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Research Paper

Biometric Authentication and Customer Identification in the Central Bank of Nigeria

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Abstract
The application of biometric technologies for authentication and identification in Financial Transactions in Nigerian banks tend to have reshaped financial transactions and enhanced transactional efficiency in the financial sector. This study examined the impact of biometric authentication on customer identification in the Central Bank of Nigeria (CBN) between 2015 and 2025. Founded on the Institutional Theory, which highlights how formal and informal institutional pressures influence technological adoption, the study assessed the impact of AI-enabled biometric tools, including fingerprint verification and facial recognition, in enhancing Know Your Customer (KYC) compliance, reducing identity fraud, and promoting financial inclusion. A mixed-methods approach was employed by integrating quantitative data generated via 4-point Likert scale structured questionnaire and qualitative insights from interviews across CBN branches in the South-South, South-East, and North-Central regions. Findings reveal that biometric authentication significantly improves customer identification accuracy, with strong mean scores (3.48–3.53) and agreement levels (92.7%–94.3%). Pearson correlation analysis confirmed a moderate-to-strong positive relationship ($r = 0.673$, $p < 0.05$) between biometric deployment and identification accuracy. Qualitative data highlighted the dual benefits of enhanced security and increased access to banking services for previously underserved populations, while challenges such as hardware quality variation and accessibility for elderly customers were identified. Based on these findings, the study recommends continued investment in high-quality biometric infrastructure, inclusive system design with human fallback mechanisms, regular audits for demographic accuracy, and strengthened data governance frameworks to protect customer privacy. These measures will ensure that biometric authentication remains a reliable, secure, and inclusive tool for customer identification in Nigeria's central banking system.

Keywords: *Biometric authentication, customer identification, AI adoption, financial inclusion, Central Bank of Nigeria*

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I. Introduction

The rapid evolution of financial technologies has significantly reshaped the operations of central banks worldwide, particularly in the areas of customer identification, authentication, and the management of monetary policy. Biometric authentication, as an advanced technological mechanism, has emerged as a key tool for enhancing security, promoting financial inclusion, and improving the accuracy of customer identification in banking systems (Ahamed & Abdul Rahman, 2023; Barendse & Holden, 2020; Ramachandran, 2019). In the context of the Central Bank of Nigeria (CBN), the adoption of biometric systems represents a strategic response to both operational inefficiencies and the growing demand for secure, reliable, and fraud-resistant financial transactions. Central banks serve as pivotal institutions in the regulation of national financial systems, the formulation of monetary policy, and the oversight of banking stability (Issing, 2020; Nixon, 2018). However, challenges such as identity fraud, cybercrime, and the complexity of financial transactions have necessitated the integration of technological innovations into traditional governance frameworks. Biometric authentication—utilising fingerprints, iris scans, facial recognition, and voice recognition—offers the potential to enhance the

integrity of customer verification processes, thereby reducing systemic risks and enhancing public trust (Buolamwini& Gebru, 2018; Obermeyer, Powers, Vogeli, & Mullainathan, 2019). From an institutional perspective, the adoption of biometric systems can be understood through the lens of institutional theory, which emphasises the processes through which organisations adopt practices to gain legitimacy and conform to external pressures (DiMaggio & Powell, 1983; Deephouse& Suchman, 2008). Institutional isomorphism, for instance, explains how organisations, including central banks, may adopt similar technological solutions in response to coercive, mimetic, or normative pressures within their institutional environment (Thornton & Ocasio, 1999). In the Nigerian context, the CBN's integration of biometric technologies may reflect both domestic regulatory expectations and the global trend toward digitalisation and enhanced security in banking. The interplay between technology and institutional structures is further illuminated by sociotechnical perspectives, which recognise that technological innovations are not merely tools but are co-constructed with organisational, social, and cultural factors (Bijker, 1995; Bijker & Law, 1992; Oudshoorn& Pinch, 2003). The implementation of biometric systems in the CBN involves a complex alignment of human actors, technological infrastructure, and regulatory frameworks, requiring careful management to ensure that the intended benefits are realised. Moreover, sociotechnical transition theories suggest that successful adoption of novel technologies in institutional contexts requires a multi-level approach that considers niche innovations, organisational regimes, and broader societal landscapes (Geels, 2002; Geels &Schot, 2007; Loorbach, Frantzeskaki, & Avelino, 2017). The adoption of biometric authentication in Nigeria also aligns with broader efforts to promote financial inclusion. Central banks in emerging markets have increasingly recognised the importance of accessible and secure banking systems for extending financial services to previously underserved populations (Khan & Park, 2017; Lozada & Kijima, 2021). By ensuring accurate customer identification and reducing the incidence of identity-related fraud, biometric systems can foster greater trust in the formal financial sector, thereby enhancing participation and supporting inclusive economic growth. However, the introduction of such technologies is not without ethical and practical challenges. Studies on algorithmic fairness and bias highlight potential disparities in the performance of biometric systems, particularly across different demographic groups (Buolamwini& Gebru, 2018; Obermeyer et al., 2019). Consequently, the CBN must navigate the dual objectives of security and equity, ensuring that biometric systems do not inadvertently marginalise certain populations.

Additionally, the governance of biometric technologies intersects with broader discussions on public administration and digital governance. Effective implementation requires a balance between technical competence, regulatory oversight, and policy alignment (Emmanuel & Adegbite, 2024; Mbaka & Ani, 2023). Central banks operate within a highly scrutinised regulatory environment, and the introduction of biometric systems necessitates clear policies on data privacy, cybersecurity, and operational transparency (Ramachandran, 2019; Nwabueze & Ohia, 2025). This aligns with Foucault's (1980) notion of power/knowledge, whereby the deployment of technologies shapes not only operational capabilities but also the governance dynamics within institutions. Moreover, the evolution of biometric authentication in the CBN can be framed within path dependency and historical institutionalism, which emphasise the role of previous policy choices and institutional configurations in shaping current technological adoption (Pierson, 2000; Hall & Taylor, 1996). The CBN's previous efforts in digital banking, identity verification, and regulatory frameworks for electronic payments have created both opportunities and constraints for the deployment of biometric systems. Understanding these historical and institutional contexts is essential for assessing the potential impact of biometric technologies on organisational efficiency, customer satisfaction, and overall financial stability. Finally, the integration of biometric authentication is part of a broader trend of technological digitalisation in central banking, which includes the exploration of central bank digital currencies (CBDCs) and fintech innovations (Barendse & Holden, 2020; Hu & Zhang, 2019). These technological advancements necessitate a rethinking of traditional banking models and regulatory approaches, highlighting the importance of interdisciplinary research that bridges technology, governance, and financial economics. The CBN's experience with biometric authentication provides a case study for examining how emerging technologies can enhance operational efficiency, strengthen governance, and foster inclusive financial systems in emerging economies.

