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**Adoption Of Information Systems Engineering
Practices in Driving Financial Inclusion in
Underbanked Economies - Opportunities and
Challenges in Nigeria**

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Abstract

The relevance of financial inclusion has grown in importance globally. Within the past few years, the efforts of different economies to incorporate at least 80% of their population into their national financial system became important. The incorporation of innovative technological solutions and embracing the transformative power of digital advancements, underbanked population in developing economies can speed up achieving financial inclusion, thereby ensuring equal access to financial services for all individuals and communities. This thesis investigates the adoption of Information Systems Engineering (FinTech) practices in driving financial inclusion in the underbanked economies, with a particular focus on Nigeria. The study is structured around four primary objectives. First, it analyzes the capabilities of FinTech solutions in bridging the financial inclusion gap among underbanked populations in developing economies. This analysis explores how FinTech innovations can provide accessible, affordable, and efficient financial services to those traditionally excluded from formal financial systems. Second, the research identifies the challenges and opportunities associated with adopting FinTech for financial inclusion initiatives in underbanked economies. Third, the study explores a successful case study of ISE-driven (FinTech) financial inclusion programs in a developing economy. By examining these case studies, the research identified, best practices, critical success factors, and lessons learned from various underdeveloped economies' initiatives and successful adoption of Financial Technology in enhancing financial inclusion. Finally, the thesis proposes recommendations for policymakers, financial institutions, and technology providers aimed at enhancing the effectiveness of Information Systems Engineering in promoting financial inclusion. Through a comprehensive analysis of the opportunities, challenges, and case studies, this thesis provides a tailored technology design approach as recommendation of what needs to be done technologically to further enroll the underbanked populations into the formal financial system. The findings and recommendations are intended to guide stakeholders in developing effective strategies to harness FinTech for inclusive economic development.

Keywords: Information Systems Engineering (ISE), FinTech, Financial Inclusion (FI), SDLC, blockchain , Underbanked, Developing Economies, Nigeria.

1. Chapter One: Introduction

1.1 Background

Digital financial services have the potential to drive economic development and financial inclusion in developing economies. The global financial inclusion has become a major preoccupation of international communities, especially the United Nations, the World Bank, and Financial Institution in association with the policymakers (Demirguc-Kunt et al., 2022). We propose to investigate the Nigerian context for financial inclusion whose obstacles and prospects are little known, and lack of tailored technology design model in driving financial inclusion growth which we identify as a research gap. The interest in Nigeria stems from the fact that it is a typical underbanked country which has enormous cultural and economic diversity, providing a unique landscape for analysis. Financial inclusion in Nigeria has improved but remains uneven, with higher exclusion rates in the northern regions and among rural and female populations (Isukul et al, 2019). According to a 2023 report by EFINA (Enhancing Financial Innovation & Access), Nigeria's financial inclusion rate rose to 74%, meaning 26% of the adult population remains unbanked. This translates to roughly 28.8 million adults. But a different perspective comes from GRID3 (Data Science Nigeria), which estimates a higher percentage of unbanked population at 61%. Despite the improvement in access to finance. EFINA said more work needs to be done to achieve the 95 percent long-term inclusion set by Central Bank of Nigeria (CBN) in the Nigeria Financial Inclusion Strategy (NFIS) 3.0.

Additionally, policies designed specifically for Nigeria can be measured against similar sub-Saharan African territory, shedding light on effective strategies that can inform the better decisions of the central banks of Nigeria and, by extension, those of other sub-Saharan nations. This research endeavour is crucial in fostering inclusive economic growth, reducing inequality, and promoting sustainable development in the region. By addressing this, and deepening our understanding of financial inclusion in Nigeria, we can work towards building a more prosperous and financially secure future for all Nigerians.

It has been postulated that the obstacles to financial inclusion in these economies at worst arise from structural constraints relating to the regulatory framework, institutions of finance, and the enabling environment (Ediagbonya & Tioluwani, 2023). However, the comprehensive study shows that in the short-term, technology use or the adoption and seamless integration of Information System Engineering (ISE) conversions, (FinTech) can be effectively

utilized to fast track the prompt attainment of financial inclusion. By incorporating innovative technological solutions and embracing the transformative power of digital advancements, these economies can speed up achieving financial inclusion, thereby ensuring equal access to financial services for all individuals and communities. These advancements in technology have the potential to revolutionize the traditional financial landscape, bridging the gaps that hindered financial inclusion previously (Adeoye et al., 2024). Through the strategic implementation of various digital platforms, such as mobile banking applications, online payment systems, and secure digital identities, individuals from underserved and marginalized populations can now enjoy the benefits and opportunities that come with financial inclusion. Furthermore, the incorporation of Information System Engineering (ISE) conversions (FinTech) enables seamless data management, streamlining financial operations, enhancing transparency, and facilitating efficient risk assessments (Fashina, 2021). The transformative potential of technology, coupled with an enabling regulatory environment and supportive financial institutions, presents a promising pathway towards comprehensive and sustainable financial inclusion in these economies. By embracing the disruptive forces of technology and leveraging them to overcome the existing barriers, these economies can pave the way for an inclusive and equitable financial future. With concerted efforts and strategic collaborations, the realization of financial inclusion becomes not only an achievable goal but also a catalyst for socioeconomic development and poverty alleviation.

The social implication is that economic growth cannot be sustained as there are fewer people who are saving and contributing to formal pension schemes alongside existing social inclusion problems, including the promotion of poverty and environmental degradation of an economy (Lyons et al., 2022). Financial inclusion offers the benefits of efficiency and growth of the economy. In underbanked economies where financial inclusion lags, the economy experiences fewer funds invested in its system; this slows investments in economic and social infrastructures and contradicts economic principles at play in advanced economies where rapid monetization of the economy drives improvements in infrastructural facilities.

1.2 Overview of Information Systems Engineering (ISE)

Information systems engineering is the complex and intricate process of meticulously designing, developing, thoroughly testing, and perpetually maintaining an elaborate information system with the overarching objective of fulfilling and supporting the multifarious information needs of diverse users (Pearlson et al., 2024). As extensively discussed by Ishak et al. and Manyo and Ishak, information systems are inherently composed of a synergistic amalgamation of human personnel, systematic processes, voluminous data, robust infrastructure, sophisticated software, and purpose-built facilities that dynamically interact and collaborate symbiotically to seamlessly generate and disseminate critical information indispensable for effective decision-making. The paramount importance of a meticulous and methodical approach in the design of information systems cannot be overstated, as it necessitates adhering to a comprehensive and systematic framework colloquially referred to as information systems engineering (Odonkor et al., 2024).

This holistic and exhaustive process entails a multitude of crucial aspects, including but not limited to intricately defining functional requirements with meticulous attention to detail, meticulously designing user-friendly and intuitive interfaces, formulating intricate and robust data structures, devising and fine-tuning procedural protocols for seamless operation, as well as meticulously establishing and constantly monitoring performance metrics to ensure optimal system efficiency. To facilitate this intricate information systems engineering process, a plethora of diverse models have been devised by experts and industry professionals, meticulously fashioned to serve as robust and versatile frameworks that comprehensively address and guide each facet of the systems requirement analysis process. This comprehensive process encompasses a myriad of indispensable stages, encompassing meticulous planning, in-depth analysis and conceptualization, precise and meticulous system design, diligent and systematic system development, rigorous testing and quality assurance, meticulous implementation and integration into existing frameworks, and perpetual maintenance to ensure seamless and efficient operation throughout the system's lifecycle (Charrel, 2004).

1.2.1 Overview of Financial Technology

Financial technology, commonly referred to as FinTech, can be broadly defined as software and other modern technologies which support or establish the delivery of financial services. As digitalization and modernization is a rising trend in the finance sector, FinTech is gaining

importance at an overwhelming pace. It exists in various forms such as digital banking, AI, asset management software and so forth.

Banking, insurance, asset management, etc. have begun to increasingly use heterogeneous digital tools in various operational as well as strategic aspects. The extensive proliferation of advanced digital solutions can be invariably linked with the industry's need for a technological breakthrough to cope with the increasing pressure of an ever-competitive industry, and to truly target consumers for improved service delivery based on consistently changing behavioral patterns (Yang & Gu, 2021). Digital competences in strategic literature are paramount in any competitive industry. Every single function of financial services in this digital era is being transformed. Financial technologies, also referred to as FinTech, cover a wide level of implementations which include multi-sided platforms, digital currencies, mobile wallets, and digital Islamic banks.

The scale, scope, and definition of FinTech economically is difficult to measure. This arises in part because of the diverse businesses and activities they encompass, from well-established (high tech) banking operations relying on extensive IT infrastructure through to new start-ups not yet capitalized to run finance businesses, to businesses that might be better described as non-bank finance innovators. The definitions used to measure FinTech broadly included unlicensed money lending, more traditional payment systems and applications, insurance, and AI assistant and investment management, among other things (AlMomani and Alomari, 2021). Other ways of measuring economic activity have focused on the locus of financial innovation, i.e. defining FinTech based on the 'tech' rather than the 'fin'.

FinTech, or financial technology, dates back at least over 200 years. Early examples of FinTech include the developments inspired by the growing acceptance of credit cards by consumers and businesses in the United States, and the related technology infrastructure these payment systems required (Bajwa et al., 2022). Large processing technology and digital infrastructures were in some cases built into credit card authorizations for the supermarkets in the early 1970s. This increased the pace, value, and scope of information exchanged and action including payment arrangements versus previous systems that used telecommunications networks for telegraphic image exchange featuring significant delays in transactions. Many further developments have reformulated parts of the existing financial services sector, but the tight banking regulations slowed the sector's more innovative disruption for multiple, frightening reasons. That rapidly changed after the deregulatory moves in the 1980s and 1990s

and continued rapid changes to the financial services industry and its economic fortunes continues.

The effects of the continual rise of fintech can be observed in the many unbanked and underbanked initiatives around the world that strive to involve those with limited access to right intermediation points. Data for September 2022 released by the World Bank estimates that 56.7% of the world's unbanked, excluded adults (those age 15 or older) live in seven countries. In ascending order, they are Cambodia, Indonesia, Egypt, Peru, Pakistan, Bangladesh, and Nigeria, the country that houses the largest "poorly banked" population (Abdulquadri et al., 2021).

Key Technologies in FinTech: Financial technology also includes key technologies such as big data, artificial intelligence (AI), blockchain, and cloud computing. In terms of big data, the huge amounts of transactions and personal information as well as the internet browsing habits of users involved in financial services provide sufficient data support for financial-related risk control and decision-making through big data technology. In the field of AI, its core technology includes algorithms like graph demonstration, path planning demonstration, natural language processing (NLP), and computer vision. While, in the blockchain field, many worlds' top investment banks have begun to pay attention to the development and application of blockchain technology by joining the R3 Blockchain Alliance (Safak and Alagoz, 2024). These technologies, especially in big data, AI, and cloud computing, offer the best potential in the logic-based FinTech model.

Regulatory environments in many countries or the lack of effective regulation are seen as barriers to financial technology taking hold. As early as 2016, the Secretary-General of the Financial Stability Board commented that 'stablecoins' and digital currencies, as well as other forms of mini-financial technology (FinTech), were 'part of the widening world of Shadow Banking', thereby erstwhile bringing them within the determination set for regulation (Hashemi, 2024). Since then, the jurisdiction-by-jurisdiction approach to understanding the industry has been one in which varying forms of regulation have been applied.

The FinTech industry is rapidly evolving. The increasing adoption of big data and AI, the growing number of innovative products, and the expanding market growth are leading the way for a host of new trends within the FinTech space. These trends will likely shape the future of this industry looking forward to the next decade and beyond, transforming FinTech as we

know it. These emerging trends have the potential to drastically impact several aspects of the financial services industry, from banking and insurance to trading and investments.

1.2.2 Overview of Financial Inclusion and Underbanked Economies

The Central Bank of Nigeria (CBN) classifies the underbanked population as "those who at present do not have bank accounts or a functional deposit (noncurrent account) and savings (current account) but are substantially reliant on informal service providers (ISPs) in order to fulfill their financial needs" (Ayadi, 2022). Informal service providers, which are not under the regulatory umbrella of the Central Bank of Nigeria, refer to those who work outside the regulations of formal banking and are often inadequately capitalized. This includes a varied group of services provided by savings and credit groups, village savings and loan associations, money lenders, and social savings clubs. However, these low-income consumers usually do not utilize the formal financial system in a profound way and, as a result, are not able to benefit from traditional banking services offered to those who have active accounts. Small businesses may have a functional account relationship, but they deem the cost of regulated services of the formal banking system too high, so they often make their own decision to access informal financing for their business activities while forming their own credit relationships with some fringe financial service provider.

Financial inclusion refers to the creation and strengthening of access points for the unbanked and underbanked populations (Kamran & Uusitalo, 2024). While there is an increasing number of definitions in the academic sphere, financial inclusion may generally be summarized to involve at least two operational dimensions: access to regulated financial services and the achievement of a sustainable and long-term form of financial integration. It is considered a multidimensional concept for the purpose of offering pertinent policy prescriptions to the financial services utilized by the unbanked and underbanked population segments. Access to regulated financial services has consistently been emphasized either directly or as a component in financial inclusion studies. According to Alternative Business School Malaysia (2015), "financial inclusion is the state in which the underbanked and unbanked consumers have access to suitable, convenient, and affordable financial products and services; where the delivery channels are responsible to consumer needs; and where reputable providers and regulation exist".

1.2.3 Latest Trend in Information Systems Engineering Design for FinTech

1.2.3.1 Microservices Design Pattern

Microservices design pattern is one of the methodical approaches in the design of information systems engineering. The microservices design approach is a more modern approach employed by some global technology driven giants such as Amazon, Twitter, PayPal, Netflix, Uber, Bestbuy.com, Coca-Cola, eBay, Spotify, Gilt.com, Etsy and so on.

Tech companies are embracing microservices due to the increased flexibility and scalability that they offer. Microservices allow companies to build large, complex applications without having to manage and maintain a monolithic code base. Instead, they can break down the application into small, independently deployable components that can be developed, tested, and deployed in isolation. This allows for faster development cycles, improved scalability, and better fault isolation. Microservices architecture is ideal for modern digital businesses that cannot always account for all the different types of devices that will access their infrastructure (Hosseini, 2022).

Figure 1 below depicts the difference between microservice architecture and monolithic architecture.

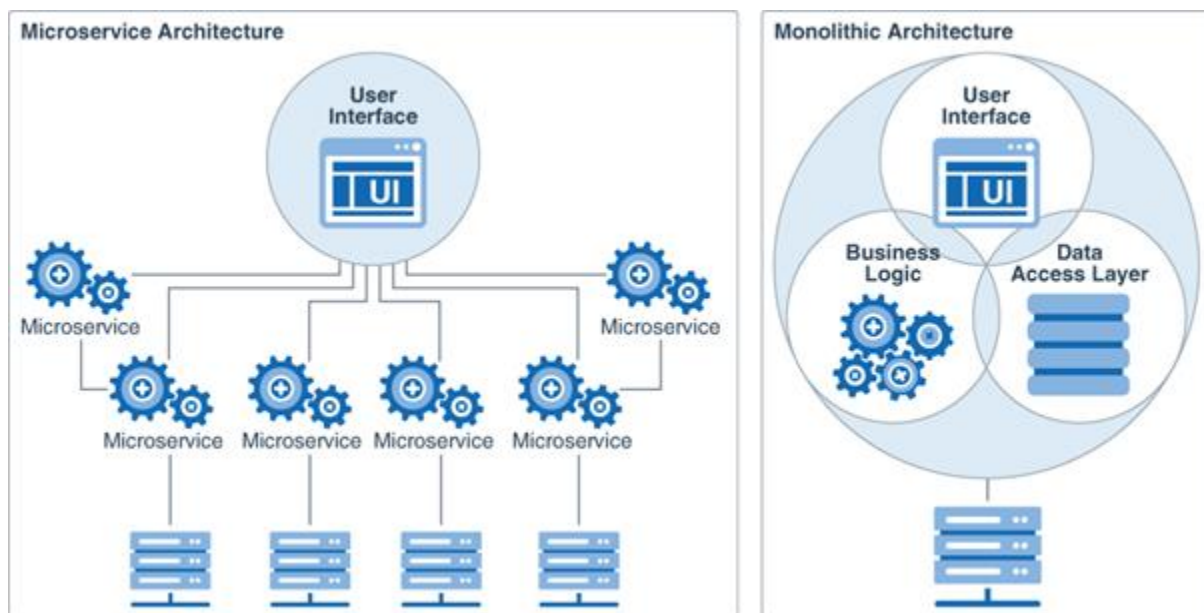


Figure 1: Difference Between Microservices and Monolithic Architectures

Source: microservices.io

Some of the major characteristics of microservices architecture are:

- Split into Numerous Components - Software built using microservice architecture is, by definition, broken down into numerous component services. Each service can be created,

deployed, and updated independently, scaled up by tweaking a few specific services without compromising application integrity.

- **Robust and Resistant to Failure** - It is not easy for an application built using a microservices architecture to fail. However, individual services can fail, undoubtedly affecting operations. It is also easy to reduce the risk of disruption by monitoring microservices and bringing them back up as soon as possible in case of failure.
- **Simple Routing Process** - Microservices consist of intelligent components capable of processing data and applying logic. These components are connected by ‘dumb wires’ that transmit information from one element to another. This simple routing process is the opposite of the architecture used by some other enterprise applications.
- **Decentralized Operations** - Microservices leverage numerous platforms and technologies. This makes traditional centralized governance methods inefficient for operating a microservices architecture. Microservices architecture favours decentralized data management, as every microservice application manages its unique database. Conversely, monolithic systems typically operate using a centralized logical database for all applications.
- **Built for Modern Businesses** - Microservices architecture is created to focus on fulfilling the requirements of modern, digital businesses. Traditional monolithic architectures have teams working on developing functions such as UI, technology layers, databases, and server-side logic. Microservices, on the other hand, rely on cross-functional teams. Each team takes responsibility for creating specific products based on individual services transmitting and receiving data through a message bus.

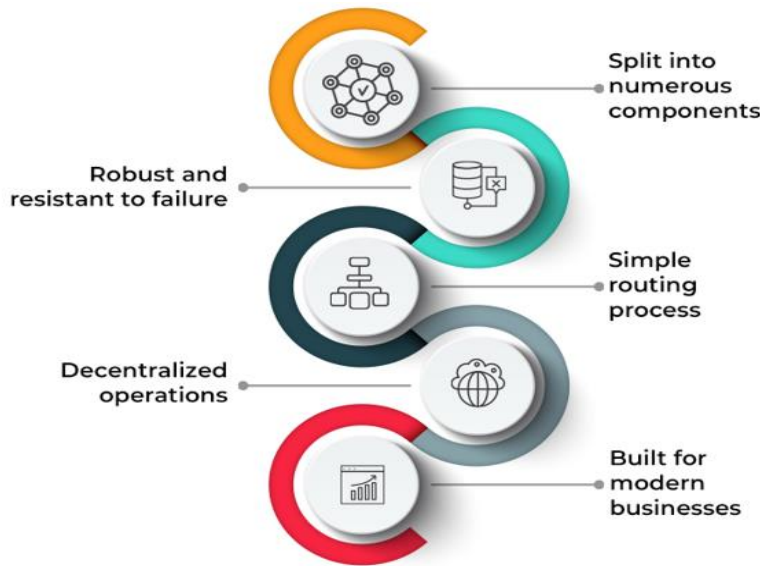


Figure 2: Characteristics of a Microservices Architecture
Source: microservices.io

1.2.3.2 Emerging Opportunities for AI-Driven Technology

The field of Software Engineering is not immune to the disruption caused by Artificial Intelligence (AI). Rather than being just impressive, Generative AI is awe-inspiring when it comes to coding, database design, testing, and DevOps.

