates, t-statistics, and p-values to determine the significance and strength of each independent variable's contribution. The model summary statistics also provide insight into the overall explanatory power of the regression model.

**Table 4 Regression Results**

Ind. Variables	Coefficients OLS	T Statistics OLS	P-Values
Constants	0.376	-.445	0.656
FACS	0.163	3.076	0.002
ARIT	0.188	3.060	0.002
ETMS	0.400	6.799	0.000
CSIF	0.179	3.097	0.002
R-Squared	0.525		
Adj. R-Squared	0.516		
F-Statistic	59.139		
P-Value	0.0000		

**Source: SPSS Outputs 2025.**

Forensic accounting software (FACS) has a positive and statistically significant effect on financial crime investigation efficiency, with a coefficient of 0.163, t-value of 3.076, and a p-value of 0.002. This indicates that a one-unit increase in the use of Forensic Accounting Software is associated with a 0.163 unit increase in the efficiency of investigating financial crimes, holding other variables constant. The significance level ( $p < 0.01$ ) shows strong evidence that Forensic Accounting Software such as evidence recovery software and computer-aided forensic analysis play a vital role in enhancing crime investigation efforts in banks and this finding is in line with those of Ogundana et al, (2021).

Artificial intelligence tools (ARIT) also have a positive and statistically significant impact on financial crime investigation efficiency, with a coefficient of 0.188, a t-statistic of 3.060, and a p-value of 0.002. This means that the integration of AI technologies like machine learning, predictive analytics, and pattern recognition in investigation processes contributes substantially to efficiency improvements. The statistically significant result at the 1% level confirms the importance of advanced AI-driven tools in modern financial crime detection mechanisms within the banking sector which corroborates the findings of Okere et al. (2022).

Electronic transaction monitoring systems (ETMS) exhibit the strongest positive effect among the independent variables, with a coefficient of 0.400, a t-value of 6.799, and a p-value of 0.000. This suggests

that a unit increase in the implementation or sophistication of transaction monitoring systems leads to a substantial 0.400 increase in investigation efficiency. The high t-statistic and highly significant p-value ( $p < 0.001$ ) highlight the critical role of real-time transaction monitoring in identifying and curbing suspicious financial activities effectively which confirms the findings by Adebayo and Ogunleye (2023) and Nwankwo and Bello (2024). This variable emerges as the most influential predictor in the model. Cybersecurity infrastructure (CSIF) also significantly and positively influences financial crime investigation efficiency, with a coefficient of 0.179, a t-statistic of 3.097, and a p-value of 0.002. This shows that improving cybersecurity frameworks such as firewalls, encryption systems, intrusion detection, and secure network architecture contributes to more efficient detection and investigation of financial crimes. This finding is in tandem with those of Omodero and Ogbonnaya (2022) and Omar et al. (2022). The statistical significance at the 1% level affirms the necessity of robust cybersecurity measures as a foundation for effective forensic and investigative operations in the banking environment.

The R-squared value of 0.525 indicates that approximately 52.5% of the variation in financial crime investigation efficiency is explained by the combined influence of the four independent variables. The adjusted R-squared value of 0.516 accounts for the number of predictors and provides a slightly more conservative estimate, reinforcing the strength of the model. The F-statistic of 59.139 and its p-value of

0.0000 confirm the overall model's statistical significance, meaning that the predictors jointly have a strong influence on the dependent variable.

## 5.0 Conclusion and Recommendation

The study concluded that among the techniques studied, the regression results showed that all four technological variables significantly enhance financial crime investigation efficiency. Forensic accounting software usage had a positive impact, supporting evidence recovery and data analysis during investigations. Artificial intelligence tools also contribute significantly, improving detection through predictive and analytical capabilities. Electronic transaction monitoring systems have the strongest influence, enabling real-time tracking and identification of suspicious activities. Cybersecurity infrastructure plays a crucial role by securing digital environments and enabling traceable investigations. All variables are statistically significant at the 1% level, affirming their individual importance.

To enhance financial crime investigation efficiency, listed deposit money banks in Nigeria, it is recommended that they should prioritize investment in electronic transaction monitoring systems, as they demonstrated the strongest positive impact by enabling real-time detection and tracking of suspicious activities. In addition, Forensic accounting software should be regularly upgraded and effectively deployed to support the recovery and analysis of digital evidence during investigations. The integration of artificial intelligence tools is also crucial, as they offer predictive and analytical capabilities that improve the accuracy and speed of financial crime detection. Strengthening cybersecurity infrastructure is essential to provide a secure digital environment and support traceable and accountable investigation processes. Staff training and development must be emphasized to ensure that personnel possess the technical skills required to operate and interpret outputs from these digital tools efficiently.

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