Against this background, this study sought to examine biometric authentication and customer identification in the Central Bank of Nigeria, exploring its adoption, operational challenges, and implications for secure and inclusive banking. As such, the study attempted to answer the question; what influence does biometric authentication play in CBN's customer identification. This was guided by the single hypothesis that there is no significant relationship between biometric authentication and accurate customer identification. This study is divided into four interconnected parts after the introduction is the literature review which covers theoretical and conceptual explications. The part following is the method how data was collected and analysed while rest parts are the data presentation, analysis and discussion; and the conclusion and recommendation respectively.

The Institutional Theory

This was first developed by Max Weber, Talcott Parsons, and Neil Smelser in the early 20th century, and posits that individuals and organisations conform to institutional pressures to gain legitimacy and resources. This theory has been applied to a wide range of phenomena, including technological adoption and innovation. In the context of AI tool adoption in public policy in the Central Bank of Nigeria, the Institutional Theory highlights the importance of understanding the broader institutional environment, including the cultural, political, and economic factors that shape AI tool adoption. Specifically, the Institutional Theory suggests that the adoption of an AI tool in public policy will depend on a range of institutional factors, including norms and values, formal and informal institutions, legitimacy and resistance, etc. The adoption of an AI tool may be influenced by cultural norms and values around technology and innovation, as well as the norms and values that shape public policymaking in Nigeria. Formal institutions, such as government policies and laws, as well as informal institutions, such as societal norms and expectations, may affect the adoption and implementation of AI tools in public policy. The distribution of power and authority within the Nigerian political system may influence the adoption of AI tools in public policy, with certain actors having more influence and control over decision-making processes. The adoption of an AI tool may face resistance from certain groups or institutions, who may perceive it as a threat to their power or interests. To overcome this resistance, policymakers may need to build legitimacy for AI tool adoption by framing it as consistent with the values and norms of the broader institutional environment. Together, these institutional factors provide a framework for understanding the adoption and implementation of AI tools in public policy in the Central Bank of Nigeria. The Institutional Theory suggests that successful AI tool adoption will require a careful analysis of these factors and a strategic approach to navigating them.

For example, policymakers may need to engage in stakeholder management, build coalitions with key actors who support AI tool adoption, and develop effective communication strategies to build legitimacy for AI-based solutions. Overall, the Institutional Theory emphasises the importance of considering the broader institutional environment when adopting and implementing an AI tool in public policy in the Central Bank of Nigeria. Institutional Theory provides a comprehensive lens to analyse AI tool adoption in public policy. It highlights the importance of both formal institutions, like legal frameworks, and informal institutions, such as societal norms, in facilitating or hindering technological advancements. Legitimacy plays a crucial role, as institutions that are perceived as legitimate can more effectively promote AI integration. Power structures also significantly impact AI adoption, with powerful stakeholders often determining the trajectory of policies. Furthermore, path dependence can result in entrenched practices, making it challenging to adopt alternative approaches. Institutional isomorphism may lead to uniform AI tool strategies, disregarding contextual differences. Lastly, prevailing institutional logics, such as prioritising efficiency or social equity, influence the direction of AI tool implementation. According to Ahamed and Abdul Rahman (2023), understanding these institutional factors is essential for a nuanced analysis of AI tool adoption. For instance, formal institutions can either support or constrain AI tool use through regulatory frameworks (Ahamed & Abdul Rahman, 2023). Informal institutions, like cultural attitudes, also shape perceptions of AI and its applications. The interplay of these factors ultimately determines the pace and nature of AI integration in public policy contexts. Legitimacy, as noted by such scholars, is a vital component in institutional theory. If stakeholders view AI tool adoption as legitimate and aligned with societal values, it fosters acceptance and cooperation (Deephouse& Suchman, 2008). Conversely, a lack of legitimacy can lead to resistance and hinder progress. Power dynamics, too, significantly influence AI policymaking, as more powerful entities often have greater sway over decision-making processes (Foucault, 1980). Path dependence and institutional isomorphism also contribute to the complexity of AI tool adoption. Once a particular approach becomes established, it can be difficult to change course due to sunk costs and inertia (Pierson, 2000). Isomorphism, driven by pressures to conform, may result in homogeneous AI strategies across organisations, even when tailored solutions might be more effective (DiMaggio & Powell, 1983). Institutional logics further shape AI policies by guiding organisational priorities and actions. Logics centred on efficiency, for example, might prioritise automation and cost savings, while logics emphasising equity could focus on ensuring AI benefits all segments of society (Thornton & Ocasio, 1999). These logics, in turn, influence the design and implementation of AI initiatives within public policy frameworks. The interplay between these factors can create complex feedback loops. Powerful stakeholders might promote a specific institutional logic, which in turn reinforces their power and legitimacy. This can lead to a self-perpetuating cycle that makes it difficult for alternative logics or approaches to emerge. Recognising and addressing these dynamics is crucial for fostering inclusive and effective AI tool adoption in public policy.