The Generative AI branch of Artificial Intelligence is focused on the creation and generation of new content, such as images, texts, audio, or even video, that is difficult to distinguish from human-generated content (Lev, 2023) It has gained significant attention in recent months primarily due to advancements in Large Language Models (LLM) and the release of flagship products from OpenAI, Stable Diffusion, and Google.

The AI revolution includes software engineering, and generative AI can be beneficial to all phases of Software Development Life Cycle (SDLC).

Due to the nature of some of the work in software engineering, advances in this field can be especially beneficial. Specific engineering tasks, such as numeric analysis and data engineering, documentation, coding, and quality control, can be somewhat repetitive; therefore, a great candidate to be aided by a well-trained AI model (Lev, 2023). Secondly, complex, and algorithmic code structures are suitable and available for generations by an AI assistant. Moreover, many challenges software developers face could have already been solved. Therefore, for the trained AI model, the code modules are already available, and generating entire functions or classes becomes feasible.

The use of generative AI is an effective way to augment human abilities while accelerating software development. AI tools can offer companies that develop, maintain, or sell software an edge over their competitors and increase developer productivity.

The AI-Driven SDLC

AI can assist in every phase of the SDLC, shortening the feedback loop and enabling companies to roll out products faster. Organizations increasing their competitive advantage by using AI-driven tools in their SDLC.

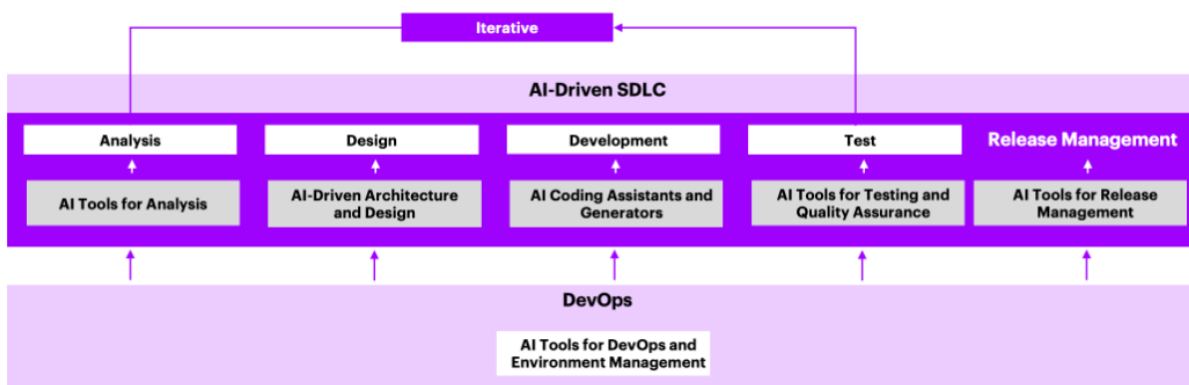


Figure 3: A new-generation AI-Driven SDLC,

Figure 3 above represents a new generation AI-Driven SDLC where every phase of the life cycle can be accelerated by AI. AI tools such as GitHub Copilot and AWS CodeWhisperer can make developers more productive by auto-completing large code blocks and code-checking for quality issues within the IDE. A recent study conducted by GitHub and Microsoft demonstrated developer gains of more than 55% when developers used Copilot for code assistance (Lev, 2023).

Design Principles for AI enabled FinTech Applications

It is crucial to emphasize that AI solutions are developed, trained, and analyzed from the perspective of informed and responsible AI creators. There is a need to prioritize user-friendly AI-enabled FinTech application designs that consider the end users' knowledge, experience, and requirements in the entire application development process (Karunarathna, 2024). Those familiar with the project at a high level must be satisfied with the application's capability to create solutions that users can trust, foster innovation, and promote both compliance and proactivity in technical and business components. The following areas are, nevertheless, deserving of digital entrepreneur and employee investment: - User-friendly AI application design including relevant graphical user interfaces, user input/output paradigms, data

visualization tools, secure login methods, etc. Ensuring secure and private AI applications that satisfy the norms known in digital technologies, especially cyber-secure ones. In particular, compliance with regulations requires secure handling and storage of personal data and its protection from misuse. Enhancement of the ethical performance of AI in terms of application creation and the AI design process. Considerations to avoid bias in AI algorithms, decision-making control, and opinion transparency and communication. Overcoming concerns regarding the adoption of AI in FinTech, in such areas as technological obsolescence and skills gaps. Further work is required to pave the way for harnessing trust in AI solutions, fostering public and regulatory acceptance to contribute decisively to champions involved in changing the industry.

User-Centered Design

The design of AI-enabled FinTech applications has to be user-centered. This guarantees that the application will meet users' expectations and will follow users' behaviors while using it. To make a product user-centered, user's requirements need to be placed in the center of the design process from the initial steps to the final steps. Users should be involved in the design process from the beginning via methodologies such as interviews, co-design, design workshops, and usability testing. Users' feedback should be regularly collected, and the design proposal should be iteratively refined during all the stages of the design to meet users' expectations.

Dealing with users ensures that the application will be accessible, easy to understand, and to use. To be effective, user-centered design employs several principles such as active involvement of users, visibility of the system status, the prevention of errors, and recognition rather than recall of information. System elements and messages should be displayed in a clear and understandable way, and relevant information should be available on demand. The effective design of AI-enabled applications is based on an analysis of the human-system interface and seamless user experience. Indeed, the final and variable objective of many AI-enabled systems in FinTech must be that the end user does not even realize that he or she is interacting with a machine. This is the final stage of an increasing capability of the machine to be human-like by engaging the person in a natural interaction, knowing the user's preference and expertise, both in product choice and consumption. The characteristics of the application that will be developed will depend on which trade-off results between personal assistance offered to each user and the customization of the AI-based system.

The aim of the user-centered design for FinTech software is clear: to empower the FinTech market share - in number and economic value through the design and development of financial software that is user-driven, that is capable of being more adapted to the change and heterogeneous users' needs and offer services that are more relevant and adapted to the overall user's financial management path and to the goods that their software owns and operates.

1.2.3.3 Design Principles in Cloud Computing for FinTech

In order to excel operationally in the turbulent and challenging FinTech environment, it is necessary to adhere to the following design principles. Scalability and elasticity are critical since digital financial products frequently need to accommodate surges in transaction volume, which can place a burden on existing systems. Financial institutions must ensure that the systems they develop can handle load changes such as these smoothly and cost-effectively. Security and compliance are a priority as they are regulated by security protocols and data protection laws. Financial institutions that fail to protect and control their data will face significant penalties if they are breached by a malevolent party.

The principles of cost optimization require that financial institutions manage their cloud expense patterns so that they use only what they need and pay only for what they use. This can be achieved using patterns that defer action such as calculation or processing as long as possible. The use of resource optimization through techniques like refactoring redundant data into a dedicated data store is essential. FinTech products need to be developed with an eye towards risk management, both in terms of business and compliance (Hassan et al., 2023). To excel in customer-centricity, the systems that operate the FinTech products we develop need to be designed with a focus on individual customer experiences, as part of a journey applying user and task segmentation patterns. This means the real-world desires, needs, and circumstances of individual users and their goals are considered in system design. A cloud computing solution built within the FinTech context must embody all the above principles of operational excellence and must incorporate best practices, design patterns, and documentation in a highly iterative manner (Satish, 2024).

Scalability and Elasticity

Modern FinTech solutions are often expected to grow rapidly while providing both strong performance and end-user centric functionalities. The ability to handle incoming demand, without compromising on quality of service, is important. One of the major components of

cloud computing is the ability to handle varying amounts of transaction volume without directly impacting the results to the end user. This is provided via the scalable and elastic nature of cloud resource provisioning. Scalability refers to the ability to dynamically add or remove resources to and from the system in order to effectively accommodate the amount of work (Rane et al., 2024). Scalability can be noticed with end user transaction load, operational data, and the amount of stored or persisted data. Elasticity refers to the ability to automatically scale provisioning and deprovisioning resources to accommodate the dynamic change of load based on observed performance needs. A more generic term for this scaling behavior is flexible scaling. Dynamic scaling allows the system to automatically provision or remove resources based on organizational policies derived from a performance metric in real time. Techniques for scaling include provisions for scaling both horizontally and vertically. Some cloud providers offer APIs which can be configured to automatically handle scaling. Benefits for planning to grow dynamically and split the infrastructure into smaller logical units are proven as an efficient solution for startups. It also covers the importance of comprehensive monitoring tools to identify issues proactively before they affect the service, mainly suggesting investing in robust monitoring solutions early on as they help in customer retention, as users will always prefer services that are online 24/7. Cloud scalability in e-business services includes auto-scaling features as constantly evaluating the requirements and making provisions easily result in a service that can dynamically scale up or down.

Security and Compliance

Security and compliance are two of the FinTech industry's biggest concerns. Security provides confidentiality to the data generated in the FinTech application and needs to be protected from being accessed by any third parties. Compliance with standards would ensure the trustworthiness of the application, privacy, and legal considerations for personal data. Security and compliance are the abilities of the cloud computing design pattern to provide confidentiality of its services and comply with standards (Seth et al., 2024). The cloud computing design pattern for FinTech should consider these aspects very carefully and deeply for security and compliance.

There are frameworks and standards for compliance that are applied to build security rules in the cloud computing design pattern for FinTech. Some of the requirements that must be fulfilled in cloud computing design patterns are that data must be encrypted while at rest, encrypted while in transit, and must ensure that strict access and user policies are maintained

inside the cloud infrastructure as well (Nandakumar et al., 2021). All regulations regarding the financial service data stored in the cloud infrastructure provide some common responses and best practices to ensure the security of the financial data. It is found that the basic security measures of encrypting data in transit and rest are followed in the patterns for compliance in the cloud while storing financial data.

One of the aspects of security and compliance in the design pattern for banking and finance using cloud computing is the role of security information and event management solutions for threat detection. Security risks on financial applications are rapidly evolving, and the need of the hour is to increase security measures by staying ahead of threats, thereby reducing risks in advance by identifying and resolving problems before they occur in the architecture. Security audits and penetration testing, along with a secure encryption and key management system, are required to be done from time to time to meet compliance. Legal compliance conditions are linked to financial regulations with regional, national, and international variations in banking laws. A penetration testing service provider is required to regularly perform penetration testing and vulnerability assessments to ensure that an entity's networks remain free of any cyber threats that affect sensitive financial data.

Cost Optimization

Cost optimization is critical for FinTech companies that need to balance budget constraints while providing cloud computing services that are technically cutting edge. By opting for cloud technologies, FinTech companies must choose the right cloud service provider by considering pricing models that consist of operational expense schemes, which could also encompass performance. There are different mechanisms to implement this pattern. One is to apply strategies for the agile management of costs, such as resource tagging, alarming, notifications, monitoring of usage patterns, and reservation of cloud services. This allows for modifications and expiration of the reserved services to identify areas of wastage and extra costs, and where savings could be made.

Serverless architectures are also used as a cost management pattern, which supports up-to-the-moment accurate cost of usage by charging for actual usage of computing resources, in comparison to metered architectures such as pay-as-you-go. These architectures provide a complete serverless solution for running web services as long as the payment is made only for when resources are utilized. Successful companies have used cloud computing to manage the cost of usage while making a pre-tax profit. For example, a budget that utilizes data from

previous months' usage patterns keeps track of an organization's cloud spending with advanced analytics alerts in real time.

1.2.3.4 Big Data Technologies for FinTech

First, it is important to outline the conceptual underpinnings of big data that shape the FinTech landscape. Volume, variety, and velocity are considered the three main dimensions of big data. Volume refers to the amount of information generated within a certain time period, while variety denotes the different types of data. Alternative, or "dark data," are unprocessed, non-traditional data in their "raw" format, while structured data conform to a tabular schema. Velocity takes into account the rapid rate at which new data is generated. Besides the three well-established V's, veracity is considered an additional dimension. Veracity measures the quality or trustworthiness of the data. Veracity incorporates both quality and integrity and hence should be considered two separate dimensions by itself (Cappa et al., 2021).

Cloud computing provides easy and scalable access to applications, platforms, and data services over the Internet. The cloud ecosystem enables efficient collaboration among the world's financial institutions and provides accessible data to all concerned with the process. Big Data applications require the most recent technology for scalability and real-time analysis. Hadoop is the most widely used technology for Big Data. Hadoop is a framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models. This allows the system to scale up from a single server to thousands of machines, each of which offers local computation and storage (Hussein, 2020).

All the big players are focusing on Big Data and offering multiple options. The demand for real-time data streams led to the evolution of Spark. The power and simplicity of the MapReduce model have driven the Hadoop environment to an almost de facto standard (Adamov, 2020). Spark is able to execute MapReduce in a close to real-time setting rather than a batch job. Harnessing the latest software has allowed businesses to offer new tools, services, loans, bank account options, insurance products, and a new crypto financial market, among other things. In the same sense, FinTech companies are also harnessing new software to create financial opportunities. Every section mentioned above gives a clear idea about the technologies that are part of the FinTech ecosystem. These technologies are used to analyze and store Big Data. Using these technologies, financial institutions can suggest savings on almost any product, including skydiving insurance. All tools or technologies have benefits

starting from advanced management security and from historical reporting to automated marketing. It is very important to choose the right Big Data technology in Big Data design for finance.

Data Storage and Processing Technologies

Financial institutions and FinTech companies continuously store financial and transactional data, market data, and more. Data is the raw material for any data management and data analysis efforts. There are different solutions to store these vast quantities of data: classical methods and approaches are commonly used, and newer modern solutions are getting more and more into focus. Traditional databases or storage solutions within the classical RDBMS environment are very common in the FinTech sector. They provide a safe, easy to understand and manage, consistent, and powerful way to store and operate data. On the other hand, data is growing faster than ever and much faster than the new regulatory constraints. Structured data storage solutions max out when it comes to storing and managing larger amounts of data.

Nowadays, modern storage technologies and solutions are stepping into the market. Data lakes are used to store these vast volumes of data. A data lake is a centralized repository that organizes and stores raw data. It is commonly used to store structured data, semi-structured data, and unstructured data (Sawadogo & Darmont, 2021). These kinds of storage typically run on the storage and computing solutions of cloud providers. Processing large volumes of data to gather actionable insights raises problems: microservices and systems are becoming more asynchronous. Persistent topics are used to transmit data among microservices, or they are used to limit information. Technologies are used to manage this kind of asynchronous and event-driven system. Transactions are not used very often. Businesses want to know at the moment when something happens. They do not always need to know less than a second ago, but they are not happy with old information. These are the driving technological forces that have to be considered when designing systems that handle financial information. These systems have to be able to process large data volumes in near-real-time.

1.3 Purpose of the Study

The purpose of this study is to critically examine the adoption of Information Systems Engineering (ISE) practices, otherwise refers to as Financial Technology (FinTech) in this context, as a catalyst for enhancing financial inclusion in underbanked economies, with particular focus on Nigeria. Financial inclusion is defined as the accessibility and use of affordable financial services by the deserved, underserved and unbanked populations remains a significant challenge in many developing economies. Despite global efforts to address this issue, a substantial portion of the population in these regions still lacks access to essential financial services.

This study seeks to explore how the integration of advanced Information Systems Engineering practices (FinTech) can bridge this gap, offering innovative solutions that meet the unique needs of underbanked populations. The research aims to analyze the capabilities of these practices in transforming financial services, making them more accessible, affordable, and user-friendly for those traditionally excluded from the formal financial sector.

Additionally, the study aims to identify the challenges and barriers that hinder the effective adoption and implementation of these technologies in fostering financial inclusion. Understanding these challenges is crucial for developing strategies that can mitigate risks and enhance the success rate of such initiatives.

Moreover, the research intends to explore and document a successful case study where FinTech-driven initiatives have significantly improved financial inclusion in a developing economy in Africa. These case studies will provide valuable insights into best practices, critical success factors, and potential pitfalls to avoid.

Ultimately, the study will culminate in providing actionable recommendations for policymakers, financial institutions, and technology providers. These recommendations will focus on creating an enabling environment that supports the effective deployment of Information Systems Engineering practices to drive financial inclusion, thereby contributing to the overall economic development of underbanked regions like Nigeria.

1.4 Scope and Limitation of the Study

This study focuses on the adoption of Information Systems Engineering (ISE) practices, otherwise refers as Financial Technology (FinTech), to drive financial inclusion in underbanked economies, with Nigeria serving as a case study. The research examines the role of the adoption of Financial Technologies in addressing the needs of the populations traditionally excluded from formal financial systems. The study covers the following areas:

The primary focus is on Nigeria, representing a developing economy with significant underbanked populations. However, the study also draws on comparative insights from other developing economies to contextualize findings and propose general recommendations.

The study delves into various FinTech solutions, including mobile banking, digital payment platforms, blockchain technologies, and other innovative financial services enabled by FinTech. It explores how these technologies can enhance financial accessibility, affordability, and usability for underbanked populations. Furthermore, the research examines the roles of key stakeholders, including policymakers, financial institutions, technology providers, and consumers, in the adoption and implementation of ISE-driven financial inclusion initiatives.

The study includes the analysis of successful case studies of FinTech-driven financial inclusion programs in another Africa country to mine all the success factors for application into the Nigeria context. These case studies provide a practical perspective on the opportunities and challenges associated with these initiatives. The research proposes actionable recommendations for enhancing the effectiveness of FinTech in promoting financial inclusion, targeting policymakers, financial institutions, and technology providers.

Despite its comprehensive approach, the study acknowledges several limitations:

- 1) The availability and reliability of data specific to the underbanked populations in Nigeria and similar contexts may pose challenges, potentially affecting the depth and accuracy of the analysis.
- 2) While Nigeria serves as the primary case study, the findings and recommendations may not be fully generalizable to all developing economies due to differences in economic structures, regulatory environments, cultural contexts, and technological infrastructure.
- 3) The rapid evolution of FinTech technologies means that some findings may become outdated as new innovations and practices emerge. The study's conclusions are based on the current state of technology and may need periodic revision as the field evolves.

- 4) The study is limited by the regulatory and political context within Nigeria, which may differ significantly from other developing economies. These factors can influence the adoption and success of ISE-driven financial inclusion initiatives, and the study's recommendations may require adaptation to different regulatory environments.
- 5) The selected case study is intended to provide a representative sample of FinTech-driven financial inclusion initiatives. However, the study may not capture the full diversity of experiences across different regions or financial inclusion models, potentially limiting the breadth of insights derived from these examples.

These limitations are acknowledged in the study's analysis and discussion, and efforts are made to mitigate their impact where possible. Despite these constraints, the study aims to contribute valuable insights into the role of Information Systems Engineering in fostering financial inclusion in Nigeria and other underbanked economies.

2. Chapter 2: The Research Focus

2.1 Research Description

This research aims to investigate the role of Financial Technology (FinTech), a product of Information Systems Engineering (ISE) practices in fostering financial inclusion in Nigeria's underbanked population. By examining the opportunities and challenges associated with the adoption of FinTech, the study seeks to contribute to the development of effective strategies for expanding access to financial services.

The research focus on the following Objectives:

- Identify and analyze the key Financial Technology design model that can be leveraged to enhance financial inclusion in Nigeria.
- Assess the current state of FinTech adoption in the Nigerian financial sector.
- Evaluate the impact of FinTech on financial inclusion outcomes.
- Identify the primary opportunities, and challenges hindering the effective adoption of FinTech for financial inclusion in Nigeria.
- Develop a framework of recommendations for policymakers, financial institutions, and technology providers to optimize the use of ISE in promoting financial inclusion.

By addressing these objectives, the research provides valuable insights into the potential of FinTech to drive financial inclusion in Nigeria, informing the development of targeted policies and initiatives to address the specific needs of the underbanked population.

The research employs a mixed-methods approach, combining qualitative and quantitative research methods.

Data collection involves:

- A comprehensive literature review of relevant academic and industry publications.
- In-depth survey/questionnaire from key stakeholders, including representatives from financial institutions, regulatory authorities, technology providers, and other FinTech and financial inclusion enthusiasts.
- A case study of FinTech implementation and adoption from any other Africa country with a successful outcome.

The collected data are analyzed to identify patterns, trends, and relationships between FinTech adoption and Financial Inclusion outcomes, and the contextual factors influencing their adoption.

The findings of this research are aimed at contributing to the following:

- A deeper understanding of the potential of FinTech in driving financial inclusion in underbanked economies.
- Practical recommendations for policymakers, financial institutions, and technology providers to enhance the adoption and impact of ISE practices.
- A foundation for future research on the intersection of technology and financial inclusion in developing countries.

2.2 Problem Statement

Technology advancement has played a crucial role in driving economic development in recent times by transforming industries, improving productivity, and fostering innovation. The digital revolution has transformed how services are delivered, making them more accessible and efficient. For instance, e-commerce platforms have expanded market access for businesses and consumers, while online banking and FinTech innovations have democratized financial services, boosting economic activity. Furthermore, technological innovations like mobile banking and digital payments have brought financial services to previously underserved populations, particularly in developing countries. This has increased economic participation, enabled small businesses to thrive, and reduced poverty levels. Overall, technological advancement has been a key driver of economic development by fostering innovation, improving efficiency, and creating new opportunities for growth across the globe.

In Nigeria, a significant portion of the population remains underbanked, lacking access to basic financial services that are crucial for economic empowerment and poverty reduction. Despite advancements in financial technologies, there is still a gap in reaching these underserved populations, especially in rural and low-income areas. Financial technology (FinTech), a product of Information Systems Engineering (ISE) practices offers innovative solutions to bridge this gap by designing, implementing, and optimizing financial systems that are accessible, secure, and user-friendly.

However, the adoption of these practices in Nigeria faces multiple challenges, including technological infrastructure deficits, regulatory hurdles, low levels of digital literacy, and resistance to change among traditional financial institutions (Ediagbonya & Tioluwani, 2022). Moreover, the diverse socioeconomic landscape of Nigeria requires tailored approaches to

ensure that FinTech-driven solutions effectively address the unique needs of various communities.

The research problem, therefore, centres on understanding how Information Systems Engineering practices (FinTech) adoption can drive financial inclusion in Nigeria's underbanked economy. Specifically, it seeks to identify the key opportunities that FinTech presents, the challenges impeding its adoption, and the strategies that can be employed to overcome these challenges and enhance financial inclusion across the country. This research problem is critical as it addresses the intersection of technology, finance, and socio-economic development, with the potential to contribute significantly to policymaking decision, technology deployment, and the overall goal of financial inclusion in Nigeria.

2.3 Research Questions

The main idea behind this research pertains to ISE - Financial Technology (FinTech) and Financial Inclusion, and the exploration of the adoption of FinTech in driving Financial Inclusion in Nigeria. Through this research, this idea will be the common thread running through our work and all the activities we conduct in this framework. From this main idea, the central question of our research topic is born, namely:

Q1: What is the relationship between Financial Technology (FinTech) adoption and Financial Inclusion in Nigeria.

Q2: What are the opportunities and challenges with the adoption of FinTech in promoting financial inclusion in Nigeria?

Q3: What are the latest trends in Financial Technology solution design that facilitates user acceptance and adoption?

Q4: How can stakeholders, including government bodies, financial institutions, and technology providers, collaborate to foster an environment conducive to financial inclusion through information systems engineering?

2.4 Significance of the Research

The significance of this study cannot be overemphasized. This study is critically important for several reasons and is segmented into financial services accessibility, economic growth, technological innovation, strategic policy, infrastructural deficit, academic research, empowerment, and global focus:

Addressing Financial Exclusion: Nigeria, like many other developing economies, has a significant portion of its population that remains underbanked or unbanked. This research is crucial in identifying and understanding how Information Systems Engineering (ISE) practices can be leveraged to bridge this gap, providing millions with access to financial services that are essential for economic participation and poverty alleviation.

Enhancing Economic Growth: Financial inclusion is a key driver of economic growth, as it enables individuals and businesses to save, invest, and access credit. By investigating how ISE can enhance financial inclusion, this research contributes to broader economic development goals, particularly in underbanked regions of Nigeria.

Promoting Technological Innovation: This research highlights the role of technological innovation in financial services. By exploring the adoption of the FinTech initiative, the study has shown how innovative technologies, such as mobile banking, digital payment systems, and blockchain, are transforming the financial landscape, making it more inclusive and efficient.

Informing Policy and Strategy: Policymakers and financial institutions need evidence-based strategies to promote financial inclusion. The findings of this research can inform the development of policies, regulations, and business strategies that support the integration of ISE practices in financial services, leading to more inclusive and accessible financial ecosystems.

Addressing Local Challenges: The research is particularly important for Nigeria, where unique challenges such as infrastructure deficits, regulatory hurdles, and cultural factors impact the adoption of ISE practices. By identifying these challenges and proposing solutions, the study provides tailored recommendations that are relevant to the Nigerian context.

Contributing to the Academic Field: The intersection of Information Systems Engineering and financial inclusion is a relatively underexplored area in academic research, especially in the context of underbanked economies. This thesis contributes to the body of knowledge by providing new insights and expanding the understanding of how ISE can be utilized to drive financial inclusion.

Empowering Marginalized Populations: Financial inclusion has a direct impact on the empowerment of marginalized populations, including women, rural communities, and low-income groups. This research is important as it explores how ISE can create opportunities for these groups to participate in the financial system, thereby improving their socio-economic conditions.

Global Relevance with Local Focus: While the focus is on Nigeria, the insights and findings from this research can be applied to other underbanked economies globally. The study offers a model for how other countries facing similar challenges can adopt ISE practices to enhance financial inclusion.

In conclusion, this research is vital not only for advancing financial inclusion in Nigeria but also for providing a framework that can be adapted in other developing economies. It stands at the intersection of technology, finance, and development, offering practical solutions to some of the most pressing challenges in underbanked regions.

2.5 Theoretical Framework

Several theories and models underpin the relationship between FinTech innovations and financial inclusion. Because of the interdisciplinary nature of this research, financial technology and financial inclusion, the theory of Technology Acceptance Model (TAM) forms the bases of this research.

2.5.1 *Technology Acceptance Model (TAM)*

The Technology Acceptance Model (TAM) is a widely used theory in information systems that explains how users come to accept and use technology (Bradley, 2012). The Technology Acceptance Model remains a valuable tool for understanding and predicting user acceptance of technology. It suggests that the acceptance of technology is primarily influenced by two key factors:

- *Perceived Usefulness:* This refers to the degree to which a person believes that using a particular system would enhance their job performance.
- *Perceived Ease of Use:* This refers to the degree to which a person believes that using a particular system would be free from effort.

These two factors directly influence a user's attitude towards using the technology, which in turn, impacts their behavioral intention to use the technology.

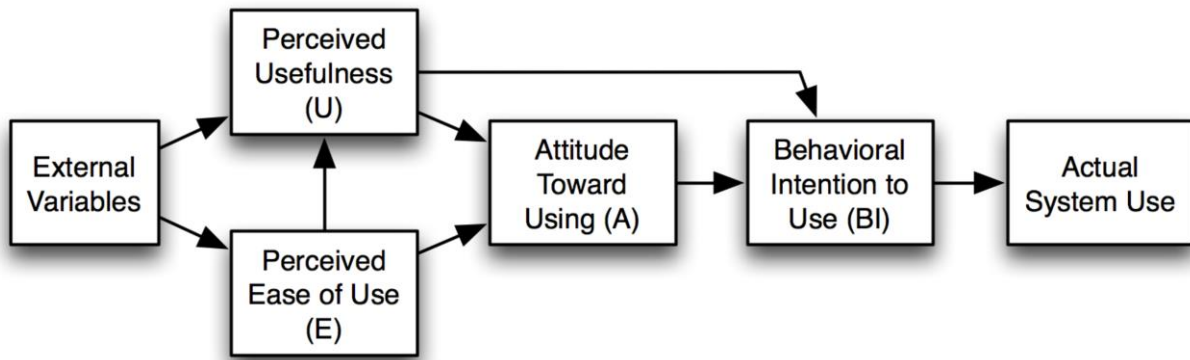


Figure 3: Diagrammatic Representation of TAM Model

As shown in the diagram, TAM posits a causal relationship between:

- *Perceived Usefulness and Perceived Ease of Use:* These are the independent variables that influence the dependent variables.
- *Attitude towards Using Technology:* This is formed based on the perceptions of usefulness and ease of use.
- *Behavioral Intention:* This is the user's intention to use the technology.
- *Actual System Use:* This is the ultimate outcome of the model, representing the actual usage of the technology.

The key implications of the use of TAM are as follows:

- *Focus on User Perception:* TAM emphasizes the importance of understanding users' perceptions of a technology, rather than relying solely on the developer's perspective.
- *Impact on Technology Design:* By identifying factors that influence user acceptance, TAM can help developers design technologies that are more likely to be adopted.
- *Role of Training and Support:* TAM highlights the importance of providing users with adequate training and support to increase perceived ease of use.
- *Measurement of Technology Success:* TAM provides a framework for evaluating the success of a technology by measuring user acceptance and usage.

While TAM has been widely used and validated, it also has some limitations such as 1) Limited Scope, which focuses on individual-level acceptance and may not fully explain organizational-level adoption, and 2) Neglect of Post-adoption Factors, where the model primarily focuses on the initial adoption process and doesn't extensively cover factors influencing continued use or long-term adoption.

2.6 Definition of Terms

- **Information Systems Engineering (ISE):** The systematic application of engineering principles to the development, implementation, and maintenance of information systems.
- **Financial Inclusion:** The process of ensuring access to and use of quality financial services by all adults and legal entities at affordable costs.
- **Underbanked Economy:** An economy where a significant portion of the population has limited or no access to formal financial services offered by regulated financial institutions.
- **Adoption:** The process of accepting and using a new product or service.
- **Financial Services:** A broad range of products and services offered by financial institutions, including savings and checking accounts, loans, insurance, and payment systems.
- **Information Systems:** Computer-based systems that collect, store, process, and distribute information to support decision making, coordination, control, analysis, and visualization.
- **Digital Financial Services (DFS):** Financial services delivered through electronic channels, such as mobile phones, internet, and automated teller machines (ATMs).
- **Financial Technology (FinTech):** Technology-driven innovation in financial services.
- **Agent Banking:** A banking delivery model where financial services are provided through a network of agents, often located in retail outlets, who act on behalf of a bank.
- **Mobile Money:** A mobile-based money transfer, payment, and storage service.
- **Cashless Policy:** A government initiative to reduce the use of physical cash in favour of electronic transactions.
- **Opportunities:** Favourable circumstances or chances for progress or advancement.
- **Challenges:** Difficulties or obstacles that must be overcome.
- **Drivers:** Factors that contribute to or accelerate something.
- **USSD (Unstructured Supplementary Service Data):** Is a text messaging service that allows users to access mobile services by inputting a short code on their phone
- **Correlation Coefficient:** A number between -1 and 1 that tells you the strength and direction of a relationship between variables

- **Microservices Architecture:** A method for developing applications by breaking them down into smaller, independent services
- **Big Data:** Large and diverse datasets that are huge in volume and also rapidly grow in size over time
- **Cloud Computing:** A model that provides computing resources, like storage, servers, and software, over the internet
- **Artificial Intelligence:** Machines that can learn, reason, and act in ways that would normally require human intelligence
- **Blockchain:** A system in which a record of transactions, especially those made in a cryptocurrency, is maintained across computers that are linked in a peer-to-peer network.
- **TAM:** Technology Acceptance Model
- **DOI:** Diffusion Of Innovation
- **IT:** Information Technology
- **Cryptocurrencies:** Cryptocurrencies are crypto tokens designed to be used as payment methods

3. Chapter 3: Literature Review

3.1 Introduction

FinTech, a portmanteau of "financial technology," and a product of Information Systems Engineering (ISE) refers to the application of innovative technologies to deliver financial products and services (Di Pietro et al., 2020). It encompasses various areas including payments, advisory services, financing, and compliance (Sung, 2018). FinTech is characterized by the use of sophisticated technology relative to existing solutions in the market (Knewton & Rosenbaum, 2020). The concept has evolved rapidly, disrupting traditional financial services with technologies such as mobile payments, cryptocurrencies, and artificial intelligence (Di Pietro et al., 2020). FinTech firms are primarily defined by their use of these innovative technologies (Knewton & Rosenbaum, 2020). The field is cross-disciplinary, combining finance, technology management, and innovation management (Leong & Sung, 2018). While FinTech has gained significant attention and investment in recent years, there are still gaps in research, particularly regarding its precise definition and taxonomy (Ratecka, 2020). Understanding FinTech is crucial for developing new solutions and creating business value in the financial sector (Almomani & Alomari, 2021).

Essentially, financial inclusion refers to the systematic integration of concerns for financial development with social goals (Kara et al., 2021). It seeks to provide access to the appropriate financial products and formal financial systems that the financially excluded segment of the economy is lacking (Ozili, 2021). The concept became significant for the developing economies. A paradigm shift in the world has necessitated a new form of capital for social and economic inclusiveness, recognizing that in most economies in the world, the majority live in abject poverty, earning one dollar daily, and therefore are economically excluded. It follows that there is a connection between financial services, economic growth, and poverty reduction. (Zulher & Ratnasih, 2021).

3.2 Level of FinTech Adoption in Promoting Financial Inclusion in Nigeria

Financial technology (FinTech) has emerged as a key driver of financial inclusion in Nigeria, offering improved access to financial services, especially for underserved populations (Ogunode & Akintoye, 2023). While progress has been made, the financial inclusion gap has expanded despite the government, regulators, and financial institutions' various efforts by

developing various digital platforms, including encouraging the use of smartphones for mobile payments and automated teller machines (ATMs) and mobile money. Several reasons are responsible for the gap in financial inclusion: illiteracy, poor infrastructural facilities, intermittent power supply, poor mobile receptions, especially in rural areas, constant banks' network failures, unnecessary charges, information asymmetry and data privacy breaches, amongst others as concluded by Ediagbonya & Tioluwani (2022). The research methodology employed by this researcher is the exploratory research design using secondary data sources. The researcher uses a 4-phase review process as follows Identification - Searching academic databases using keywords; Screening - Narrowing down to 422 records based on scope, title, abstract, and keywords; Eligibility - Full-text review of 422 records, resulting in 98 documents; and Inclusion - Final selection of 26 papers aligned with research objective.

Over the last decade, Fintech's contribution to financial inclusion in Nigeria has exploded. Despite the contributions of FinTech to financial inclusion in Nigeria, Ezeocha (2024) noted in his findings that the issue of high level of attrition in customer patronization and the threat of Cyber-attacks are major challenges. Based on this therefore, the researcher recommends the need for regulatory bodies to do more to bring synergy between the operating companies and their interactions with the customers and prospective consumers for proper sensitization about these fintech services, considering the disinterest of many due to distrust of the system. The objectives of this exploratory qualitative research paper include to critically discuss the emerging trends in financial technology and how they enhance financial inclusion, as well as the problems faced by financial technology in financial inclusion, with specific focus on Nigeria. To achieve these, the paper adopted the exploratory research approach using secondary data sources involving extensive review of recent articles, periodicals, empirical and analytical studies, policy discussion and working papers as well as other documented materials found to be pertinent to the study.

Soetan & Umukoro (2023) in their study "Financial Inclusion in Rural and Urban Nigeria: A Quantitative and Qualitative Approach" noted that quantitative outcomes showed that residential status had a significant main effect on access to marketing financial inclusion services, such that rural residents had limited access to financial inclusion services; while perceived cost of financial inclusion had a significant main effect on usage of financial inclusion services, such that perceptions of high cost of perceived inclusion resulted in less usage of financial inclusion services. Their study provided insights into current realities of

financial inclusion among financially vulnerable (financially illiterate and semi-literate) customers in an emerging economy. The two-phased study adopted both quantitative and qualitative methods in which cross-sectional and phenomenological approaches were used for data collection, with specific emphasis on rural-urban differentials. Data for the first phase was obtained from an urban (n=211) and rural (n=242) sample selected via a combination of purposive and convenient sampling. A structured questionnaire was utilized in eliciting relevant information from the study participants. Data for the second phase was obtained from bank managers who are key informants with professional knowledge about trends of financial inclusion in Nigeria.

Information Systems Engineering product, FinTech addresses constraints in traditional financial products, especially access and equality and even threatens to phase out those products. Despite the ease associated with FinTech products, the risks and disadvantages are also numerous. FinTech products, especially cryptocurrency, give off the notion of anonymity and invincibility, that is, the confidence that the participants are off-the-reach financial sector regulators as Iheanacho & Oluwasemilore, (2021) examined. This notion has given rise to risky and criminal utilization of FinTech products. For Nigeria, which is at the teething stage of financial regulation, the adoption of FinTech poses serious challenges. This is evident in the regulatory indecisiveness of the Central Bank of Nigeria (CBN) and the Securities and Exchange Commission (SEC) as to how to treat FinTech (Iheanacho & Oluwasemilore, 2021). The researcher adopted the qualitative as well as doctrinal legal research methodologies, using the material of the statutory provisions of Nigeria and judicial pronouncements from Nigeria for examination especially with respect to the legal status of FinTech products such as cryptocurrency.

Joseph et al, (2021) in their research noted that FinTech improves the effectiveness of monetary policy in achieving financial inclusion in Nigeria. Their findings anchor on the fact that: monetary policy effectiveness, as measured by inflation rate and lending rate, has a significant effect on financial inclusion in Nigeria; moreover, accounting for FinTech in the model improves the effectiveness of Monetary policy in driving financial inclusion, contrary to the popular belief that FinTech impedes Monetary policy effectiveness; and FinTech positively drives the relationship between lending rate and financial inclusion. The researchers used the following methodologies in testing their data: Stationarity testing using the Augmented Dickey-Fuller (ADF) unit root test to establish the order of integration of the

variables; Cointegration testing using Johansen's cointegration test to determine if there is a long-run relationship among the variables; and Estimation of the models using the Fully Modified Ordinary Least Squares (FMOLS) method, which is suitable for estimating cointegrating relationships.