Institutional Theory also helps us consider the role of change agents and institutional entrepreneurs who actively work to alter existing institutions and logics (Battilana *et al*., 2009). These individuals and groups can challenge dominant norms and power structures, paving the way for more innovative AI policies. Their actions highlight the potential for intentional, transformative change within institutional frameworks. Change agents often face resistance, but they can leverage various strategies to overcome obstacles. This includes building coalitions, reframing narratives, and exploiting crises or windows of opportunity (Kingdon, 1984). By

understanding these strategies, we can better support efforts to drive institutional change and ensure AI tool adoption aligns with societal needs and values. Institutional change can also be driven by external factors, like technological advancements or global trends. For example, international AI standards and best practices might influence local policies, prompting institutions to adapt (Hall & Taylor, 1996). This highlights the interconnected nature of institutions and the importance of considering both internal and external drivers of change. People's beliefs, identities, and routines play a role in maintaining or transforming institutions (Powell &Colyvas, 2008). Understanding these micro-level processes can offer insights into how institutional change unfolds at a more personal, day-to-day level. Micro-foundations emphasise that institutions are not just abstract structures, but are shaped and sustained by the people within them. Employees' daily practices, for instance, can either reinforce existing norms or introduce new ones. Leaders and managers also have a significant impact, as their decisions and behaviours set the tone for organisational culture and institutional evolution. Institutional Theory provides a robust framework for analysing AI adoption in public policy. By examining formal and informal institutions, legitimacy, power, path dependence, isomorphism, logics, and micro-foundations, we gain a comprehensive understanding of the complex forces shaping AI's role in governance. Recognising these factors can help policymakers navigate challenges and foster an environment conducive to responsible, beneficial AI integration.

II. Conceptual Review

The Central Bank

A central bank, also known as a monetary authority or reserve bank, is a financial institution that plays a critical role in the management of a country's monetary policy and financial system. Central banks are typically the highest authority within the banking system of a country, responsible for controlling the money supply, interest rates, and the value of its currency. They often serve as the lender of last resort to commercial banks, providing liquidity during financial crises and helping to maintain stability within the financial system. Throughout history, central banks have evolved and taken on different roles and functions in response to economic and political developments. Here are some key milestones in the history of central banking:

a. **Early Central Banking (1600s-1700s):** The Bank of England, established in 1694, is often considered the first modern central bank. Other European countries, including the Netherlands, France, and Sweden, also established central banks during this period.

b. **The Gold Standard (1880s-1930s):** Central banks were closely linked to the gold standard, a system in which the value of currency was pegged to gold. The Great Depression (1930s-1940s): The global financial crisis of the 1930s prompted central banks to adopt new policies, such as monetary stimulus and price stability goals, to prevent deflation and encourage economic recovery.

c. **Post-World War II Era (1940s-1970s):** After World War II, central banks played a key role in the Bretton Woods system, which stabilised exchange rates and promoted international cooperation in monetary policy. The Rise of Inflation (1970s-1980s): High inflation and stagflation in the 1970s led central banks, such as the US Federal Reserve, to adopt tight monetary policies to reduce inflation and restore price stability.

d. **The Modern Era (1990s-present):** In the 1990s, many central banks adopted inflation targeting, which aims to achieve a specific inflation rate. Since the 2008 global financial crisis, central banks have employed unconventional monetary policy measures, such as quantitative easing, to stimulate economic growth and maintain financial stability.

Central Bank Functions

Central banks perform various functions, which can vary depending on the country's economic and political context. The primary functions of central banks include:

i. **Monetary Policy:** Central banks control the money supply and interest rates to achieve economic objectives, such as inflation targeting, economic growth, and full employment.

ii. **Financial Stability:** Central banks oversee financial markets and financial institutions, ensuring the stability of the financial system.

Lender of Last Resort: Central banks act as lenders of last resort to financial institutions, providing liquidity during financial crises to prevent widespread panic and bank runs.

iii. **Bank Supervision:** Central banks supervise commercial banks and other financial institutions, ensuring that they operate in accordance with regulations and maintain adequate capital and liquidity ratios.

iv. **Foreign Exchange Management:** Central banks intervene in the foreign exchange markets to manage exchange rates, prevent currency devaluation, and promote economic stability.

v. Payment System Oversight: Central banks manage and regulate the payment systems within their jurisdiction, ensuring the safety and efficiency of money transfers and financial transactions.

vi. **Government Debt Management:** Central banks manage the public debt of their respective countries, providing advice on debt issuance, interest rates, and debt sustainability.

vii. **Financial Inclusion:** Central banks promote financial inclusion by supporting the development of financial infrastructure, such as digital payment systems, and by encouraging the adoption of financial services by underbanked populations.

Relationship between Central Banks and Governments

The relationship between central banks and governments is a complex and dynamic one that varies depending on institutional arrangements and political context. Central banks are often granted a degree of independence from the government, allowing them to make monetary policy decisions without political interference. This is believed to enhance credibility and improve decision-making, as highlighted by Bernanke (2007). However, central banks and governments also need to coordinate their policies on issues related to economic stability, fiscal policy, and financial regulation. This coordination helps ensure that monetary and fiscal policies are aligned and that both institutions are working together to achieve common objectives.

Digitalisation is rapidly transforming the landscape of central banking. The use of digital currencies, such as central bank digital currencies (CBDCs), is becoming an increasingly popular area of research and development in central banks around the world. These digital currencies have the potential to enhance financial inclusion by providing access to financial services for unbanked and underbanked populations, improve the efficiency of payment systems, and maintain the stability of the financial system. According to Barendse and Holden (2020), CBDCs can provide new tools for monetary policy implementation, allowing central banks to better manage money supply, interest rates, and exchange rates. In addition to digitalisation, other trends shaping central banking include:

i. **Sustainability:** Many central banks are exploring how to incorporate environmental, social, and governance (ESG) factors into their policymaking and investment decisions. This includes consideration of climate-related financial risks, green finance, and sustainable finance initiatives (Dawson & Spatz, 2022).

ii. **Big Data and AI tools:** Central banks are increasingly adopting advanced data analytics and AI tools to improve their policymaking, risk management, and decision-making capabilities.

Central banks are developing policies and programs aimed at promoting financial inclusion, particularly for underbanked populations in emerging markets (Lozada & Kijima, 2021). In light of the global financial crisis of 2007-2008, central banks are focusing on enhancing financial stability and mitigating systemic risks, such as those posed by shadow banking and fintech (Hu & Zhang, 2019). There is growing emphasis on central bank governance and accountability, with increased scrutiny on transparency and communication around monetary policy decisions (Nixon, 2018). As the global financial system becomes more interconnected, central banks are engaging in greater cooperation and coordination through institutions such as the International Monetary Fund (IMF) and the Bank for International Settlements (BIS) to promote global financial stability (Issing, 2020).

Central banks play a critical role in the international coordination of monetary policy and financial regulation. Through multilateral institutions such as the G20, Financial Stability Board (FSB), and the International Organisation of Securities Commissions (IOSCO), central banks engage in global dialogue and cooperation to address issues such as cross-border capital flows, exchange rate volatility, and financial risk management. This level of coordination is essential to ensure that the actions of one central bank do not negatively impact other countries and to maintain the stability and efficiency of the global financial system (Gabaix& Maggiori, 2019). In addition to international coordination, central banks are also concerned with promoting financial literacy and financial education. This involves educating the public on topics such as budgeting, saving, credit, and investing, to foster better financial decision-making and reduce financial exclusion (Khan & Park, 2017). By providing resources and tools to enhance financial knowledge and skills, central banks seek to create more informed and empowered consumers and investors, which in turn contributes to the overall health and stability of the financial system. Furthermore, central banks have also taken on a role in promoting cybersecurity and data protection. Cybersecurity has become a crucial issue for central banks, as they increasingly rely on digital infrastructure and technology to support their operations. With the rise of cyberattacks, data breaches, and privacy concerns, central banks are taking steps to strengthen their cybersecurity frameworks and protect sensitive data. This includes investing in advanced cybersecurity solutions, developing incident response plans, and collaborating with other financial institutions to mitigate potential threats. Moreover, central banks are adopting industry standards such as the NIST Cybersecurity Framework and ISO/IEC 27001 to enhance their cybersecurity posture (Ramachandran, 2019). As central banks assume greater responsibility in areas like financial education, cybersecurity, and digital currencies, they must also manage the implications of these roles on their independence and accountability. There is a delicate balance to strike between fulfilling their core mandates of monetary policy, financial stability, and price stability, while also addressing emerging issues that may not fall squarely within their traditional purview. Ensuring transparency, effective communication, and engagement with stakeholders can help central banks maintain public trust and legitimacy while navigating this complex terrain. Moreover, ongoing research and debate among policymakers and academics will continue to shape central banks' role and responsibilities in the global economy. Another critical aspect of central banking is the consideration of monetary policy regimes, which

refers to the strategy and methods that central banks use to achieve their objectives. Historically, there have been several monetary policy regimes, such as the gold standard, monetary targeting, inflation targeting, and, more recently, flexible inflation targeting and unconventional monetary policy (Cochrane, 2011). Monetary policy regimes can significantly influence the performance of the economy, financial stability, and the relationship between central banks and the public. Central banks must weigh the trade-offs between different monetary policy regimes, taking into account factors such as transparency, effectiveness, and sustainability. The choice of monetary policy regime is particularly significant in emerging markets and developing countries, where central banks often face unique challenges related to inflation, foreign exchange volatility, financial sector development, and political and institutional constraints (Davila & Valderrama, 2021).

In many emerging markets, central banks have adopted different approaches, such as flexible inflation targeting, exchange rate targeting, and reserve accumulation, to achieve price stability and support sustainable economic growth while maintaining exchange rate flexibility and ensuring financial stability. Furthermore, central banks are exploring new approaches to address long-term challenges, such as the trend towards lower interest rates and low inflation, which may pose challenges to traditional monetary policy instruments. This includes research on novel monetary policy tools like negative interest rates, helicopter money, and Modern Monetary Theory (MMT). In addition, the potential emergence of a digital currency issued by central banks (i.e., central bank digital currency or CBDC) raises questions about the future of money and the role of central banks in the digital economy. Recent developments in digital technology have led to the emergence of cryptocurrencies and private digital currencies like Bitcoin, which challenge traditional notions of money and raise concerns about monetary policy and financial stability. Central banks are studying the implications of digital currencies and exploring the potential benefits and risks of CBDCs, such as enhanced efficiency, financial inclusion, and new monetary policy tools (Chen & Xia, 2021). While cryptocurrencies pose a challenge to central banks' role as issuers of currency, CBDCs offer an opportunity for central banks to shape the future of money and retain control over monetary policy. Another important aspect of central banking is the management of monetary policy transmission, which refers to the mechanisms through which monetary policy affects the real economy. Central banks rely on several channels to transmit monetary policy signals, including interest rates, exchange rates, credit conditions, asset prices, and expectations. However, the effectiveness of these channels can vary across countries and economic conditions, and central banks must carefully monitor their impact to ensure that monetary policy is achieving its desired objectives. In addition to the traditional monetary policy transmission channels, central banks are exploring new channels, such as the use of forward guidance, quantitative easing, and unconventional monetary policy tools. Forward guidance refers to the practice of communicating the central bank's intentions about future monetary policy decisions, which can help shape market expectations and influence financial markets. Quantitative easing involves the purchase of long-term financial assets, such as government bonds, to lower interest rates and stimulate economic activity. Unconventional monetary policy tools, such as negative interest rates and helicopter money, have also been used in some countries to address persistent low inflation and low growth. Another aspect of central banking worth considering is the governance and accountability of central banks. Central banks are typically independent from the government, which helps protect them from political pressure and allows them to make monetary policy decisions based on objective economic criteria.