Enebeli-Uzor & Mukhtar (2023) postulate in their study that Digital finance can improve financial inclusion in Nigeria, but challenges remain in integrating the informal financial market. Their main findings hinges on commercial bank branches and internet access are the strongest drivers of financial inclusion in Nigeria in the short run; digital credit to the private sector and a period lag in interest rate hinder financial inclusion in the short run; and in the long run, commercial bank branches, internet access, and exchange rates significantly affect financial inclusion, while digital credit to the private sector and lending rate are the critical factors contributing to financial exclusion. The researcher explores the roles of digital finance in achieving financial inclusion in Nigeria. Following the dissatisfaction theory, a quantitative research method was adopted using an ex-post facto research design. The study employed annual time series data spanning 2004 - 2020 (17 years) and captured the key independent variable digital finance using proportion of population with access to internet and digital credit, while commercial bank branches per 100,000 population, lending rate and exchange rate are incorporated as control variables.

Nigeria's financial inclusion strategy should leverage digital financial services to overcome low digital financial literacy and infrastructure to further reduce the 26% unbanked population according to Wezel & Ree (2023). They stated further that despite progress in financial inclusion, Nigeria is still falling short of its targets, in part due to low financial literacy among the population. Noting that Nigeria lags behind other African countries in financial inclusion, as it has a lower rate of mobile money account ownership compared to countries with higher overall financial inclusion rates. Wezel & Ree recommended promoting digital financial services, such as mobile money, could significantly improve financial inclusion in Nigeria by reaching underserved rural and low-income populations.

Nigeria's financial inclusion rate has improved but remains below the 2020 target, requiring concerted implementation efforts across four key areas (Aro-Gordon, 2017). The findings of their study present that Nigeria's financial exclusion rate has decreased from 52.5% in 2008 to 41.6% in 2016, but over 55% of the female adult population remains financially excluded. The South-West geopolitical zone has met the 20% exclusion rate target, but the

remaining zones, particularly in the North, remain largely financially excluded. Out of 9 key performance indicators, only the expansion of bank branches and agency banking have made significant progress towards the 2020 targets.

Alabi & Olaoye (2022) in their study revealed that technology adoption has significant potential to improve financial inclusion in underbanked economies like China and Nigeria, but its impact has been limited so far. Their findings also suggest that: Automated Teller Machines, Internet usage, and Mobile Cellular Subscriptions have an insignificant positive effect on financial inclusion in China and Nigeria, but a significant positive effect in other countries; GDP growth rate has a significant negative relationship with financial inclusion in China, Nigeria, and the other countries in the panel; Technology adoption has significant potential to improve financial inclusion in China and Nigeria, but this potential is currently untapped.

The methodology of the study by A. W. Alabi and F. Olaoye (2022) involved using Pooled OLS and Feasible Generalized Least Squares (FGLS) estimators to examine the impact of technology adoption on financial inclusion. Financial inclusion was measured by the number of depositors with commercial banks per 1,000 adults. The sample included 20 countries, with Nigeria and China as the main focus, and 18 other developed, developing, and emerging economies. The data was secondary data extracted from the World Bank open data source.

Fintech innovations can enhance financial inclusion in underbanked economies like Nigeria but face regulatory and infrastructure challenges as noted by Ololade (2024) in their study. The study outcome reveals that: Fintech innovations have the potential to significantly increase financial inclusion, especially in Africa where they provide basic financial services to the unbanked population; The focus and adoption of FinTech solutions differ between Africa and the U.S., with Africa emphasizing accessibility and affordability, while the U.S. focuses on enhancing existing financial services; and that FinTech adoption rates are higher in Africa for mobile money services due to their immediate value to the unbanked, while in the U.S., adoption varies across different fintech solutions with higher uptake among younger demographics.

Aidonojie et al. (2023) examines the legal issues and challenges affecting the operation of FinTech in Nigeria, including the need for legal regulations and alignment with Nigerian laws. Their findings pointed out that: The introduction of Fin-Tech has greatly enhanced the commercial sector in Nigeria; and there are several legal and socio-economic challenges affecting the smooth operation of Fin-Tech in Nigeria. Finally, the lack of a primary legal

framework regulating Fin-Tech operations is the most significant challenge. The researcher uses the Doctrinal Research - Examining primary legal sources and scholarly literature related to fintech operations in Nigeria; Non-Doctrinal Research - Generating data through an online questionnaire survey of 301 respondents in Nigeria; and Data analysis - Using descriptive and analytical statistical methods to analyze the survey data and identify the prospects, challenges, and possible remedies for fintech operations in Nigeria.

FinTech innovations have transformed financial services in Nigeria, but providing access to the underbanked population remains a key challenge (Alexander & Karametaxas 2020). The result of their research reveals that: Fintech innovations have the potential to increase financial inclusion, but they also create risks such as over-indebtedness and consumer protection issues that need to be addressed through regulation; The digital transformation of the financial sector can spur financial inclusion of low-income households and businesses, but it also leads to higher debt levels for individuals and SMEs; and fintech innovations raise concerns about consumer protection and over-indebtedness that need to be carefully managed.

Techno-driven banking services in rural Nigeria face challenges related to age, gender, education, infrastructure, and poverty, limiting financial inclusion (Oluwatayo, 2017). Demographic and socioeconomic factors such as age, gender, household size, education, poverty, infrastructure, and cooperative membership are important drivers or enablers of the use of techno-driven banking services in rural Nigeria. Older age, male gender, higher education, and cooperative membership are positively associated with the use of techno-driven banking services, while larger household size, greater distance to banking facilities, poor power infrastructure, and higher poverty levels are negatively associated. The methodology used in this study was a questionnaire-based survey of a random sample of 250 respondents from rural Southwest Nigeria, with descriptive analysis of the sample characteristics and use of a probit model to identify the key drivers/enablers of techno-driven banking services.

3.3 A Case Study of Successful FinTech Implementations in Sub-Saharan Africa

Using the most common measuring yardstick of financial inclusion (account ownership), the latest World Bank Findex Report (World Bank Group, 2021), Figure 5 indicated that within the last ten (10) years culminating in 2021, account ownership significantly grew from 51% to 76% of global adult population. However, when compared with the performance of nation states in Sub Saharan Africa (SSA), the position is significantly lower at 51% of its eligible

adult population. This suggests that while some measures of progress have been achieved using alternative channels such as mobile devices, the growth is still hampered by issues around internet connectivity and access, poor broad-band penetration and cultural inhibitions (Ogunode & Akintoye, 2023).

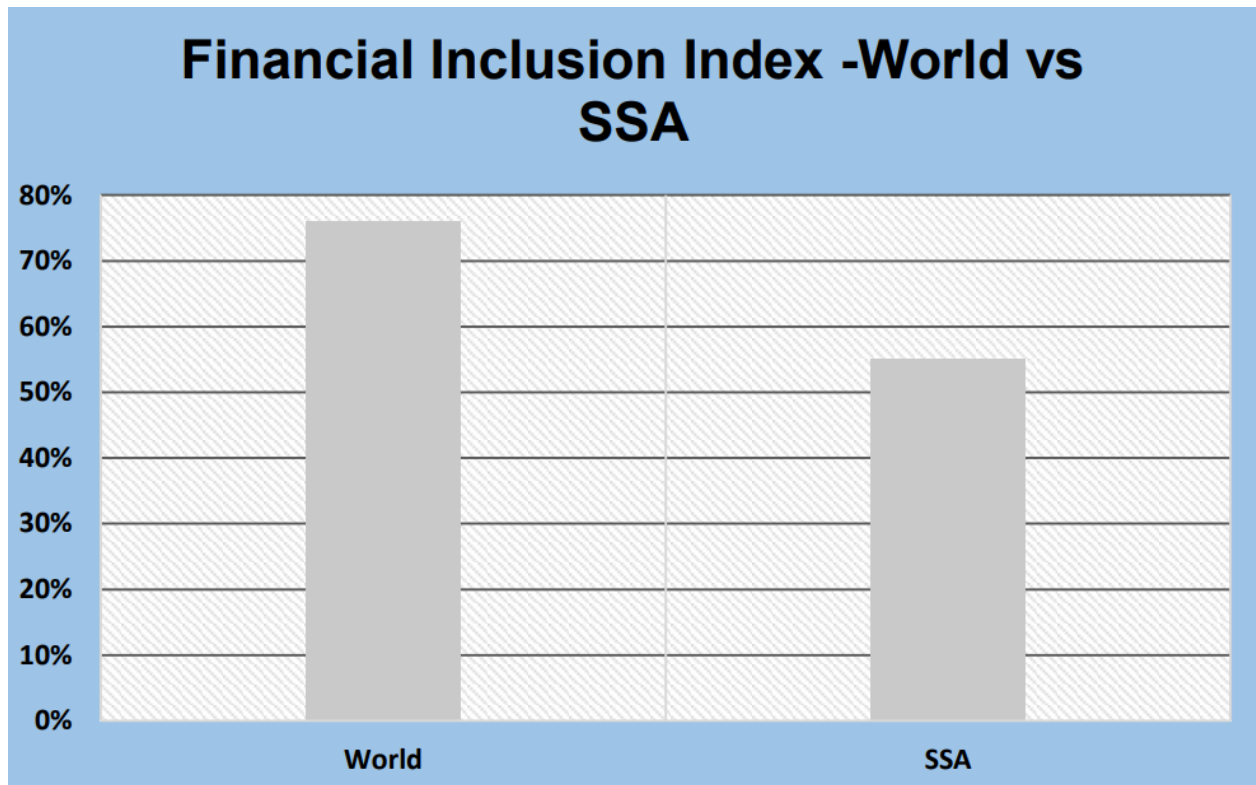


Figure 4. Financial Inclusion Status (World Vs Sub-Sahara Africa)

Source: Adapted from World Bank Group Findex Report (2021)

As shown in Fig. 6, a comparative analysis of the financial inclusion status of three (3) key African countries – Kenya, South Africa and Ghana compared with Nigeria within the same time horizon of 10 years terminating in 2021. The results show that while these countries witnessed significant upside in their growth trajectory: Kenya -87%; South Africa – 59%; Ghana – 132%, Nigeria experienced what is at best a muted progress which stood at 53%. This suggests that while financial inclusion initiatives such as the M-Pesa in Kenya, Mbansi scheme in South Africa, Cash-Lite initiative in Ghana has witnessed noteworthy impact, that of the Nigerian authorities championed by its National Financial Inclusion Strategy has been less than successful for various factors. It is the intention of this research therefore to interrogate these successful factors in the case of Kenya and how the lesson learnt should be cascaded to other developing and underbanked economies.

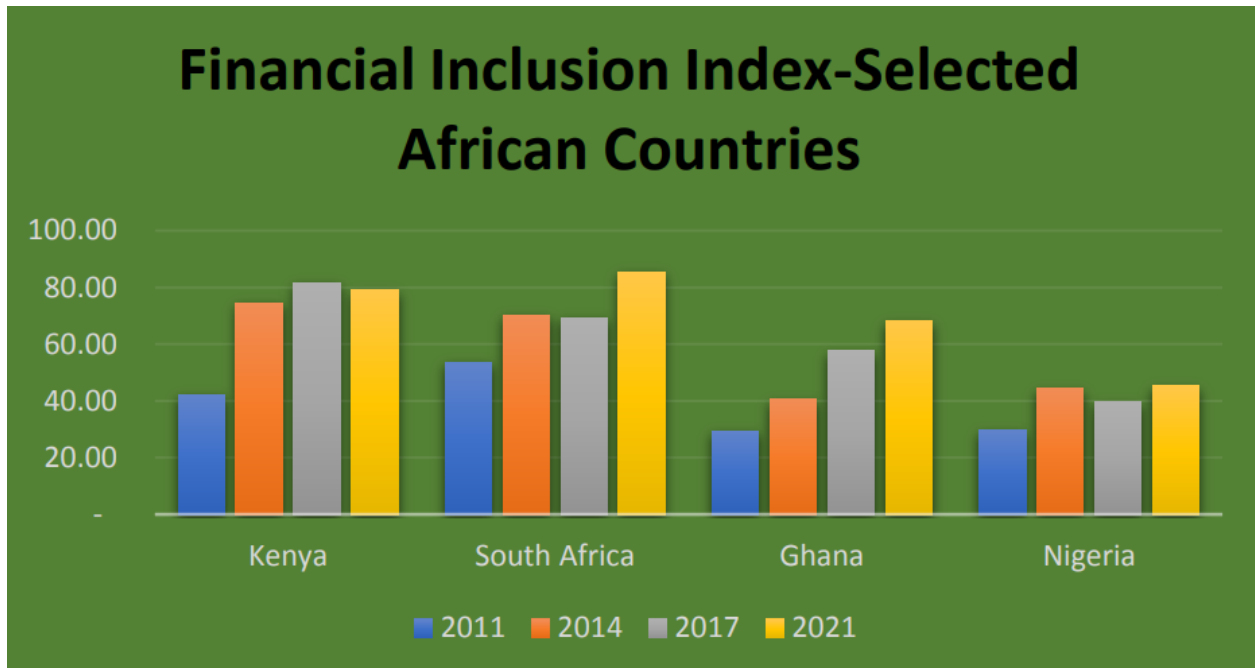


Figure 5. Financial Inclusion Status (Selected African Countries Vs Nigeria)

Source: Adapted from World Bank Group Findex Report (2021)

3.3.1 Case Study of M-Pesa in Kenya

Historical Development

The groundbreaking mobile money application M-Pesa was launched in Kenya in March 2007. It has since been lauded as a major technological innovation and has attracted not only an extensive customer base, but significant media interest, with reports of its usage also featuring in international corporate and academic literature. The Economist depicted the glass-beaded M-Pesa user on its 2007 Christmas issue, acknowledging its instant success, forecasting that other companies would soon be watching to see if copycats succeed (Mulili, 2022). Finally, M-Pesa is mentioned by Milford Bateman who adds that it was "accorded an enthusiastic and generous commentary in the global financial press from almost the outset".

M-Pesa, however, had initially been conceptualized as a component of an altogether different proposal. Consultations in 2004 between Vodafone's UK headquarters and Safaricom had identified a means to exploit Safaricom's fledgling infrastructure and network organization in the Kenyan market for the purpose of facilitating the migrant remittances that Kenyans in the UK and US were every week expending large sums of money to effect from commercial money transfer operators and emigrant host countries (Fardowsa, 2022). The realization envisaged that Kenyan relatives would in future phone or use a smart card to send and receive money on M-Pesa's domestic immune-system instead of using the highly slow and expensive methods that

currently prevail. However, those larger potentialities had to be suspended when the highly interventionist national government decided to oppose a planned national banking license and on October 25th, 2005, the embryonic local team terminated the original strategy, elected to scale down the pilot and ask its new customers if they wanted to access postal accounts. Thus, the decision was made to confine the project to a larger pilot with softer regulation, kick-start M-Pesa with that money and to suspend the trans-national venture with the UK.

Key Features and Services

Increasing access to money while applying the brakes on physical interaction has proved an almost symbiotic remedy to any economy since it keeps transactions alive. If left unchecked, economic problems may lead to the collapse of a financial system, which in turn will endanger an entire economy.

M-Pesa is a mobile money transfer and micro-financing service that was released in 2007 and is owned by Vodafone and Safaricom, a subsidiary of Vodafone. M-Pesa was initially developed and introduced in Kenya to meet the needs of an unbanked population by enabling users to send and receive money through mobile phones and make payments in retail stores and elsewhere. M-Pesa has well and truly demonstrated not only the capabilities of mobile technology but also its power as a lantern for productivity change in emerging economies with its massive, almost viral, uptake and integrated services and user groups in Kenya and Tanzania (Tiony, 2024).

The main features of M-Pesa are a secure, speedier, cheaper, and more user-friendly solution to sending remittances; the ability to bank at the village level; the ability to send and receive money to mobiles even without access to bank accounts. Transactions are conducted in Kenyan Shillings, with an exchange rate to the home currency. Services include airtime top-up, pay goods and send money. An agent is then responsible for converting cash to airtime or vice versa. Creating and operating a bank account may attract an account fee which is not applicable in the case of an M-Pesa account.

According to Wachira & Njuguna (2023), “in the heavily under-banked rural areas where one likelihood is of our empirical fieldwork, having very little in an M-Pesa phone account is probably not a problem because, in times of financial drought, few people will have more than about KSh. 2,000 to KSh. 5,000 at one time. Therefore, an M-Pesa account performs a banking function using mobile phones which is simple, user friendly and directly creates much potential

informal economic (urban and rural) growth, likely through productivity change both in Kenya and Tanzania as demonstrated throughout the exploratory period."

Impact of M-Pesa on Financial Inclusion

M-Pesa, being a mobile-based platform, has allowed for improved accessibility, which, unlike banks, allows for much larger geography. Functions offered by M-Pesa range from essentially allowing for money transfer and payment services, to more complex services such as saving. Due to the increased usage of M-Pesa, along with other mobile branches, the number of inactive accounts by adults has also increased from 8% in 2006 to 29.2% in 2009 (Pashayan, 2022).

Another aspect of financial inclusion is seen through the point of ease of access for different segments of the population. With M-Pesa, accounts can easily be accessed without any set minimum price compared to traditional 'brick and mortar' bank branches. In the context of the Kenyan economy, 60% of adults used informal financial methods for savings as of 2009, and similarly, 60.5% of adults saved in the previous calendar year (Mwangi, 2020). Accounts from banks or other formal bank services were down in comparison to informal services to a rate of 35% (Ngumi, 2022). It presented to an extent a causal problem. M-Pesa usage permitted greater access to handling money and paying bills for those who would not have had access to full-service bank accounts but now can make transactions on a much smaller budget scale. For example, research showed that 26% of M-Pesa customers were below the minimum income requirements for a bank, based on a survey of Kenyans of the M-Pesa system.

Economic Growth and M-Pesa

As shown earlier, it is evident that M-Pesa has made significant contributions toward inciting economic growth in Kenya by providing a wide range of business opportunities, which, in turn, has created employment. In 2015, it was reported that a total of 194,000 jobs directly relied on M-Pesa, whilst 3.35 million jobs were dependent upon M-Pesa catalyzed activities. Examples of M-Pesa led jobs were evident in the increased network of airtime/scratch card dealers in urban and rural Kenya. Furthermore, M-Pesa agents also provided employment through the hiring of M-Pesa 'float' holders, sales personnel, support staff, and, in some cases, security personnel. Small shops and supermarkets also took advantage of the increased footfall generated by M-Pesa agents, leading to product sales, whilst transport companies, motorcycle and car taxi operators, and fresh produce traders all focused-on customer relations with M-Pesa services, which in turn led to an increase in productivity (Wachira & Njuguna, 2023).

Challenges and Future Prospects

A common concern of the M-Pesa service is that the Kenyan context, which has had an absence of electronic funds transfer mechanisms, led to an in-built advantage in its early days which does not necessarily translate to other country contexts. The challenges for the M-Pesa service and the future for M-Pesa are multi-faceted and both are examined to some extent under the following broad headings: Regulatory issues and partnerships; competition; and innovation.

Regulatory Environment

Kenya became the first country to introduce a regulatory regime to govern the operations of mobile money transfer services through the enactment of the Kenya Information and Communications Act (KICA) in 1998 and the Kenya Communications (Amendment) Act 2009 (Uwamariya and Loebbecke, 2020). Savita Bailur highlights that the Central Bank of Kenya and the Communication Commission of Kenya can encourage mobile phone operators to partner with money remittance companies and banks to support and develop more financial products, taking the innovation of M-Pesa as the point of departure.

On the one hand, Kenyan regulatory authorities have achieved a breakthrough by ensuring the development of mobile telephony services through licensing. On the other hand, Safaricom, a mobile operator, is licensed to offer mobile phones and current accounts. Kenyan banks are considered the main competitor in the wholesale and retail financial markets. Safaricom has secured a niche position by providing loans and other products that were actually provided by Kenyan commercial banks. Regulatory authorities regulate and promote competition between all financial service providers. M-PESA faces challenges and new opportunities with high rates of financial exclusion in other developing countries. Regulatory, infrastructural, and geopolitical settings can be significant barriers to expansion.

Competition and Innovation

M-Pesa was successful in Kenya and has emerged as a strong and transformative mobile service, and all performed the few forms that present annual positive returns. While this study offers a qualitative empirical analysis of competition and innovation, data shows that all M-Pesa agents were located inside a retail outlet or pharmacy (Mulili, 2022). There are only two M-Pesa agents which were not located inside major stores - one was located outside the chemist, and another was located outside a jewellery store. The reason behind selecting agents in retail outlets is the large volume of foot-traffic that these places attract. These retail outlets

also have a competitive advantage towards attracting M-Pesa users, as people who visit other stores need not step out of the outlet to visit an M-Pesa agent.

Post-launch, the initial requirements which a customer needed for registration with M-Pesa agents were lowered, and KWFT no longer mandates the use of an ATM card or bank account for M-Pesa registration. KWFT has stated that it might allow users to register without a credit rating if they have operated an MPower loan facility for a reasonable length of time. Starting in November 2011, KIP now also accepts M-Pesa deposits and withdrawals of cash from M-Pesa accounts.

Conclusion

This case study has elucidated the remarkable possibilities of mobile money for a lower middle-income country. The M-Pesa case is rare, not only in Kenya but globally. Its rate of adoption has been higher than any other such initiative, and its impact goes way beyond mere money transfer. Adopters have been able to reduce the costs of doing business and have given rise to a large assortment of other digital and financial services. The lives of ordinary people have been transformed. Remittances have increased by over 50 percent. The number of Kenyans with access to water has grown by 10 percent. Businesses, too, have been using mobile phone technology in their operations to reach the unbanked and to expand their clients' base. All this has attracted foreign investment.

The FinTech effect can be seen in the ease with which the idea of M-Pesa was adopted by large sums of common people. Its growth was initially slow because it took some time for the M-Pesa advertisers to establish trust in the mobile phone system. M-Pesa needed to seek permissions from the government, and it had to first win the right to pilot the project in Kenya. Finally, it was tested in some households and then in the whole country. Stakeholders, including banks, were ready to make investments; all for the good of Kenyans and to bring about a fast ROI. Lopez-Claros and Margolis acknowledge M-Pesa for having revolutionized commerce and banking in the East African economy. Impressively, since the introduction of M-Pesa within Kenya, other countries have also benefited greatly from it by embracing its technology.

4. Chapter 4: Methodology

4.1 Introduction

The current chapter describes the core research tools and processes deployed to examine the impact of the adoption of Information Systems Engineering practices otherwise refers to as FinTech in driving financial inclusion in underbanked populations of Nigeria. Accordingly, the examination of the challenges and opportunities in its adoption and implementation. This approach allows for a proper understanding of the relationship between financial technology (FinTech) adoption and its impacts in financial inclusion, thereby coming up with conclusions from the data to explore what more can be done in the Financial Technology space to further drive financial inclusion. Consequently, the theoretical framework of this research is based on the Technology Acceptance Model (TAM). This chapter also consists of other crucial sections such as the research methods and design used, and sampling design for the target population. The processes followed and the techniques used to acquire and process the research data are parts of this chapter thereby meeting the intended deliverables. The ethical factors observed during the actual research process are also discussed in this chapter.

4.2 Research Aim

This thesis aims to investigate the potential of Information System Engineering (ISE) also known as FinTech, in driving financial inclusion in the underbanked population of Nigeria. The study explores the opportunities and challenges associated with FinTech adoption and its role in bringing financial services to the unbanked and underbanked population and contributes to the development of effective strategies for expanding access to formal financial services.

4.3 Research Objectives

The research focuses on the following Objectives:

- To explore how FinTech solutions adoption can promote financial inclusion rates in Nigeria.
- To explore case study of existing and a successful FinTech-driven financial inclusion programs in a developing economy in Africa.
- Explore the application of AI Tailored Language and Voice Design to Address the Needs of Low Literacy Users.

- Identifying the specific opportunities FinTech offers in developing user-centric, secure, and scalable financial service platforms accessible to the underbanked.
- To identify and analyzing the challenges hindering widespread Fintech adoption in Nigeria.
- Providing insights for policymakers, financial institutions, and Fintech companies to develop strategies that promote effective Fintech adoption for financial inclusion.

4.4 Research Design

An effective research design enables proper planning of the research process and facilitates the implementation of these tactics. It serves the purpose of a blueprint, indicating a clear pathway as to the means by which data collection will occur, then processing and analyzing data as the study demands. A recent study used the exploratory research approach, in which the researcher gained insight into the research problem through familiarity with past data (Schoonenboom & Johnson, 2017). Additionally, exploratory research allows researchers to explore viewpoints that have yet to be exhausted by previous studies. By combining the promotion of financial inclusion with financial technology adoption, the researcher could gain new insights into the economic impact of financial inclusion on underbanked communities. A final contribution of the exploratory model was to guide future research regarding the feasibility and sustainability of modern financial technology solutions.

4.5 Research Method

A combination of primary and secondary data collection methods is used in this study. The researchers implemented qualitative and quantitative approaches in order to collect data and provide feedback on research objectives. Research using qualitative methods is necessary when it involves exploring phenomena by utilizing people's knowledge, perceptions, and experiences in a given situation (Browne et al., 2019). However, when investigating the association between variables, the quantitative research method is appropriate. We employ a qualitative approach to examine trends, opportunities, and challenges related to the adoption of information systems engineering, such as the use of FinTech to promote financial inclusion. A significant part of the primary research process is data collection by means of surveys or questionnaires. In order to effectively implement financial technology (FinTech) solutions and its acceptance, it is important to understand the opinions and perspectives of those who have used these technologies and the challenges they faced. The study aims to determine the relationship

between FinTech adoption and financial inclusion, and to identify the latest trends, as well as to identify the challenges and opportunities associated with FinTech adoption.

A secondary data analysis research method involves reviewing past literature that relates to the problem of study. Through the use of primary and secondary research methods in this research, a comprehensive analysis of the study assumptions was made. As a result, researchers can examine multiple perspectives related to the research topic, which makes them more capable of dealing with the implications of the study.

4.6 Sampling Design

A combination of primary data and secondary data sampling approaches was used to collect data for this study. As outlined at the start of this study, a sampling approach needed to be developed that aligned with the technological deliverables. In this study, the purposive sampling technique was utilized since it allows researchers to determine sample size according to factors and parameters deemed important to the study (Etikan et al., 2016). As part of the primary data collection method, thirty (30) participants were selected based on their extensive knowledge of the subject matter. The target population includes experts in FinTech startups companies (10), deposit banks - commercial and microfinance banks (10), financial regulatory institutions such as the Central Bank of Nigeria (CBN), Security and Exchange Commission (SEC) of Nigeria (2), and information technology experts who have worked for firms that have successfully implemented FinTech solutions (8). These individuals are expected to have in-depth knowledge of the research topic and discuss the latest opportunities and challenges presented by FinTech adoption in promoting financial inclusion. Consequently, the gathered information from the study can be used by financial technology developers to effectively improve the design and implementation processes of FinTech solution development.

4.7 Data Collection

The data collection process provides the necessary data for establishing the foundation for research and for gaining a substantial amount of information about research objectives. Depending on the type of research, data collection is one of the most important steps in the process since it involves using validated methods to collect information, which will then be analyzed to develop conclusions about the study (Maxwell, 2018). Moreover, overall information is essential for the research process since it enables the researcher to estimate their

research questions or hypotheses based on the data. As a result, it is the researchers' responsibility to ensure that the results obtained during data collection are comprehensive and reliable, so they can be used in making evidence-based decisions.

The data gathered in this piece is based on multiple variables and aspects to determine validity and accuracy. For this reason, before conducting research, it is necessary to implement appropriate measures to ensure the data collected from the study is reliable and valid. Studies can be used to formulate appropriate conclusions, influence corporate practices, and introduce new technology based on the gathered information from the study. Based on the information gathered in this study, different stakeholders from different economies and organizations can draw crucial conclusions in relation to the adoption of FinTech in promoting financial inclusion, the opportunities and challenges, and its use in different underbanked economies. A properly structured data collection process is utilized in this research to facilitate the validation of the collected data and its integration into the associated field. Since the data collected will be valid and accurate, useful insights can be derived from it, which can then be used to evaluate the impact of FinTech adoption in promoting financial inclusion.

4.7.1 Primary Data

A survey technique is used as part of this research process. It is an important research method because it allows researchers to receive neutral and objective answers to their questions. The questionnaire allows participants to choose from a set of closed-ended questions with a variety of options. The questionnaire is divided into three sections. Accordingly, the questionnaire's first section asks respondents about their basic information, including their age and gender. Furthermore, this section asks about the individual's current occupation, and employer.

The second section of the questionnaire consists of questions based on FinTech Adoption, while the third session comprises of questions based on Financial Inclusion which in totality provides information on how FinTech and banking stakeholders perceive the opportunities and challenges of FinTech adoption in promoting financial inclusion in Nigerians without access to financial services.

4.7.2 Secondary Data

This study relies on existing literature to uncover data related to the topic. There are multiple existing pieces of literature that focus on the topic of research, the opportunities and challenges of the implementation and adoption of FinTech in the underbanked population in Nigeria. Thus, obtaining these sources of information can help answer research questions. To obtain secondary data, it is necessary to review these sets of literature and determine their contribution to the research problem. Identifying and analyzing relevant literature can lead to identifying the opportunities and challenges presented by the latest studies in order to answer the current research questions. The data collected from secondary sources is then analyzed using content analysis. These secondary qualitative data are obtained from technology and business innovation databases, including OECD, EBSCO, Semantic Scholar, Google Scholar, and ProQuest. The next step is to develop specific keywords related to the research problem after identifying the databases. Among the keywords significant in this study are FinTech, Financial Technology, Mobile Banking, Internet banking, Mobile App, Mobile wallets, Digital wallets, e-wallet, block chain, Digital currency, Point of Sale (POS), Information Systems Engineering (ISE), financial inclusion, underbanked economy, and underbanked population.

In order to answer the different research questions effectively, keywords must be developed for each. After these keywords have been gathered, relevant articles can be searched through databases. As a general rule, when collecting secondary data, the first step is to identify and understand the specific research topic, which is the implementation and adoption of information systems engineering or FinTech to promote financial inclusion to identify and understand the latest opportunities and challenges.

Through secondary research, we are able to gather data on the challenges and opportunities associated with leveraging the use of Financial Technology (FinTech) for financial inclusion. The study also examines different constraints facing Nigeria's underbanked population in terms of implementing these technologies effectively. FinTech technology must be adopted within an appropriate strategic context, which includes analyzing the appropriate measures to be taken. A comparison and combination of the myriad findings is required once the data has been effectively collected for the research topic. It is crucial that the researcher possess extensive critical thinking skills as using a single descriptive perspective decreases the quality of the outcomes and therefore strains the research process.

The use of secondary data collection offers researchers significant benefits, since there is an abundance of expensive data available. Since data acquisition is cheap and easy compared to primary data collection, it continues to be a low-cost process (Maxwell, 2018). Using it gives the researcher the convenience of obtaining data from various authentic sources in a quick and relatively efficient manner. In spite of this, other secondary data sources tend to provide information that contradicts and does not relate to the topic of the research. By using primary and secondary research methods, we can carry out a thorough and comprehensive study while taking advantage of the most recent statistics and gaining a wide range of perspectives on the issue (Pal, 2017).

4.8 Data Analysis

Data analysis in research is a systematic process of inspecting, cleaning, transforming, and modeling data to discover useful information, draw conclusions, and support decision-making. It is a critical component of the research process that helps researchers make sense of collected data and extract meaningful insights.

According to Adi Bhat (2023), Data analysis in research is defined as the process of reducing large amounts of collected data to make sense of them. Its primary purpose is to:

- Reduce data to a manageable form
- Identify patterns and relationships within the data
- Interpret the data to derive insights
- Answer research questions or test hypotheses.

There are two common types of data analysis in research, qualitative and quantitative data.

The data analysis employed in this research is both quantitative and qualitative data analysis.

4.8.1 Qualitative Data Analysis

Since the data collected in this research is partly qualitative, it is essential to use both inductive and deductive content analysis approach to analyze such data.

Content Analysis is widely accepted and the most frequently employed technique for qualitative data analysis in research methodology. It can be used to analyze the documented information from text, images, and sometimes from physical items. It depends on the research questions to predict when and where to use this method.

Taking the point of view of this research paradigm, one can conclude that society, due to the limitation of perspectives and various insights that could be obtained from the research,

is often not viewed from a singular or objective angle. Qualitative content analysis involves a process designed to condense raw data into categories or themes based on valid inference and interpretation. This process uses inductive reasoning, by which themes and categories emerge from the data through the researcher's careful examination and constant comparison. But qualitative content analysis does not need to exclude deductive reasoning (Patton, 2002). Generating concepts or variables from theory or previous studies is also very useful for qualitative research, especially at the inception of data analysis (Berg, 2001). Determination of the meaning of the collected data is further made easier through social interactions, which gives multiple points of view on the opportunities and challenges of the adoption of FinTech in promoting financial inclusion.

The process of qualitative content analysis often begins during the early stages of data collection. This early involvement in the analysis phase helps to move back and forth between concept development and data collection and may help direct subsequent data collection toward sources that are more useful for addressing the research questions. To support valid and reliable inferences, qualitative content analysis involves a set of systematic and transparent procedures for processing data. The various stages of content analysis are data preparation which involves the transformation of data into written text before analysis can start; definition of the unit of analysis which is the basic unit of text to be classified during content analysis; development of categories and coding scheme, this can be derived from three sources: the data, previous related studies, and theories; testing of the coding scheme on a sample of text; coding of all the text; assess coding consistency; draw conclusions from the coded data; and finally, report the methods and findings.

Throughout the research process and while carrying out content analysis, the integrity of data has to be maintained, so that trustworthiness of the research is preserved. The information gathered in this research can be crucial in influencing the implementation of information systems engineering such as FinTech in promoting financial inclusion in the underbanked populations. In this research process, the researcher was able to remain keen and provide sufficient attention to details, and consequently, individuals who interact with this research afterward have the room to criticize it and review its credibility.

Coding of data by researchers allows understanding of the opinion and perspectives of the subjects, and this allows for easy analysis of the provided responses. In the context of this research, codes are established as the research progresses, and this is carried out based on data

gathered to achieve data analysis. Achieving coding of data can be carried out through a manual process or the use of qualitative data analysis software such as NVivo1 or ATLAS.ti. However, the researcher used the manual process option.

4.8.2 Quantitative Data Analysis

Data collected in this research is partly quantitative, therefore, quantitative correlational data analysis was also utilized for this study. Quantitative research methods are either descriptive (establishing associations between variables that are measured once) and experimental (establishing causality by measuring before and after a treatment) (Barbie, 2010). The goal of quantitative researchers is to identify and segregate specific variables in a study framework. They search for connection, associations, and causality, with an attempt to control the setting in which the data are collected. This is done to avoid the risk that variables other than the one being studied may account for the relationships identified. Quantitative methods have an objective approach to studying research problems, which may lead to results that are statistically significant but often humanly insignificant. This is because data are controlled and measured to address the gathering of facts to determine the causes of behavior (Anderson, 2010).

Quantitative research methods focus on measurements that are objective with statistical analysis or numerical data collecting. Data is gathered through different methods such as polls and questionnaires (Creswell, 2009). This approach is centered on gathering statistical data to generalize it across groups of people to give details on a particular phenomenon (Barbie, 2010). The relevance of the chosen Pearson Correlation coefficient is that it can be used to assess the correlation between FinTech adoption (e.g., number of FinTech startups, users, transactions) and financial inclusion indicators (e.g., account ownership, credit access).

Using quantitative analysis allowed more people to participate in the study and provided the opportunity to receive more responses from the stakeholders and other interest groups that have experience with FinTech practices in their domains. Correction Analysis tool in Microsoft Excel was used to run a Pearson's correlation coefficient test to find the relationship between FinTech adoption and financial inclusion. Denoted by r , Pearson's correlation coefficient is a measure of the strength of a linear association between two variables. This statistical test was best suited for this study because it measures the linear correlation between two variables X and Y. The three types of correlation that are identified are positive correlation, negative correlation, and no correlation. Positive correlation can be explained when an increase in one

variable leads to an increase in the other and a decrease in one lead to a decrease in the other. Negative correlation is when an increase in one variable leads to a decrease in another and vice versa (Neuman, 2003). No correlation is when a change in one variable does not lead to a change in the other and vice versa. A Pearson correlation coefficient varies between +1 and -1. A strong positive correlation is a value close to +1 and a strong negative correlation is value close to -1; if variables are uncorrelated a value near zero will be shown (Creswell, 2013).

4.9 Ethical Considerations

Ethical considerations remain at the forefront of the research. In particular, these ethical considerations are largely concerned with the primary research methods used in the study. Before the questionnaires are distributed to respondents, informed consent must be obtained through the informed consent form. Informed consent involves providing respondents with detailed information about the study, its purpose, and associated risks and benefits. As a result of the information they receive, participants are able to make informed decisions about whether to participate in the research or not. It is the participants' independence to withdraw from the research at any time during this research.

As part of the ethics considerations, it is indispensable to ensure that respondents' confidentiality is protected. To make sure that respondents' personal information is protected from unauthorized access, the researcher must ensure that no other individuals have access to it. In addition to improving trust in the researcher, meeting the objective improves the safety of the participants. It is also ethical to analyze and report data, and the researcher must ensure no misrepresentation of research information occurs. Data gathering and general information are crucial in providing solutions and influencing corporate decisions.

4.10 Chapter Summary

We discussed the significance of the outlined research methodology in this research chapter, which was defined as an approach that incorporates both primary and secondary research strategies to answer the research question. An overview of the research design and methods, data collection, including questionnaires. The level of impact FinTech adoption has in promoting financial inclusion is determined through quantitative correlational data analysis. This research was confounded by secondary sources, using data from old literature, searching databases through keywords, and analyzing data using content analysis theory. As a result, we

can conclude and identify the opportunities and challenges of FinTech adoption in promoting financial inclusion. By sharing their expert knowledge and experience, study participants also contributed to the answers to the research questions. Following this fourth chapter, we present the research study results and demonstrate how the methodology in this chapter was applied.

5. Chapter 5: Presentation of Findings and Analysis

5.1 Introduction

In the previous chapter, the research tools and methods were listed to answer the four research questions. Using primary data from the target respondents, this study examined the impact of FinTech adoption in promoting financial inclusion. A thorough evaluation of both primary and secondary data is crucial to the confirmation of research findings. The current chapter presents the research data in its raw form, using tables, schematics, and charts to illustrate the findings. Thus, it offers new research opportunities while mirroring real-life data characteristics. This will lead to better understanding and the decision-making process will be facilitated by visual representations. By using analytics, the data can be made more understandable. Furthermore, it helps in a variety of ways with understanding information, discovering patterns, and forming opinions.

To provide context for the data sets, shallow commentaries accompany them in order to prepare the reader for the in-depth discussion in chapter 6. There are two stages of data presentation - quantitative and qualitative. A quantitative data set was derived from the questionnaire responses of respondents. Thus, the quantitative data was analyzed using Microsoft Excel Analytics to perform in-depth statistical analysis. On the other hand, qualitative data sets were retrieved from old literature. The present study's qualitative data was analyzed using a content analysis approach, where vital viewpoints were isolated and described. There is a description of the analytical process under each subsection.