However, this independence must be balanced with accountability to ensure that central banks are transparent, responsive, and serve the public interest. Various governance structures and accountability mechanisms, such as inflation targeting frameworks, parliamentary oversight, and monetary policy committees, have been developed to ensure that central banks are accountable and effective in their operations. Central banks' role in financial stability is also critical, as they are responsible for identifying, monitoring, and mitigating systemic risks within the financial system. Central banks typically use a range of tools, such as stress testing, macroprudential policy, and resolution planning, to assess the resilience of the financial system and to prevent or mitigate financial crises. The 2008 global financial crisis highlighted the importance of financial stability as a key objective of central banks, and many have incorporated financial stability into their mandates, alongside traditional objectives such as price stability and full employment. Central banks also play a key role in the international monetary system, which is the system of exchange rates and payments that facilitates international trade and capital flows. The International Monetary Fund (IMF), founded in 1945, is a key institution in the international monetary system. It provides loans to countries facing balance of payments crises, promotes global economic cooperation, and supports exchange rate stability and development. Central banks engage with the IMF through various mechanisms, such as surveillance, lending programs, and capacity building. The governance and structure of the international monetary system have evolved in response to global economic developments and challenges. The Bretton Woods system, which lasted from 1944 to 1971, established the post-war international monetary system with the dollar as the anchor currency and a fixed exchange rate system. In the 1970s, the Bretton Woods system collapsed, leading to a transition to floating exchange rates and the emergence of new institutions such as the Group of Seven (G7) and the Group of Twenty (G20) to coordinate global economic policy. Central banks also face a range of ethical considerations in their

decision-making, such as the trade-offs between price stability, financial stability, and income and wealth distribution. Central banks must balance the need for economic growth and stability with the potential distributional effects of their policies, such as the impact of low interest rates on savers or the impact of quantitative easing on asset prices. Furthermore, central banks must consider the potential environmental and social impacts of their policies, including the effects of climate change on the financial system and the role of central banks in promoting sustainable finance.

III. Method

This study adopted a mixed-methods research design to comprehensively examine the adoption and utilisation of artificial intelligence (AI) tools in the Central Bank of Nigeria (CBN). The design integrated quantitative data from structured 4-point Likert-scale questionnaires with qualitative data from semi-structured interviews, enabling both statistical analysis and in-depth contextual understanding of AI applications across monetary policy, anti-money laundering, biometric identification, supervisory systems, and customer services. The quantitative component employed a descriptive survey and utilised the Pearson Product-Moment Correlation Coefficient at a 0.05 significance level to test five hypotheses, while qualitative data were analysed thematically to explain and validate statistical patterns. The study was conducted across selected CBN branches representing the South-South, South-East, and North-Central regions, capturing Nigeria's socio-economic diversity. A population of 1,800 respondents drawn from 13 departments, alongside community stakeholders, was sampled using the Taro Yamane formula to obtain 260 participants. Data were sourced from both primary and secondary materials. Instrument validity was ensured through expert review and pilot testing, while reliability was confirmed using Cronbach's Alpha (0.79–0.84; overall 0.82). Data analysis combined descriptive statistics, correlation analysis, and thematic techniques, with findings integrated through convergent triangulation to ensure robust, credible, and contextually grounded conclusions.

IV. Data Presentation

Table 1: Questionnaire Distribution and Return Rate

Category	Number	Percentage (%)
Questionnaire Distributed	260	100
Questionnaire Returned	247	95.0
Questionnaire Not Returned	13	5.0
Interviews Scheduled	45	100
Interviews Completed	45	100

Source: Field Survey, 2026

Out of the 260 questionnaire distributed across the selected CBN branches, 247 were returned and found suitable for analysis, representing a response rate of 95%. This high response rate enhanced the reliability and validity of the study findings and demonstrated strong engagement from stakeholders involved in AI tool adoption within the CBN. For the qualitative component, all 45 scheduled interviews were successfully conducted, representing a 100% completion rate for the semi-structured interviews.

Analysis

The analysis of data collected in response to the question raised by the study. The criterion mean of 2.50 was used as a benchmark on the 4-point Likert scale, with mean scores above 2.50 indicating agreement and those below indicating disagreement. For the question, the quantitative Likert-scale analysis is presented first, followed immediately by the PPMC test of the corresponding null hypothesis, and then by the qualitative interview analysis.

Question: What influence does biometric authentication play in CBN's customer identification?

Table 2:Biometric Authentication in CBN's Customer Identification

S/N	Statement	N	SA	A	D	SD	Mean	Decision
1.	Biometric authentication tools have significantly improved the accuracy of customer identity verification in CBN operations	247	148	87	7	5	3.53	Agree
2.	AI-powered facial recognition systems have reduced identity fraud in CBN-supervised financial institutions	247	144	87	11	5	3.50	Agree
3.	Fingerprint biometric systems	247	146	86	10	5	3.51	Agree

S/N	Statement	N	SA	A	D	SD	Mean	Decision
	have enhanced the reliability of Know Your Customer (KYC) processes in CBN-regulated banks							
4.	Biometric authentication tools have contributed to financial inclusion by simplifying account opening for underserved populations	247	140	91	11	5	3.48	Agree
5.	AI-based biometric systems have reduced the time required for customer onboarding and identity verification	247	143	88	11	5	3.49	Agree

Source: Field Survey, 2026
Key: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree

Table 2 presents responses on the role of biometric authentication in CBN's customer identification. Statement 1, examining whether biometric authentication tools have significantly improved the accuracy of customer identity verification, recorded the highest mean score across the entire study at 3.53, with 94.3% of respondents (233 of 247) agreeing or strongly agreeing, the highest agreement level recorded across all 25 items. Statement on fingerprint biometric systems enhancing KYC reliability scored 3.51, with 93.9% agreement (232 of 247). Statement on AI-powered facial recognition reducing identity fraud scored 3.50, with 93.1% agreement (230 of 247). Statement on reduced customer onboarding time scored 3.49, with 93.1% agreement (230 of 247). Statement on financial inclusion contributions scored 3.48, with 92.7% agreement (229 of 247). All five statements exceeded the criterion mean of 2.50, with agreement levels ranging from 92.7% to 94.3%, demonstrating strong consensus on biometric authentication's significant role in customer identification.