5.2 Quantitative Data Presentation and Analysis

In order to answer one of the questions of this research, we carried out a correlational study investigating the relationship between Financial Technology (FinTech) Adoption and Financial Inclusion in Nigeria.

The Purpose of the study is to determine if a relationship exists between FinTech adoption and Financial Inclusion in Nigeria, and if higher FinTech adoption correlates with increased financial inclusion among participants from various financial inclusion stakeholders.

5.2.1 Study Variables

- Independent Variable: FinTech Adoption (measured by frequency and ease of use of FinTech tools).

- Dependent Variable: Financial Inclusion (measured by accessibility to financial services and perceived impact on financial autonomy).

5.2.2 Study Participants

Our sample consists of 20 participants:

- 5 from Deposit Banks
- 5 from FinTech Startups
- 2 from the Central Bank of Nigeria
- 8 from Financial Inclusion Enthusiasts

5.2.3 Questionnaire

The questionnaire introduced captured both FinTech Adoption and Financial Inclusion.

The detail questionnaire can be seen in the Annex.

Each question is rated on a 5-point Likert scale, where:

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

5.2.4 Participant Demographics

The tables and figures below represent the demographics of the participants of the study. The entire population responded to our questionnaire, which enabled us to get the required data for the study.

Table 1: Distribution of Respondents by Age

		Age		
		Frequency	Percent	Valid Percent
Valid	18 - 30	7	35	25
	31 - 40	10	50	25
	41 - 50	2	10	10
	51 - Above	1	5	40
	Total	20	100	100

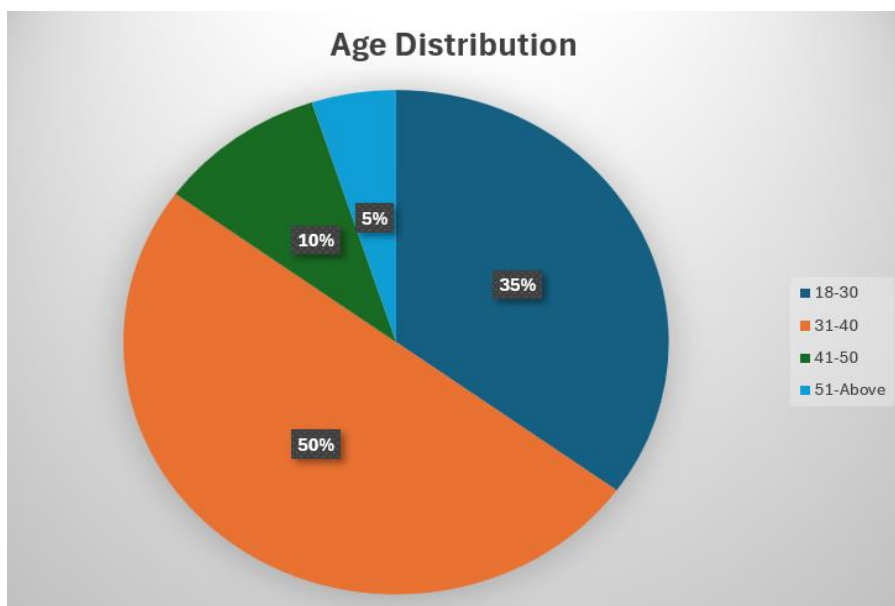


Figure 6: Distribution of Respondents by Age

Table 2: Distribution of Respondents by Gender

		Gender		
		Frequency	Percent	Valid Percent
Valid	Female	8	40	40
	Male	12	60	60
	Total	20	100	100

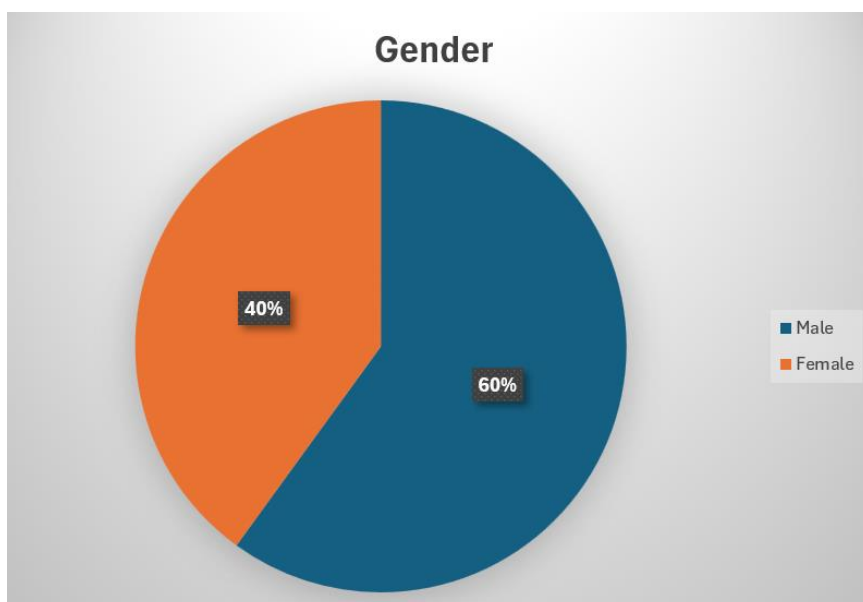


Figure 7: Distribution of Respondents by Gender

Table 3: Distribution of Respondents by Profession

Profession				
		Frequency	Percent	Valid Percent
Valid	Deposit Bank Employee	5	25	25
	FinTech Startup Employee	5	25	25
	Central Bank Employee	2	10	10
	Financial Inclusion Enthusiast	8	40	40
	Total	20	100	100

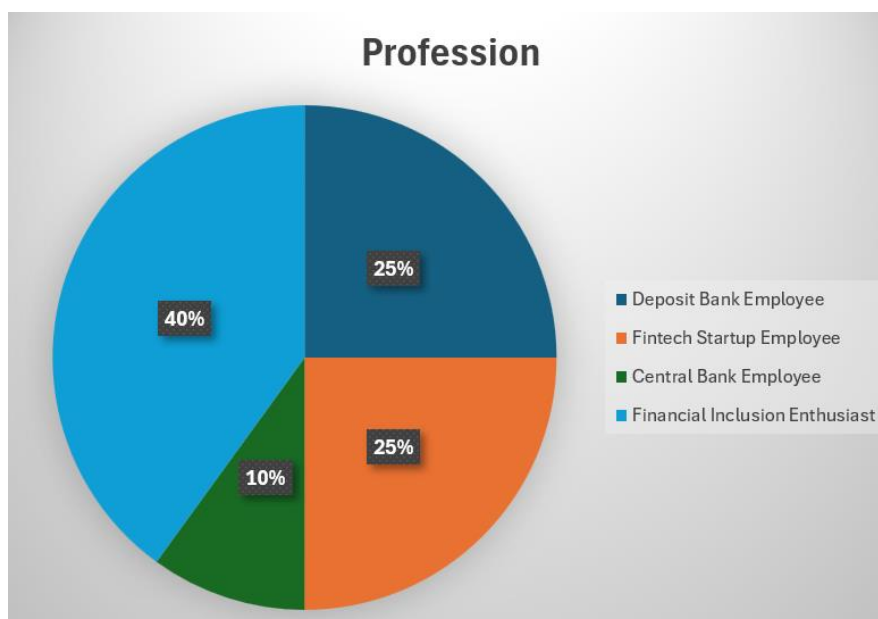


Figure 8: Distribution of Respondents by Profession

5.2.5 Data Computation

The process of data computation helps researchers comprehend the information gathered, test hypotheses, and draw conclusions based on the findings. The purpose of analysis is to identify patterns, relationships, and trends within raw data through logical reasoning and the use of various statistical and analytical techniques.

FinTech Adoption Responses

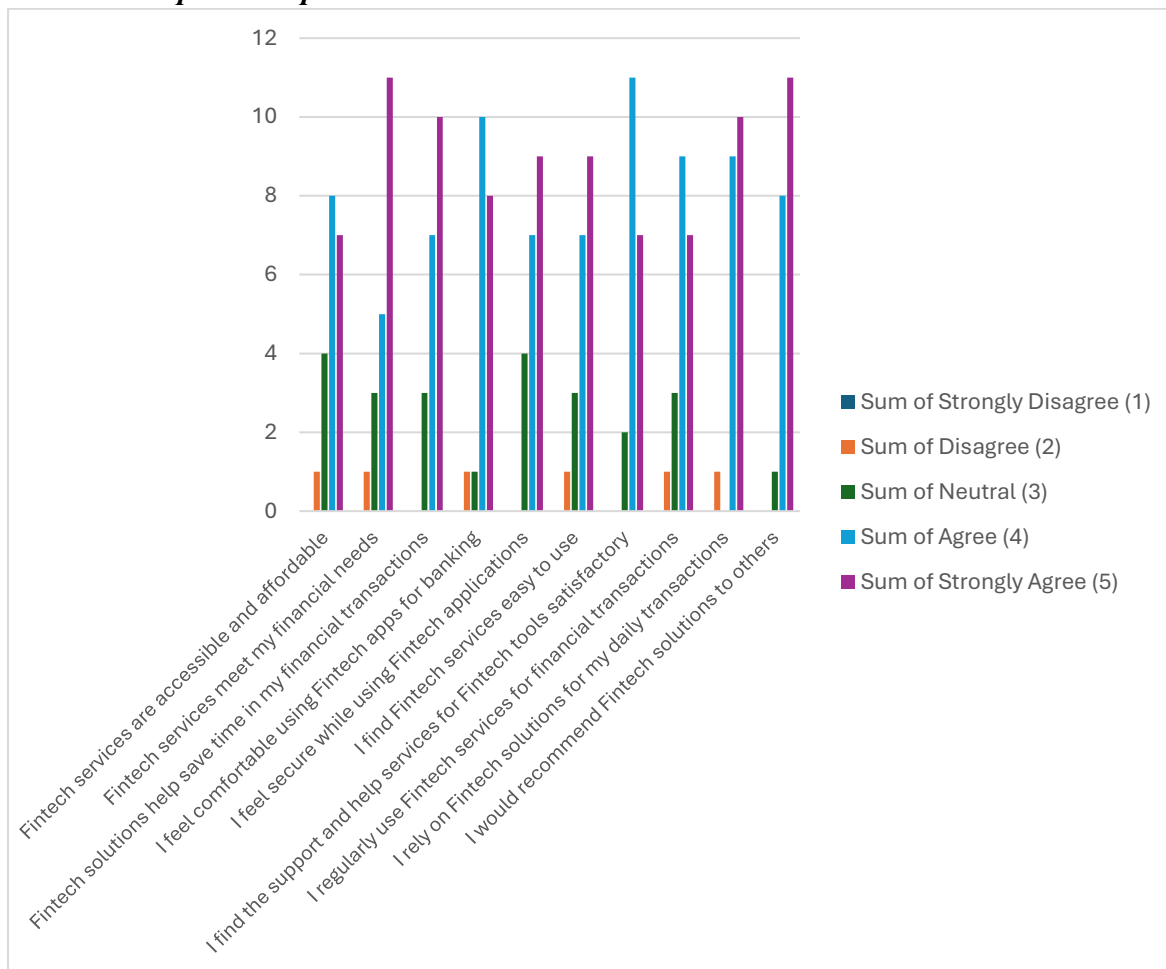


Figure 9: Presentation of Responses to FinTech Adoption Questions

Financial Inclusion Responses

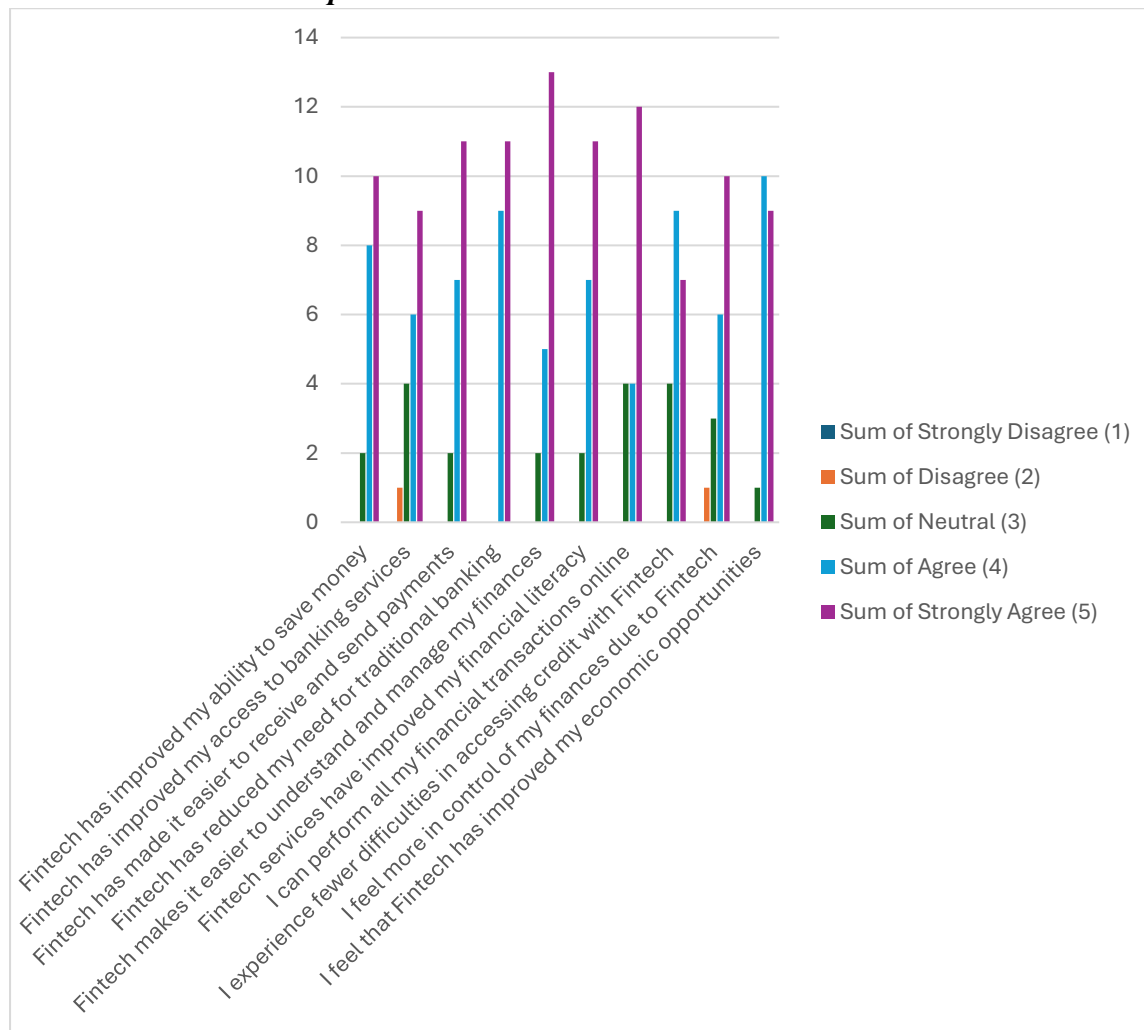


Figure 10: Presentation of Responses to Financial Inclusion Questions

The table below (table 4) represents the responses from the participants.

Table 4: Response from Participants

Participants	Questions																			
	FinTech Adoption										Financial Inclusion									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
A	4	4	3	4	4	5	4	3	4	4	3	4	5	4	3	4	4	5	5	4
B	5	4	4	5	4	4	5	4	5	5	4	5	4	5	4	5	5	4	5	5
C	3	3	3	5	3	4	3	5	3	4	3	4	3	5	3	5	3	5	4	3
D	4	4	4	5	4	5	3	4	5	4	4	4	4	4	4	4	4	4	4	4
E	4	5	4	4	4	5	5	4	5	4	5	4	3	5	3	5	4	4	5	5
F	5	2	5	3	5	4	5	5	4	5	4	5	5	5	4	4	5	4	5	5
G	4	4	4	5	4	3	5	4	4	5	4	5	5	4	5	4	5	5	4	4
H	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
I	4	5	4	4	5	4	4	5	4	4	5	3	4	4	5	4	5	4	5	4
J	5	5	5	5	4	4	5	3	5	4	5	5	5	5	5	5	5	5	5	5
K	3	3	3	3	4	5	5	4	3	5	3	3	4	4	4	3	4	5	3	5
L	2	4	2	4	2	4	2	4	5	2	2	2	5	5	4	3	3	5	3	5
M	5	5	5	5	5	5	5	5	5	5	5	5	3	5	5	4	5	5	5	5
N	4	4	5	4	5	5	4	4	4	5	4	5	5	4	4	4	4	4	4	4
O	3	3	3	3	5	5	3	4	3	4	4	3	5	4	3	5	4	3	5	3
P	4	5	5	4	4	5	5	4	5	5	5	4	5	4	4	5	5	4	5	5
Q	4	5	4	5	4	5	4	5	5	4	5	5	5	4	4	4	5	4	5	5
R	5	5	5	4	5	4	4	5	4	5	5	5	5	5	4	5	4	4	5	4
S	5	4	4	5	5	4	5	4	4	5	5	5	5	5	5	5	5	5	5	5
T	4	5	4	5	4	5	5	4	3	4	3	4	3	5	5	5	5	4	4	4

Calculation of the correlation between FinTech Adoption and Financial Inclusion:

- Computing Average Scores:** Calculating the average score for FinTech Adoption (Q1 - Q10) and Financial Inclusion (Q11 - Q20) for each participant.
- Calculating Correlation:** Using the Pearson correlation coefficient to determine the strength and direction of the relationship.

The following formula is used to compute the Pearson correlation coefficient between two variables, FinTech Adoption and Financial Inclusion:

$$r = (n\Sigma XY - \Sigma X \Sigma Y) / \sqrt{((n\Sigma X^2 - (\Sigma X)^2)(n\Sigma Y^2 - (\Sigma Y)^2))}$$

Where:

r = correlation coefficient

n = number of observations

ΣXY = sum of the product of each pair of corresponding observations of the two variables

ΣX = sum of the observations of the first variable

ΣY = sum of the observations of the second variable

ΣX^2 = sum of the squares of the observations of the first variable

ΣY^2 = sum of the squares of the observations of the second variable

The resulting correlation coefficient varies from -1 to +1, with -1 being a perfect negative correlation, +1 representing a perfect positive correlation, and 0 representing no correlation between the variables.

- Correlation coefficient can be used to determine which variables are significantly connected with one another and which are poorly correlated or not correlated at all. This information can be used to create forecasts and informed judgments based on the facts.
- Makes it easy and quick to see how the different variables are related. Variables that tend to go up or down together have high positive correlation coefficients. Variables that tend to go up or down in opposite directions have high negative correlation coefficients.
- It is important for finding patterns and relationships between variables. It can also be used to make predictions and decisions based on data. Low correlation coefficients show that the two variables don't have a strong relationship with each other

Table 5 below calculates the average score for FinTech Adoption (Q1 - Q10) and Financial Inclusion (Q11 - Q20) for each participant and also calculates the Pearson correlation coefficient generated using the Microsoft Excel CORREL function to determine the strength and direction of the relationship.