Test of Hypothesis
H_0: There is no significant relationship between biometric authentication and accurate customer identification in the CBN between 2015 and 2025.

Table 3: Correlation Analysis of Biometric Authentication and Customer Identification Accuracy

	Biometric Authentication	Accurate Customer Identification
Biometric Authentication		
Pearson Correlation	1.000	.673**
Sig. (2-tailed)		.000
N	247	247
Accurate Customer Identification		
Pearson Correlation	.673**	1.000
Sig. (2-tailed)	.000	
N	247	247

***Correlation is significant at the 0.05 level (2-tailed).*
Source: SPSS Output, 2026

Table 3 presents the Pearson correlation analysis examining the relationship between biometric authentication and accurate customer identification at the CBN. The analysis reveals a moderate-to-strong positive correlation ($r = 0.673$, $p < 0.05$) between biometric authentication deployment and customer identification accuracy, the strongest correlation recorded across all five hypotheses in this study. The correlation coefficient of 0.673 indicates that the adoption of biometric tools, including fingerprint verification systems, facial recognition applications, AI-powered KYC platforms, and biometric-enabled customer onboarding tools, is strongly and positively associated with improved accuracy in customer identification, reduced identity fraud, enhanced KYC compliance, and expanded financial inclusion for previously unbanked populations. The significance value of 0.000 is less than the alpha level of 0.05, confirming statistical significance. Since the p-value (0.000) is less than 0.05, the null hypothesis is rejected. Therefore, there is a statistically significant positive relationship between biometric authentication and accurate customer identification in the CBN between 2015 and 2025. This finding is reinforced by the descriptive analysis, in which all five biometric authentication items recorded the highest agreement levels of the entire study, ranging

from means of 3.48 to 3.53, with agreement levels of 92.7% to 94.3% the strongest affirmation of any AI tool dimension studied the strong positive correlation shows that biometric tools enhance security by reducing identity fraud while also supporting the CBN's financial inclusion goals—highlighting a dual benefit unique to biometric AI investments.

Qualitative Analysis

The semi-structured interviews provided rich contextual data on how biometric authentication tools have reshaped customer identification processes at the CBN and supervised institutions during the study period. The following interview questions and representative responses illuminate both the transformative impacts and the operational limitations of biometric AI tool deployment.

Interview Question 1: How have biometric authentication tools changed the customer identification process at CBN-supervised institutions?

A Development Finance officer from the North-Central zone disclosed that biometric tools have most profoundly impacted financial inclusion, stating that 'in rural communities in Benue, many potential customers have never had a document-based identity. Biometric onboarding using fingerprints has allowed us to bring these people into formal banking for the first time. A person can open a basic account with their fingerprint alone, which is transformative for communities that documentary systems had excluded for decades (Development Finance Officer A, CBN Benue Branch, personal communication, January 12, 2026). A Banking Supervision analyst echoed the fraud reduction impact, noting that 'before biometric authentication, identity fraud was a persistent problem. People would use multiple identities to access credit from different institutions simultaneously. Biometric verification has made this essentially impossible because your fingerprint or face is unique and cannot be replicated across institutions (Banking Supervision Analyst A, CBN Imo Branch, personal communication, January 12, 2026).

Interview Question 2: To what extent have biometric tools improved compliance with Know Your Customer requirements?

A senior compliance officer confirmed that biometric tools have materially strengthened KYC compliance, disclosing that 'the biometric-linked BVN system has made KYC verification far more reliable and auditable. When we conduct examinations, we can verify that identity checks were actually performed and that the identity recorded matches a real, unique individual. The documentary approach was always vulnerable to falsification; biometrics have closed that gap significantly' (Senior Compliance Officer, CBN Delta Branch, personal communication, January 14, 2026). A customer service manager further noted that 'the time saving is also significant, biometric verification at account opening takes minutes rather than the hours that documentary verification could take when customers lacked the right combination of documents' (Customer Service Manager A, CBN Rivers Branch, personal communication, January 14, 2026).

Interview Question 3: What limitations or challenges have you encountered with biometric authentication tools?

An IT specialist from the Rivers State branch highlighted hardware quality variation as a significant operational limitation, disclosing that 'biometric systems are only as reliable as the hardware capturing the biometric data and the database storing it. In some of our remote branches, the quality of fingerprint readers varies. We have also had cases where elderly customers with worn fingerprints experience matching difficulties. This is a real accessibility issue that requires human fallback procedures' (IT Specialist A, CBN Rivers Branch, personal communication, January 14, 2026). A currency operations officer raised data privacy concerns, noting that 'the collection and storage of biometric data raises governance questions we have not fully resolved. Customers sometimes ask who has access to their biometric data and how it is protected. We need clearer communication frameworks to address those concerns proactively' (Currency Operations Officer A, CBN Enugu Branch, personal communication, January 14, 2026). These interview responses reinforce and enrich the quantitative findings. The qualitative data confirm that biometric tools have delivered the most tangible and widely experienced improvements of any AI tool category studied, consistent with this dimension recording both the highest PPMC correlation ($r = 0.673$) and the highest descriptive means across all five research questions. The financial inclusion impact described by the Development Finance officer from Benue validates the quantitative finding on that dimension (mean 3.48), while the fraud reduction and KYC reliability accounts align precisely with the highest-scoring items (means 3.53 and 3.51). Hardware quality variation and elderly customer accessibility limitations identified in the interviews provide important context for why a small minority of respondents (approximately 7% across items) did not agree with biometric improvement statements, and underscore the continued need for human fallback protocols and inclusive biometric system design.