Table 5: FinTech Adoption and Financial Inclusion Average Scores

	(Q1 to Q10) Average	(Q11 to Q20) Average	
Participants	FinTech Adoption	Financial Inclusion	
A	3.9	4.1	
B	4.5	4.6	
C	3.6	3.8	
D	4.2	4	
E	4.4	4.3	
F	4.3	4.6	
G	4.2	4.5	
H	5	5	
I	4.3	4.3	
J	4.5	5	
K	3.8	3.8	
L	3.1	3.7	
M	5	4.7	
N	4.4	4.2	
O	3.6	3.9	
P	4.6	4.6	
Q	4.5	4.6	
R	4.6	4.6	
S	4.5	5	
T	4.3	4.2	
Fintech Adoption (Q1 to Q10) Total Average:			85.3
Financial Inclusion (Q11 to Q20) Total Average:			87.5
Correlation Coefficient:			0.84728

5.3 Qualitative Data Presentation and Analysis

Qualitative data was collected, analysed and used to address question two (2) of the research questions using content analysis methodology. Content analysis can be used to quantify the occurrence of certain words, phrases, subjects or concepts in a set of historical or contemporary texts (Amy Luo, 2022).

The table below (Table 4) outlines the key procedural steps for preparing content analysis:

Table 6: Procedural description of the content analysis process deployed in the study

S/N	Step	Description
1	Define research question	Formulate a clear, focused research question that content analysis can address.
2	Select content	Choose the texts, media, or materials to analyze based on your research question.
3	Determine sampling strategy	Decide how to sample from the selected content if analyzing all of it is not feasible.
4	Define units of analysis	Specify whether you will analyze words, phrases, sentences, themes, etc.
5	Develop coding categories	Create a coding scheme with categories relevant to your research question.
6	Create coding rules.	Establish clear rules and definitions for how to apply the coding categories.
7	Conduct pilot coding.	Test the coding scheme on a small sample and refine as needed.
8	Assess reliability	Check inter-coder reliability if multiple coders are used
9	Prepare data collection tools.	Set up spreadsheets, software, or other tools to record coding results.
10	Analyze the results and draw conclusions.	Once coding is complete, the collected data is examined to find patterns and draw conclusions in response to your research question.

Table 7: Systematic Categorization

Systematic Categorization of Content Analysis		
Main Category	Category	Sub-Category (Unit of Analysis)
Challenges of FinTech Adoption in Nigeria Underbanked Population	Infrastructural Deficiency (A)	Energy Supply Issues
		Telecommunication Infrastructure
		Limited Internet Access
		Interoperability and Integration
		Inadequate Cybersecurity Infrastructure
	Economic, Socio-Cultural and Regulatory Issues (B)	Cultural Resistance
		Security and Privacy Concerns
		Regulatory Uncertainty
		Consumer Protection Issues
		Compliance Issues
	Technology Distrust, Standards & Security Risks (C)	Data Interoperability and Standardization
		Cross-border Regulatory Coordination
		Scalability and Performance
		Lack of Universal Standards
		Cybersecurity Risks
		User Experience and Accessibility
	Development and Maintenance Costs	
	Low Literacy Level (D)	Digital Illiteracy
Financial Illiteracy		
Functional Illiteracy		
Cultural and Social Illiteracy		
Opportunities of FinTech Adoption in Nigeria Underbanked Population	Easy Financial Accessibility (E)	Increased Accessibility
		Affordability
		Simplified enrolment
	Transaction Efficiency (F)	Faster Financial Transactions
		Instant Account Status Update
		Lower Transaction Cost
		Increase Competition
	Innovation & Entrepreneurship (G)	Fostering Entrepreneurial Activities
		Promoting Technology Startups
		Acquisition of Skills in Technology Usage
		Encourages Digital Literacy
		Boost Technology Innovation
	Economic Growth (H)	Job Creation
		Economic Resilience
		Boost to the Banking Sector
Poverty Reduction		
Increase Financial Inclusion		

Table 8: Mapping of the Unit of Analysis (Challenges and Opportunities) to Category

Challenges & Opportunities Associated with the Adoption of FinTech in Driving Financial Inclusion in Nigeria											
		Challenges						Opportunity			
S/No.	Literature Title	Author	Reference Page	Infrastructural Deficiency (A)	Economic, Socio-Cultural and Regulatory Issues (B)	Technology Distrust, Standards & Security Risks (C)	Low Literacy Level (D)	Easy Financial Accessibility (E)	Financial Efficiency Transactions (F)	Innovation and Entrepreneurship (G)	Economic Growth (H)
1	Industry 4.0 in Finance, Digital Financial Services and Digital Financial Inclusion in Developing Countries: Opportunities, Challenges, and Possible Policy Responses.	Mpofu, F.Y. (2024)	125-126		X	X	X	X	X		X
2	Ogunode, O.A., & Akintoye, R.I. (2023). Financial Technologies and Financial Inclusion in Emerging Economies: Perspectives from Nigeria.	Ogunode, O.A., & Akintoye, R.I. (2023)	48-49	X	X	X	X	X		X	
3	Financial Inclusion in Rural and Urban Nigeria: A Quantitative and Qualitative Approach.	Soetan, T.O., & Umukoro, O.S. (2023)	75-78	X	X	X	X	X	X		X
4	Financial Technology as a Tool for Promoting Financial Inclusion in Nigeria.	Ezeocha, C.M. (2024)	178-179		X	X	X	X	X	X	X
5	The role of fintech in driving financial inclusion in developing and emerging markets: issues, challenges and prospects.	Ediagbonya, V., & Tioluwani, C. (2022)	110-114	X	X	X	X		X	X	X
6	ICT and Financial Inclusion in Nigeria: An Overview of Current Challenges and Policy Options	Jonathan E. Ogbuabor, et al. (2020)	92-94	X	X	X	X	X		X	
7	Technologies for Financial Inclusion in Nigeria. Emerging Markets Economics: Macroeconomic Issues & Challenges.	Wayne, T., Soetan, T.O., Bajepade, G., & Mogaji, E. (2020)	52-54	X	X	X	X	X	X	X	
8	Efficacy of Digital Finance on Financial Inclusion: Evidence from the Nigerian Banking Industry.	Enebeli-Uzor, S.E., & Mukhtar, A. (2023)	149-150	X	X	X		X			X

9	The Economic Forces Driving Fintech Adoption Across Countries.	Frost, J. (2020)	5-10	X	X	X					X
10	Advancing financial inclusion and technological innovation through cutting-edge software engineering	Odonkor, et al. (2024)	1323-1329	X	X	X	X	X		X	X
11	Financial Inclusion in Nigeria: Determinants, Challenges and Achievements.	Ozili, P.K. (2020)	8-12	X	X		X	X		X	X
12	Financial Inclusion Through Technology: A Review of Trends in Emerging Markets.	Falaiye, et al. (2024).	372-374	X	X	X	X			X	X
13	Leveraging Financial Technology: A Comparative Analysis of the Legal Readiness of Nigeria for Fintech Disruption Vis-A-Vis Other Jurisdictions	Iheanacho, N., & Oluwasemilore, I.A. (2021)	13-16		X	X		X			X
14	Can technology bridge the gap between rural development and financial inclusions?	Agwu, E.M. (2020)	9	X		X	X				X
15	Nigeria - Fostering Financial Inclusion through Digital Financial Services.	Wezel, T., & Ree, J.J. (2023)	14-17	X	X	X	X	X	X		
16	Bridging the Financial Divide: a Bibliometric Analysis on the Role of Digital Financial Services within FinTech in Enhancing Financial Inclusion and Economic Development.	Afjal, M. (2023)	25-26			X	X	X		X	X
17	Adopting FinTech to promote financial inclusion: Evidence from western African economic and monetary union.	Ahamadou, M., & Agada, D.B. (2023)	141 & 144		X	X		X	X		X
18	Advancing Financial Inclusion Through Fintech: Solutions for Unbanked and Underbanked Populations.	Adelaja, et al. (2024).	429-430	X	X	X	X			X	X
19	Digital Currency and Financial Inclusion in Nigeria: Lessons for Development.	Ekong, U.M., & Ekong, C.N. (2022)	62-64	X	X	X	X				
20	Financial Technology Financial Inclusion and MSMEs Financing in The Southwest of Nigeria.	Babajide, et al. (2020)	5-6	X	X	X	X			X	X
21	Financial Technology Solutions for Financial Inclusion: A review and future agenda.	Neelam, K., & Bhattacharya, S. (2022)	173-174	X		X	X		X	X	X

22	Unearthing antecedents to financial inclusion through FinTech innovations.	Senyo, P.K., & Osabutey, E.L. (2020)	12	X		X		X			
23	Digital Transformation in Banking: a Review of Nigeria's Journey to Economic Prosperity	Lottu, et al. (2023)	228-231	X	X	X	X	X			X
24	Fintech and financial inclusion in developing countries.	Adjasi, C.K., Hamilton, C., & Lensink, R. (2022)	303-304	X	X				X	X	
25	An Evaluation of the Effectiveness of Digital Financial Service (DFS) in Promoting Financial Inclusion (FI) among Low-Income Households.	Mela, S.L. (2024)	1577			X	X	X			X
Total Frequency				17	20	23	19	16	9	13	18

5.3.1 Statistical Findings

In order to measure the category that aggregate the most critical challenges and opportunities in the adoption of FinTech for financial inclusion in Nigeria, 25 literatures were examined to answer two of the questions of this research. The frequency of the category as specified by the authors (see table 9) was derived.

Table 9: Categories of Challenges & Opportunities and their Frequencies

	Challenges				Opportunity			
	Infrastructural Deficiency (A)	Economic, Socio-Cultural and Regulatory Issues (B)	Technology Distrust, Standards & Security Risks (C)	Low Literacy Level (D)	Easy Financial Accessibility (E)	Financial Efficiency Transactions (F)	Innovation and Entrepreneurship (G)	Economic Growth (H)
Frequency	17	20	23	19	16	9	13	18

Under the challenges, Category A scores 17; Category B scores 20; Category C scores 23; and Category D scores 19.

Under the opportunities, Category E scores 16; Category F scores 9; Category G scores 13 and Category H scores 18.

Figures 9 and 10 below depict the graphical representation of their outcome:

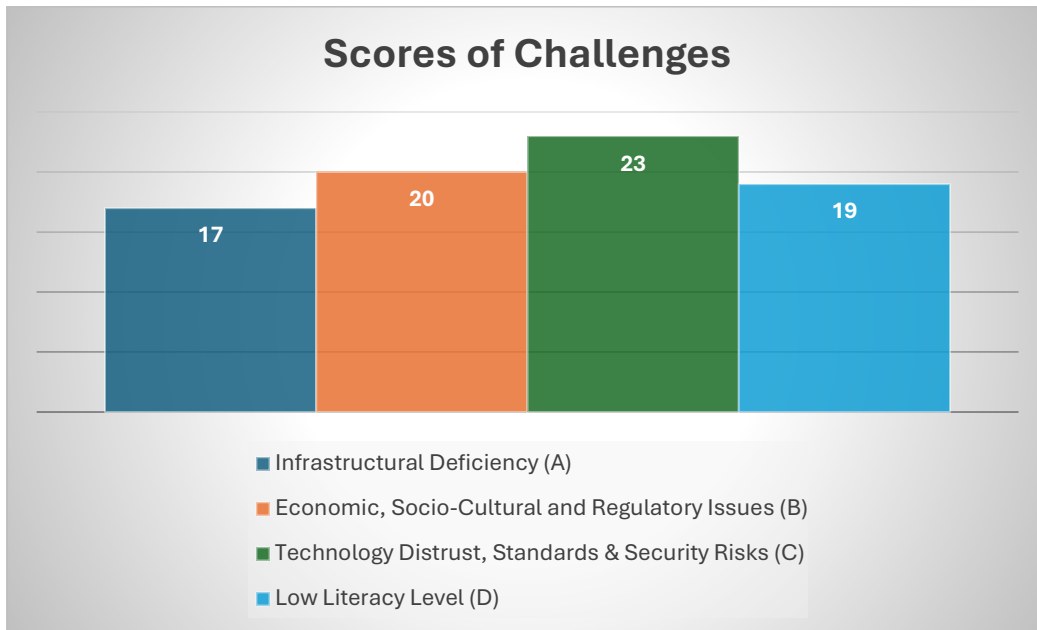


Figure 10: Categories of FinTech Challenges for Financial Inclusion in Nigeria

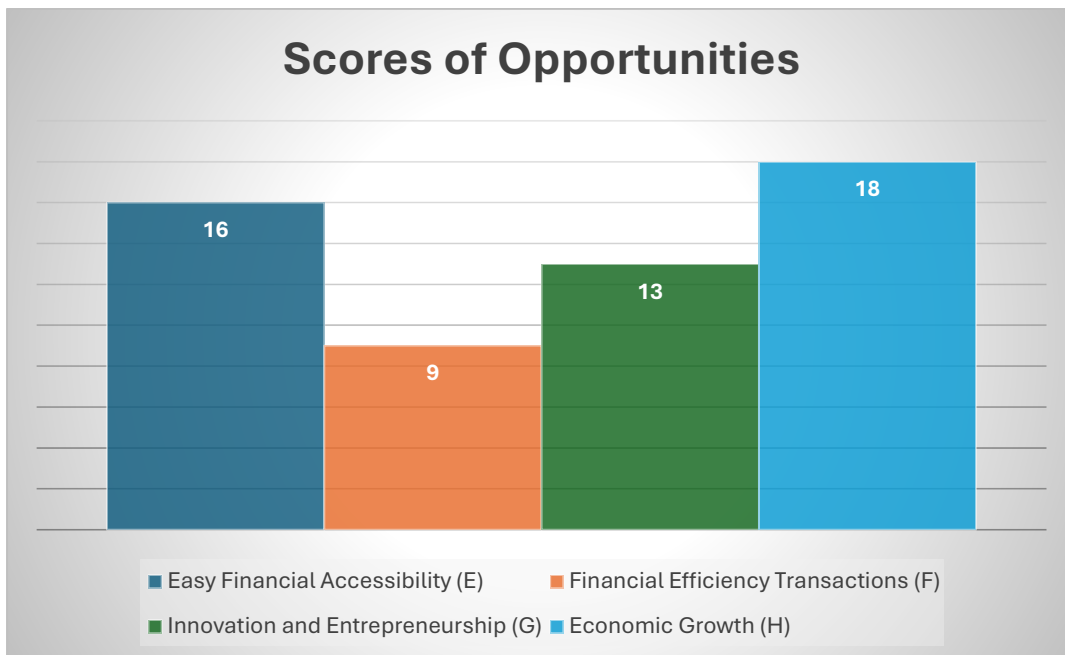


Figure 11: Categories of FinTech Opportunities for Financial Inclusion in Nigeria

5.4 Quantitative Interpretation of Results

Study findings are summarized and presented according to the key deliverables posed at the beginning of the study. Using this method enhances fluidity and coherence between the findings and the research objectives as well as helping to give answers to the research questions.

5.4.1 Introduction

The relationship between FinTech adoption and financial inclusion in the underbanked population of Nigeria is a critical area of study, especially considering the rapid growth of financial technology (FinTech) solutions in developing economies. The underbanked population refers to individuals who have limited access to traditional banking services, often due to geographical, financial, or infrastructural barriers. FinTech adoption, encompassing digital financial services such as mobile money, peer-to-peer lending, and digital wallets, has emerged as a promising solution to bridge this gap and promote financial inclusion, defined as the access to and usage of a wide range of financial services that meet the needs of individuals and businesses.

Given this backdrop, Pearson's correlation analysis was conducted to explore the relationship between FinTech adoption and financial inclusion in Nigeria's underbanked population. The purpose was to determine whether a statistically significant association exists between the extent of FinTech adoption and the level of financial inclusion among this demographic.

5.4.2 Overview of the Statistical Method

The Pearson correlation coefficient (denoted as r) is a measure of the linear relationship between two variables. The value of r ranges from -1 to +1, where:

$r = 1$ indicates a perfect positive correlation,

$r = -1$ indicates a perfect negative correlation, and

$r = 0$ indicates no correlation.

In this case, the correlation coefficient was calculated using Microsoft Excel's CORREL function, yielding a result of $r = 0.84728$. This value represents a strong positive linear relationship between FinTech adoption and financial inclusion in Nigeria's underbanked population. This result suggests that as FinTech adoption increases, financial inclusion among the underbanked also tends to increase, and vice versa.

5.4.3 Interpretation of the Correlation Coefficient

The calculated Pearson correlation coefficient of 0.84728 falls within the range that suggests a strong positive correlation:

- A correlation of 0.8 to 1.0 typically indicates a strong positive relationship between the two variables.
- This result suggests that the two variables - FinTech adoption and financial inclusion are highly positively correlated. In practical terms, it implies that higher levels of FinTech adoption are associated with higher levels of financial inclusion in the underbanked population of Nigeria.
- FinTech services such as mobile money, digital payments, and blockchain-based financial products have the potential to significantly improve access to financial services for individuals who have traditionally been excluded from the formal banking system.
- With an average FinTech adoption value of 85.3 and an average financial inclusion value of 87.5, it can be inferred that the widespread uptake of digital financial tools can effectively enhance financial inclusion in this population, particularly in rural or underserved areas where traditional banking infrastructure is lacking.

5.5 Qualitative Interpretation of Results

5.5.1 Challenges Hindering Widespread FinTech Adoption in Nigeria

Looking at the presentation in figures 10 and 11 representing content analysis outcome of old literature regarding the challenges faced in the adoption of Financial Technology (FinTech) in an underbanked economy of Nigeria, a comprehensive interpretation of the results follows:

With reference to figure 10, these scores represent the relative importance or frequency with which each challenge was discussed in the reviewed literature on FinTech adoption in Nigeria.

Technological Distrust, Standards & Security Risks : Technological distrust, along with concerns over standards and security risks, is the most significant challenge to FinTech adoption in Nigeria, with the highest score of 23. This suggests that users are highly concerned about the trustworthiness of digital financial platforms. Common issues like fears of fraud, cybersecurity breaches, and data privacy could deter people from embracing FinTech solutions.

Additionally, the lack of clear standards for FinTech products in Nigeria may create uncertainty around the safety and quality of these services.

Economic, Social-Cultural, and Regulatory Issues : The second highest score of 20 in economic, social-cultural, and regulatory issues reveals that these challenges also play a major role in hindering FinTech adoption. This category encompasses barriers such as economic constraints which relates to the cost of internet data, mobile phones, and electricity may limit the ability of certain segments of the population to use FinTech services. Another factor is social and cultural factors which include traditional attitudes towards banking and skepticism about digital platforms. Furthermore, the existing legal and regulatory frameworks are insufficient to support FinTech innovations, creating obstacles for both service providers and consumers.

Low Literacy Level : Low literacy levels, scoring 19, indicate that many potential users may not have the necessary knowledge to navigate FinTech platforms. This barrier is particularly important in an underbanked economy like Nigeria, where a significant portion of the population may lack basic literacy skills or experience with digital technologies.

Infrastructural Deficiency : Infrastructural deficiencies, which received the lowest score of 17, still represent a significant challenge to FinTech adoption, though it's less prominent than issues like technological distrust. This category likely includes: 1. Poor Internet connectivity in many areas, especially rural regions, suffer from limited access to stable internet connections, which is essential for accessing digital financial services. 2. Unreliable electricity where power outages are common in many parts of Nigeria, preventing users from consistently accessing FinTech services. 3. Limited mobile device penetration: Not everyone has access to smartphones or devices that support FinTech applications.