V. Discussion

Biometric Authentication and Customer Identification

The analysis revealed that biometric authentication produced the most impactful and uniformly positive AI tool outcomes of any dimension studied, recording the highest item means, the highest agreement levels, and the strongest PPMC correlation across all five research objectives. All five questionnaire items exceeded the criterion mean of 2.50 by substantial margins, ranging from a low of 3.48 for financial inclusion contributions to a high of 3.53 for overall customer identity verification accuracy, the highest mean score recorded across all 25 items in the entire study. Agreement levels of 92.7% to 94.3% were the strongest recorded across all five research question dimensions, with the 94.3% agreement level for customer identity verification accuracy (item 11) representing the broadest cross-stakeholder consensus documented in this research. The PPMC analysis confirmed a moderate-to-strong positive correlation ($r = 0.673$, $p = 0.000$) between biometric authentication deployment and accurate customer identification, the strongest correlation of the five hypotheses, leading to the rejection of H03. The combination of the highest descriptive means, highest agreement levels, and strongest PPMC correlation across all five dimensions positions biometric authentication as the CBN's most institutionally embedded, operationally consequential, and socially impactful AI tool investment of the study period.

The qualitative interview data corroborated these quantitative findings with accounts that documented not merely technical improvements but transformative institutional and social outcomes. A Development Finance officer from the North-Central zone provided the most striking qualitative evidence, describing the financial inclusion dimension which recorded the lowest mean in this dimension (item 14, mean = 3.48) but remains strongly above the criterion in terms that reveal a qualitative shift in who can access formal banking in Nigeria: 'in rural communities in Benue, many potential customers have never had a document-based identity. Biometric onboarding using fingerprints has allowed us to bring these people into formal banking for the first time. A person can open a basic account with their fingerprint alone, which is transformative for communities that documentary systems had excluded for decades (Development Finance Officer A, CBN Benue Branch, personal communication, January 12, 2026). The slightly lower mean for the financial inclusion item relative to the security-oriented items is explained qualitatively by the geographic unevenness of biometric infrastructure deployment: rural communities in the North-Central and South-East zones are less consistently served by high-quality biometric hardware, creating the variation that moderates the inclusion item's mean relative to the identity fraud reduction and KYC reliability items. A senior compliance officer from the Delta branch confirmed the KYC reliability transformation consistent with item 13, recording a mean of 3.51, explaining that 'the biometric-linked BVN system has made KYC verification far more reliable and auditable. The documentary approach was always vulnerable to falsification; biometrics have closed that gap significantly' (Senior Compliance Officer, CBN Delta Branch, personal communication, January 14, 2026). An IT specialist from the Rivers State branch identified the primary limitation with operational precision: 'elderly customers with worn fingerprints experience matching difficulties this is a real accessibility issue that requires human fallback procedures,' providing qualitative grounding for the small proportion (approximately 6–7%) of respondents who did not agree with biometric improvement statements and underscoring the continued governance requirement for human verification alternatives (IT Specialist A, CBN Rivers Branch, personal communication, January 14, 2026). The combined evidence establishes that biometric authentication produced unusually great and broadly distributed improvements at the CBN because it simultaneously addressed two historically distinct institutional challenges, security and inclusion, through a single technological mechanism. On the security side, biometric verification eliminated the multi-identity exploitation of credit and financial services that characterised documentary-based KYC, creating a structurally unique identification constraint that cannot be circumvented without undermining the biological basis of the verification system. On the inclusion side, biometric verification eliminated the documentary barrier to formal banking access, the requirement for a combination of identity documents that a significant proportion of the Nigerian population, particularly in rural areas, has historically lacked, by substituting a universally available biological identifier for a socially unequally distributed documentary one. This dual impact explains why biometric authentication achieved the highest agreement levels across all stakeholder categories simultaneously: CBN supervisory staff valued it for its fraud prevention and KYC compliance contributions; financial service providers valued it for its customer verification efficiency gains; civil society representatives valued it for its financial inclusion contributions; and community members valued it for the tangible service accessibility improvements it enabled. The demographic limitation fingerprint degradation among elderly customers identifies the specific boundary of the dual-benefit achievement and establishes the governance requirement for systematic human fallback protocols and continued biometric technology development to address this population subgroup. The Nigerian and African empirical literature confirms and quantifies the institutional significance of biometric authentication improvements. Adeleke *et al*. (2023), in their comparative study of AI adoption across African central banks, identified biometric authentication as the most widely adopted and operationally embedded AI tool across the continent's banking

sector, establishing that CBN's experience is not exceptional but reflects a broader African central banking pattern, with the Nigerian context distinguished primarily by the scale of the financial inclusion challenge that biometric tools address. Nwabueze and Ohia (2025), examining the regulatory implications of AI tools in Nigeria, confirmed that biometric-linked customer identification systems had substantially strengthened Nigeria's capacity to meet international KYC and AML compliance standards, with biometric verification reducing the vulnerability to identity-based financial crimes that had previously compromised Nigeria's correspondent banking relationships. Emmanuel and Adegbite (2024) documented that biometric authentication was among the AI tool investments in Nigerian public financial institutions that most consistently produced measurable, verifiable performance improvements rather than merely perceptual gains, consistent with the highest agreement levels documented in this study. Mbaka and Ani (2023) raised important governance concerns about biometric data privacy and algorithmic bias risks in Nigerian AI deployments, concerns that the qualitative evidence from this study suggests are not yet fully resolved. The currency operations officer's account of customer concerns about biometric data access and protection confirms that data governance frameworks for biometric systems require further development.

The international comparative literature provides crucial performance benchmarking for the biometric improvements documented at CBN. Buolamwini and Gebru (2018) established that biometric authentication systems, particularly facial recognition technologies, exhibit significant demographic accuracy disparities across gender and racial groups, with error rates substantially higher for darker-skinned individuals, a finding that has direct relevance for CBN's deployment context and provides the technical research basis for the qualitative evidence of fingerprint degradation challenges among elderly Nigerian customers. Obermeyer *et al*. (2019), while focused on healthcare AI, established the general principle that algorithmic systems trained on historically biased data systematically reproduce those biases in deployment, a principle that applies directly to biometric systems trained on non-representative population samples and supports the governance recommendation for systematic demographic accuracy auditing of CBN's biometric tools. The global central banking literature confirms that biometric-linked KYC systems have become a standard component of financial crime prevention infrastructure: BIS (2022) documented that central banks globally that deployed biometric customer identification achieved statistically significant reductions in identity-based financial fraud, with detection improvements of between 40% and 65% compared to documentary verification predecessors a range that contextualises the high mean scores (3.50–3.53) for the fraud reduction and KYC reliability items in this study. Social Shaping of Technology Theory (Bijker & Law, 1992; Oudshoorn& Pinch, 2003; Wyatt, 2005) provides a particularly illuminating framework for understanding the dual security-inclusion achievement of biometric authentication at CBN. The theory's emphasis on interpretive flexibility, the capacity of different social groups to assign different meanings and values to the same technology, explains why biometric tools achieved a uniquely broad cross-stakeholder consensus: different groups experienced and interpreted biometric authentication through the lens of their specific institutional positions and needs. For supervisory staff, biometric tools represented a fraud prevention and compliance mechanism; for rural community members, they represented an access enabler; for civil society organisations, they represented a financial inclusion instrument. The theory's concept of closure and stabilisation (Bijker, 1995) — the process through which technological artefacts achieve social consensus around a dominant interpretation is reflected in the exceptionally high agreement levels: biometric authentication has achieved a degree of socio-technical stabilisation at CBN that the other four AI tool dimensions have not yet reached, explaining why its item means and correlation coefficient are consistently the highest across the study. The demographic limitation identified fingerprint degradation for elderly users qualitatively represents precisely the kind of residual interpretive flexibility that the theory identifies as persisting after technological closure: minority user groups whose specific needs are not fully addressed by the stabilised technical configuration. Multi-Level Perspective Theory (Geels, 2002; Geels &Schot, 2007; Loorbach*et al*., 2017) explains biometric authentication's rapid transition from niche innovation to institutionally embedded standard practice at CBN by reference to the three-level pressure dynamics that the theory identifies as enabling accelerated socio-technical transitions. At the landscape level, the global proliferation of biometric identity systems, from national identity programmes to smartphone authentication to airport border control, created a technological normalisation context that reduced the social and institutional resistance to biometric adoption in banking. At the regime level, the Nigerian government's Bank Verification Number (BVN) policy initiative created a regulatory mandate that made biometric-linked customer identification a compliance requirement rather than a voluntary innovation, dramatically accelerating adoption across CBN and the commercial banking sector simultaneously. At the niche level, successful early deployments in urban commercial banking contexts documented by the qualitative accounts of fraud prevention and KYC reliability improvements accumulated the performance evidence that justified progressive expansion to rural and underserved banking contexts where the financial inclusion dimension of biometric tools is most consequential. The theory's prediction that innovations achieving aligned pressure from landscape, regime, and niche levels simultaneously undergo accelerated regime transitions (Geels &Schot, 2007) is directly validated

by biometric authentication's achievement of the highest institutionalisation indicators agreement levels, item means, and PPMC correlation across all five AI tool dimensions.

Institutional Theory (DiMaggio & Powell, 1983; Pierson, 2000; Deephouse& Suchman, 2008; Thornton & Ocasio, 1999) provides a comprehensive framework for understanding why biometric authentication achieved the deepest institutional embeddedness of any AI tool dimension studied. Coercive isomorphism through the BVN regulatory mandate established that biometric adoption was not discretionary for CBN or commercial banks operating under its supervision, creating the conditions under which adoption proceeded at scale and speed, regardless of internal institutional readiness variation across branches. This coercive foundation for adoption explains why biometric tools achieved the most consistent performance improvements across the geographically diverse branch contexts studied, South-South, South-East, and North-Central, relative to AI tools whose adoption was more discretionary and therefore more uneven. The theory's institutional logic framework (Thornton & Ocasio, 1999) identifies the alignment between biometric authentication and CBN's dual institutional logic, prudential regulation and financial inclusion, as a critical enabling factor: tools that serve multiple core institutional logics simultaneously achieve legitimacy with a broader coalition of institutional stakeholders and are therefore more likely to be adopted comprehensively and maintained persistently. Path dependence (Pierson, 2000) is relevant in the inverse sense for this dimension: biometric systems, once deployed, create switching costs through accumulated biometric data, linked account records, and established verification workflows that make reversion to documentary systems institutionally costly, reinforcing the persistence and deepening of biometric adoption over time and explaining why this dimension achieved the strongest stabilisation indicators across the study.

Key Finding

Biometric authentication plays a highly significant role in improving customer identification accuracy in the Central Bank of Nigeria. The findings show very high agreement levels (92.7%–94.3%) and strong mean scores (3.48–3.53), indicating widespread acceptance of its effectiveness. The correlation result ($r = 0.673$, $p < 0.05$) confirms a strong positive relationship between biometric tools and accurate identification. This demonstrates that biometric systems simultaneously enhance fraud prevention, KYC reliability, and financial inclusion.

VI. Conclusion

The study concludes that biometric authentication has become the most impactful AI tool in strengthening customer identification processes within the CBN. It significantly improves identity verification accuracy, reduces fraud, and enhances compliance with KYC requirements. The strong statistical relationship confirms that biometric technologies are essential for modern financial system security and efficiency. Additionally, biometric systems promote financial inclusion by enabling access for previously unbanked populations. However, challenges such as hardware limitations, accessibility issues for certain groups, and data privacy concerns remain. Therefore, sustained investment in infrastructure, inclusive system design, and robust data governance frameworks is necessary to maximise the benefits of biometric authentication.

VII. Recommdation

Optimising Biometric Authentication for Inclusion and Security: Given that biometric authentication recorded both the strongest PPMC correlation and the highest descriptive means in the study, the CBN should prioritise this investment stream. Minimum technical standards for biometric hardware quality should be developed and enforced across all supervised institutions, addressing the hardware variation issues identified in qualitative findings. A Biometric Inclusivity Programme should develop improved protocols for elderly customers and those in physically demanding occupations whose fingerprints may be worn. Human fallback verification must be maintained as a regulatory requirement. The National Financial Inclusion Strategy should explicitly incorporate biometric onboarding with geo-political zone-specific targets reflecting the regional diversity documented across South-South, South-East, and North-Central zones.

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