5.5.2 Opportunities of FinTech Adoption in Developing Underbanked Economy

A comprehensive interpretation of the findings regarding the opportunities in the adoption of Financial Technology (FinTech) in an underbanked economy of Nigeria, is taken according to category in figure 9 above and explore its significance. The scores reflect the frequency or importance as depicted in figure 11 of each opportunity identified in the reviewed literature using content analysis methodology.

These scores suggest how often each opportunity was highlighted in the literature, with Category H (Economic Growth) being the highest, followed by Category E (Easy Financial

Accessibility), Category G (Innovation and Entrepreneurship), and Category F (Financial Efficiency Transactions).

Economic Growth : The score of 18 in Economic Growth suggests that the adoption of FinTech is viewed as a significant driver of economic development in Nigeria. FinTech adoption can stimulate job creation, investment opportunities, and increased economic participation in underserved communities. This is especially important in an underbanked economy like Nigeria, where many people are excluded from the formal financial system.

Easy Financial Accessibility : The score of 16 for Easy Financial Accessibility highlights that FinTech can significantly improve financial inclusion in Nigeria, especially for unbanked and underbanked populations. By providing easy access to mobile payments, digital wallets, and online lending, FinTech platforms make financial services accessible without the need for physical bank branches, Innovation and Entrepreneurship

The score of 13 in Innovation and Entrepreneurship suggests that FinTech adoption opens up opportunities for innovation and entrepreneurship in Nigeria. The FinTech sector itself can become a hub for startups, offering innovative products and services that address Nigeria's unique financial challenges (e.g., mobile payment solutions, remittances, lending platforms).

Financial Efficiency Transactions : The score of 9 for Financial Efficiency Transactions indicates that while transaction efficiency is an opportunity, it is viewed as a less prominent benefit compared to other opportunities such as economic growth or accessibility. Nonetheless, FinTech can significantly improve the efficiency of financial transactions by making payments faster, reducing transaction costs, and improving transparency in financial systems.

5.6 Findings of the FinTech-Driven FI Program's Case Study in Kenya

Below is the summary of the findings in session 3.3.1 Case Study of M-Pesa programme in Kenya:

- **Empowering the Unbanked:** Prior to M-Pesa, a large portion of Kenya's population did not have access to traditional banking services. According to a 2021 report by the World Bank, 80% of Kenyan adults now have access to formal financial services, largely due to M-Pesa. The program has provided a means for millions of unbanked Kenyans to send and receive money, save, and even take loans, all via mobile phones.
- **Branchless Banking:** M-Pesa uses a network of agents instead of brick-and-mortar bank branches, which makes financial services accessible even in remote areas. This

branchless model cuts operational costs and allows for a more flexible and scalable approach to banking.

- *Creating Jobs:* M-Pesa has created millions of jobs, not only for agents and retail employees but also for entrepreneurs who use M-Pesa to run businesses. The ability to accept mobile payments has facilitated new business models, such as mobile-based micro-entrepreneurship.
- *Supporting Small and Medium Enterprises (SMEs):* M-Pesa has helped SMEs thrive by providing a fast, secure, and inexpensive way to conduct transactions. Small business owners no longer have to rely on cash, which can be risky and inefficient, especially in rural areas.
- *Domestic and International Remittances:* M-Pesa has made remittances easier and cheaper. Families in rural Kenya no longer have to rely on expensive and slow traditional money transfer services. The system has also expanded to include international remittances, allowing Kenyan diaspora communities to send money back home quickly and with low fees.
- *Direct Cash Transfers:* M-Pesa has been used in government social welfare programs, where direct cash transfers are made to beneficiaries via their mobile phones. This has increased transparency and efficiency in disbursement, reducing corruption and administrative costs.
- *M-Shwari:* One of the groundbreaking innovations built on the M-Pesa platform is M-Shwari, a mobile banking product that allows users to save and borrow money directly from their mobile phones. M-Shwari has brought millions of Kenyans into the formal financial system, offering savings accounts and micro-loans with minimal documentation and no physical bank visits.
- *Lending and Microfinance:* With services like M-Kopa, M-Pesa has enabled people to access financing for solar energy systems and other goods through pay-as-you-go models. This has provided affordable financing options for people in rural areas, contributing to sustainable development.

5.7 Design Considerations for AI-Powered Language and Voice Apps for FinTech

This design consideration is towards a tailored AI language and voice design to Address the needs of low literacy users' population and in providing digital access to financial services.

There are several design features to consider when creating a voice or language-based application powered by AI. Design strategies need to align with users' needs and capabilities to make their interactions as natural as possible. Additionally, applications should include support for built-in text-to-speech, screen readers, and consider captioning. In terms of language support, multilingual applications allow for a larger user base by considering the suitability of output features, font, and costs of translation. For voice-based applications, systems should support speech recognition, synthesis, and identity verification, although agents can be designed as voice-only or to use voice as the primary mode of input, with a protocol for switching to text input if required (Kabir et al., 2021). Inclusive feature development must begin with usability testing and continue as the product evolves. The product must be designed for ease of use and usability from coding for development to interaction for use. Systems with trainable NLP modules can be developed with speech recognition tools and integrated spoken language model APIs in the first phase, with more automation for the end user in the second phase using a trainable module, and a more conversational protocol for the third phase (Nizzad and Thelijjagoda, 2022). Usability is important as the integration of AI capabilities is designed to enhance but not complicate the user's experience. Feedback from the various conversational protocols led to recommendations including ensuring dialogue systems designed with the user in mind, testing using the pairwise user study to establish a baseline and integrating natural language input and output into the end-to-end model for a low-fidelity training methodology. In terms of the design and testing of language applications, three frameworks to consider are: User-Centered Design, Interaction Design, and User Experience (Samrgandi, 2021). Integrated and iterative design methodologies include Participatory Design, Progressive Testing, and Card Sorting. Additional considerations for the applications include aesthetics and engagement, display and spoken output, protocol for simple functionality, and the positioning and display of activities. User-centered Design is a design and test methodology ideal for adjusting artificial intelligence-based dialogue system capabilities. Essentially, the underlying organization of our keywords, and therefore categories, mimics the standard workflow for User-centered Design in developing an artificial intelligence-based dialogue system using machine learning (Schmidt et al., 2024).

6. Chapter 6: Conclusion

6.1. General Discussions

6.1.1 Introduction

This chapter deliberates the research findings presented in the previous chapter. In finding the relationship between FinTech adoption and financial inclusion in the underbanked population of Nigeria which refers to the first question of the research, a quantitative research methodology was adopted, and Pearson's correlation analysis was used.

In trying to answer the question that concerns the opportunities and challenges confronting the adoption of FinTech in promoting financial inclusion in Nigeria, we compare the data with extant literature to infer new viewpoints. This way, the current research data is interpreted to achieve one of the main aims of the study, which was to investigate the opportunities and challenges in the adoption of FinTech in promoting financial inclusion in the underbanked populations of Nigeria and other developing economies.

This chapter also deliberates on the findings regarding the investigation through case-study of the success story of a FinTech-driven program in Kenya that can be copied or adopted by other underbanked populations in other countries. This case study helped in achieving one of the objectives of this study. Furthermore, detail insights have been presented regarding AI-Assisted design pattern in developing language and voice applications for FinTech solution targeting users with low literacy level.

6.1.2 *Relationship Between FinTech Adoption and Financial Inclusion in Nigeria*

The result of our quantitative analysis gave a Pearson correlation coefficient of 0.84728 which provides strong evidence that there is a robust positive relationship between FinTech adoption and financial inclusion in Nigeria's underbanked population. This result aligns with the growing body of research suggesting that digital financial services are playing a crucial role in overcoming traditional barriers to financial inclusion in emerging economies. The findings underscore the potential for FinTech to be a transformative tool in improving access to financial services for marginalized populations, thus fostering economic inclusion and empowerment. Therefore, this quantitative study has provided answer to the first question of the research questions. This interpretation has also met the objective of how FinTech solutions adoption can promote financial inclusion in Nigeria. Future research could explore the causal dynamics

between these two variables, as well as the role of other socio-economic factors, to develop more nuanced strategies for promoting financial inclusion in underbanked populations.

6.1.3 Challenges and Opportunities of the Adoption of FinTech in Promoting Financial Inclusion in Nigeria

The findings of the challenges of FinTech adoption in Nigeria (Session 5.5.1), reveal that technological distrust and security concerns are the most significant challenges, followed closely by economic, social-cultural, and regulatory issues. Low literacy levels and infrastructural deficiencies also play important roles in hindering the widespread use of digital financial services. Addressing these challenges will require a multifaceted approach involving security enhancements, regulatory reforms, financial literacy programs, and significant infrastructure improvements. This interpretation of findings has helped us to partly give answer to questions two (2) of the research questions.

In continuation of the research in identifying the opportunities in the adoption of FinTech solution in Nigeria (Session 5.5.2), indicate that economic growth is the most significant opportunity in adopting FinTech in Nigeria, followed by easy financial accessibility, innovation and entrepreneurship, and transaction efficiency. The adoption of FinTech offers a pathway to enhancing financial inclusion, promote innovation, reduce transaction costs, and drive economic development in Nigeria. To fully realize these opportunities, policymakers should focus on creating an enabling environment for inclusive financial services, fostering entrepreneurship, improving transactional efficiency, and supporting job creation within the FinTech sector. These findings have completed the answer to question two of the research questions.

6.1.4 Exploration of Case-Study of a Successful FinTech-Driven Financial Inclusion Programs in Developing Economy

M-Pesa program in Kenya has proven to be a powerful tool for financial inclusion, economic development, and social impact. By making financial services more accessible, affordable, and convenient. It has transformed the lives of millions in Kenya. For other countries, especially those with large unbanked populations or lacking robust banking infrastructure, the M-Pesa model offers a promising solution. Copying or adapting the M-Pesa program can help foster

financial inclusion, stimulate economic growth, reduce poverty, and improve overall development in countries around the world.

6.1.5 Exploring Tailored Language and Voice Application Design Targeting Low Literacy Users population

Designing language and voice software for low-literacy populations can significantly advance financial inclusion by addressing accessibility and usability challenges. Here are several ways FinTech solutions can benefit from such designs (Session 5.7):

Simplified User Interfaces: the use of visual cues, by using intuitive icons, images, and animations to guide users through processes without relying on extensive text; Voice-Driven navigation that complement text-based navigation with voice commands and instructions; Localized languages which support multiple local dialects and languages to reach broader demographics.

Voice Assistance: Conversational AI, by developing AI-driven voice assistants to help users perform tasks like money transfers, account inquiries, and loan applications; Step-by-Step Guidance which uses voice prompts to walk users through complex processes, ensuring clarity and confidence in their transactions; Accessible Help, by offering 24/7 voice support for troubleshooting and inquiries.

Audio-First Interaction: Transaction Confirmations, which is the use of voice to confirm transactions, ensuring users understand the actions they are taking; Learning Modules that provides audio tutorials and guides on financial literacy topics, like saving, budgeting, and using digital wallets.

Security and Authentication: Voice Biometrics - implement voice-based authentication to simplify login and reduce reliance on text passwords or PINs; Fraud Alerts - use audio alerts to warn users about suspicious activities or transactions.

Contextual Awareness: Adaptive Language Levels – this has to do with tailor responses based on user preferences and past interactions to ensure comprehension; Personalization, which allow users to choose preferred languages, tone (formal/informal), and level of detail.

Offline Accessibility: Pre-Recorded Messages which uses pre-recorded voice messages for users in areas with poor connectivity; USSD and IVR Systems, which Combine voice guidance with text-free USSD or Interactive Voice Response (IVR) systems for basic financial services.

Feedback Loops: Interactive Surveys, the use of voice interfaces to collect feedback on user experiences and improve services; Iterative Design - test solutions extensively with target populations to refine language, tone, and functionality.

By leveraging these strategies, FinTech companies can reduce barriers to entry, foster trust, and empower low-literacy populations to participate in the digital economy, driving broader financial inclusion.

7. Chapter 7: Recommendations and Future Works

7.1 Recommendations

Effective promotion of FinTech adoption for financial inclusion will not be realized by deploying several strategies in silos (Jameaba, 2020). Hence, the researchers recommend that relevant stakeholders such as the government, private sector, and civil societies, especially financial inclusion promotion organizations, need to initiate interinstitutional synergies in exploring guiding principles targeted at catalyzing the adoption of FinTech applications among Nigerians. Based on the findings of this study, the FinTech adoption ecosystem should consider the following recommendations as part of consummating intervention programs that will aim at the enhancement of financial inclusion through FinTech. The demand-side user education and trust-building should be operationalized through the following strategy for marginalized individuals and communities who lack the discretionary income to be absorbed as FinTech adopters. The existing digital divide is adversely affecting people with disabilities and, therefore, may lead to further exclusion of the group. Government, FinTech providers, and financial inclusion implementers must develop collaborative initiatives to provide e-services, including financial ones, that have been designed and developed in line with the goal of promoting e-inclusion and non-discrimination of marginalized groups. Currently, there is no one-size-fits-all approach being implemented to respond to the needs of different groups of people with disabilities, as the nature of the disability and past experience with financial exclusion may vary. Plans for interventions to promote FinTech with persons with disabilities would be more effective if they are oriented to targeted groups. There is a need for an awareness creation campaign on FinTech providers to sufficiently inform and convince Nigerians about financial products and services that are obtainable in the FinTech ecosystem. To boost the confidence of users in carrying out their financial activities and transactions through FinTech, providers are encouraged to consciously drive innovation by investing in technology operations or collaborating with entities with technological capacities for quality service delivery.

7.1.1 *Regulatory Framework and Policy Recommendations*

Collaboration and dialogue among regulatory bodies, financial services players, international institutions, and FinTech companies to develop an appropriate regulatory framework for digital financial services should be built upon. Dialogue sessions between the authorized officials for financial services regulators and FinTech providers should be established as a means of

foreseeing future threats and opportunities of FinTech; and anticipate adaptation of the existing regulations or create new ones for further adoption and implication of the disruptive technologies. Adopting international best practices and contextualizing them to the Nigerian context is in the best interest of the nation and can foster innovation that will lead to broader financial inclusion. Encourage dialogue and efforts among the concerned actors in creating the appropriate environment for FinTech adoption. Regulatory bodies should focus more on encouraging FinTech in the country instead of forcing their way, as such a move will further push Nigerian FinTech developers to seek opportunities in other more friendly environments. Regulatory frameworks for FinTech in Nigeria should compromise between the much-needed customer protection and security, and encouraging creativity and innovation in the FinTech industry.

7.1.2 Collaboration and Partnerships

Collaboration and partnership is one of the strategies that can drive faster adoption of FinTech. It is collaboration between multiple entities. When sectors come together, they can come up with comprehensive solutions as partners think of solutions that range beyond their specialties. Various stakeholders can drive collaboration, such as public sector institutions including regulators and policymakers; corporates; individuals; cooperatives; and non-governmental organizations. Large corporations such as telecommunication companies are already driving financial inclusion in collaboration with other sectors.

It is prudent to mention that partnerships should be driven by a shared vision, shared goals, or objectives. There is a need for established institutional arrangements or a legal basis for partnerships, as parties should have committed resources, time, and effort towards partnerships. Furthermore, individual stakeholders should be prepared to learn from each other in order to sustain relationships, as partners need each other's survival. It should be an open partnership where no party is a leader. Collaboration between government, the private sector, and the development sector is required to drive the FinTech agenda for effective financial inclusion. Cross-sector collaborations can drive a change that no single player can achieve on their own. The establishment of forums and networks would encourage the sharing of information about successful and failed partnerships and other collaborations (Aulia et al., 2024). Coordination and links should be established between such forums and other networks that are involved in FinTech developments to ensure that knowledge is shared, and new opportunities are explored.

7.1.3 Infrastructure Development and Connectivity

This calls for a focus on the blended development of infrastructure in urban and rural areas to ensure that financial services rendered by FinTech reach the unbanked and prospective clients there as easily as they are delivered to urban customers. We propose that since power is a critical infrastructure of any type, it should be ventured into to aid increased use of digital facilities in Nigeria.

7.1.4 Capacity Building and Education Initiatives

It is critical for educational institutions, particularly in Nigeria, to begin to add elements of financial technologies to their curricula and to expose students to real-world business plans and problem-solving pitches. Those who want to develop, create, and own FinTech systems, including financial services and products, should be considered. Furthermore, public awareness is critical because a lack of understanding by the general population benefits existing financial institutions, who will step up marketing to scare people away from FinTech with uncertainties and negative stories.

7.2 Suggestions for Future Works

The findings and insights from this research have illuminated the critical need for innovative solutions to drive financial inclusion, particularly among the low-literacy populations in underbanked economies like Nigeria. Future research should focus on developing a technical and digital framework for building multilingual and voice-enabled mobile applications tailored to this demographic. Below are key areas where future work could provide significant contributions:

- **Multilingual and Localized Interfaces:** Future work should explore the integration of multiple local languages into mobile financial applications. The diversity of languages spoken in Nigeria and other underbanked regions poses a unique challenge that requires comprehensive research into effective localization strategies. This includes studying user preferences, cultural nuances, and language-specific technical constraints to ensure accessibility and usability.
- **Voice-Enabled Technology for Low Literacy Users:** Voice-enabled functionalities could bridge the literacy gap by allowing users to interact with financial applications through speech. Research should focus on developing robust voice recognition algorithms that can accurately interpret various accents, dialects, and speech patterns

common in the target demographic. Additionally, implementing text-to-speech features in local languages could further enhance usability.

- **Technical Framework Design:** A robust technical framework must underpin the development of such applications. Future studies should examine best practices for creating scalable, secure, and efficient architectures that support real-time data processing, offline capabilities, and seamless integration with existing financial systems. Emphasis should be placed on lightweight solutions to ensure compatibility with low-cost mobile devices.

By addressing these areas, future research can play a pivotal role in empowering low-literacy populations to participate actively in the financial inclusion ecosystem, ultimately driving socio-economic development in underbanked economies like Nigeria.

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Appendices

Questionnaire on Driving Financial Inclusion through the Adoption of Financial Technology (FinTech)

A – Basic Personal Information Questions

1. **Gender ***

Mark only one oval.

- Man
 Woman

2. **Age ***

Mark only one oval.

- 18 - 20
 21 - 25
 26 - 30
 31 - 40
 41 - 50
 51 - 60

3. **Profession ***

Mark only one oval.

- Deposit Bank Employee
 Fintech Startup Employee
 Central Bank Employee
 Financial Inclusion Enthusiast

B - Fintech Adoption Questions

1. I regularly use Fintech services for financial transactions. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

2. I find Fintech services easy to use. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

3. Fintech services are accessible and affordable. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

4. Fintech solutions help save time in my financial transactions. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

5. I feel comfortable using Fintech apps for banking. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

6. I would recommend Fintech solutions to others. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

7. Fintech services meet my financial needs. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

8. I find the support and help services for Fintech tools satisfactory. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

9. I feel secure while using Fintech applications. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

10. I rely on Fintech solutions for my daily transactions. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

C - Financial Inclusion Questions

11. Fintech has improved my access to banking services. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

12. I feel more in control of my finances due to Fintech. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

13. I can perform all my financial transactions online. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

14. Fintech has reduced my need for traditional banking. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

15. I experience fewer difficulties in accessing credit with Fintech. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

16. Fintech has improved my ability to save money. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

17. Fintech has made it easier to receive and send payments. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

18. I feel that Fintech has improved my economic opportunities. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

19. Fintech makes it easier to understand and manage my finances. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

20. Fintech services have improved my financial literacy. *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree