

Leveraging Blockchain, Artificial Intelligence, And Fintech for Financial Inclusion and Economic Growth in Emerging Markets

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Abstract

This study delves into how blockchain, artificial intelligence (AI), and financial technology (FinTech) can complement one another to propel inclusive banking with regard to emerging economies like Nigeria. It examines how the convergence of these technologies has the potential to improve the provision of service, lower costs of operation, improve financial inclusivity, and improve security in the financial industry. The research also investigates how AI can be leveraged to make informed decisions based on data, how blockchain technology can provide transparency and immutability, and how FinTech platforms can provide underbanked and unbanked people with easily accessible alternatives to conventional financial services. Even though it brings advantages, the convergence also comes with devastating drawbacks, such as issues of data privacy, ethical dilemmas when using AI, scalability constraints of blockchain, cybersecurity threats, and unclear regulations. This paper identifies critical risks and offers strategic suggestions to financial institutions, technology disruptors, and policymakers based on a thorough conceptual analysis and review of the literature over the last few years. These include investing in digital infrastructure, encouraging ethical AI activities, improving regulatory environments, and creating public-private partnerships. The study concludes that although this intersection of these technologies has enormous potential for fueling inclusive finance, their use will need a balanced approach combining innovation with effective governance, moral protection, and human-centered design. Developing strong, accessible, and inclusive financial systems can be expedited by the synergy of blockchain, artificial intelligence, and fintech if harnessed correctly.

Keywords: *Blockchain Technology, Artificial Intelligence, FinTech, Financial Inclusion, Unbanked and Underbanked Population.*

1.0 Introduction

The financial sector is being transformed through the convergence of Blockchain, AI, and Fintech, providing innovative ways of increasing financial inclusion (Morkunas, Paschen, & Boon, 2019). The goal of inclusive finance is to extend financial services to excluded groups, and through this convergence, new paths have been made available for achieving that (Kumar et al., 2020). Yet another major driver of economic growth and poverty alleviation is inclusive finance (CGAP, 2018). Despite being vital, most people on the planet still cannot access essential financial services (World Bank, 2020). Satoshi (2008) defines blockchain technology as a main driver of inclusive

finance because of its decentralized and unalterable nature, which increases security and transparency in financial transactions.

By eliminating intermediaries and expanding access to financial services to the underprivileged population and the wider financial system, blockchain-based solutions can offer secure, open, and efficient financial services (Hileman & Rauchs, 2017). Smart contracts also make processes like loan disbursements and cross-border payments possible, as they are self-executing contracts with conditions directly in code. This minimizes mistakes and eliminates the need for human intervention (Kouam, 2024). Artificial intelligence (AI) is another innovation which might revolutionize the financial sector by improving risk assessment and financial decision-making (Bussmann, 2020).

Massive volumes of data can be processed by AI-powered algorithms to provide personalized financial advice, chatbot customer care, and automatically identify fraudulent transactions. Financial inclusion, customer care, and risk management can all be enhanced through it (Kumar et al., 2020). For instance, financially vulnerable groups can be provided with financial advice and customer care through AI-powered chatbots (Goyal, 2018). Furthermore, AI-based credit scoring models improve marginalized groups' access to finance by capitalizing on alternative data points such as transaction history and mobile phone usage to determine the creditworthiness of individuals without traditional credit history (Kouam, 2024). Fintech, the technology and finance intermixture, has also been referred to as one of the drivers of inclusive finance as it acts as the middleman through which AI and blockchain technologies become a reality for financial services in the real world (Manyika et al., 2016).

Fintech firms are applying sophisticated technology like peer-to-peer lending platforms, mobile wallets, and mobile banking to extend financial services to poor people (CGAP, 2018). While AI improves customers' experience through automation and predictive analysis, blockchain provides security and transparency to such transactions. According to Kouam (2024), the adoption of new technologies is democratizing financial services by increasing access to previously underserved groups. Fintech, blockchain, and artificial intelligence have the potential to promote inclusive finance, but there are still a number of issues that must be resolved (Kshetri, 2020). To fully reap their advantages, problems including unclear regulations, data privacy issues, cybersecurity risks, and the requirement for infrastructure development must be resolved (Manyika et al., 2016). Therefore, cooperation between governments, financial institutions, and tech companies is necessary to create frameworks and rules that guarantee the ethical and responsible use of these technologies. Adopting the confluence of blockchain, artificial intelligence, and fintech offers a singular chance to build a more robust, inclusive, and efficient financial system for all as the global financial ecosystem develops further (Kouam, 2024).

The purpose of this study is to investigate the potential and difficulties associated with the integration of fintech, blockchain, and artificial intelligence for inclusive finance. The study will look into how these technologies are now convergent and determine the potential and problems they pose for inclusive finance. In order to fully realize the potential advantages of the confluence of blockchain, artificial intelligence, and fintech for inclusive finance, this study will also look at the infrastructure and regulatory issues that must be resolved.

2.1 The Concept of Blockchain Technology

Blockchain technology is an unsettling force on a wide variety of different companies, entirely revolutionizing the way information is passed around, stored, and protected. Blockchain itself is essentially an internet-connected electronic bookkeeper that keeps track of transactions by means

of a series of computers so that the information cannot be manipulated in the past without network permission. Blockchain is a trusted solution for many applications because it is transparent and immutable (Akinyele & Olayemi, 2023). Blockchain was first presented in 2008 as the technology behind the decentralized digital currency known as Bitcoin. In his white paper, Satoshi Nakamoto hypothesizes a peer-to-peer electronic cash system that doesn't require a trusted central authority (Nakamoto, 2008). Ever since, blockchain technology has evolved from being used just for cryptocurrencies to being applied across different industries, such as supply chains and management, healthcare and banking.

Sets of transactions are held in blocks that make up a blockchain. Blocks are connected by each to the next through cryptographic hashes, creating a chain. To guarantee data integrity and security, the system ensures that data, once saved, cannot be modified without modifying all following blocks, which would involve network consensus (Akinyele & Olayemi, 2023). Decentralization is a core component of blockchain technology. Blockchain relies on a peer-to-peer network, as contrasted with classical centralized systems, where every participant—is referred to as a node—possesses a copy of the whole ledger. Decentralization minimizes the threat of a single point of failure and increases security (Akinyele & Olayemi, 2023). Consensus methods referred to as protocols guarantee all nodes in the network that a transaction is authentic. The most well-known is Proof of Work (PoW), utilized by Bitcoin, where users must authenticate transactions by answering difficult mathematical problems. However, the high energy usage of PoW has drawn criticism. To provide such solutions, alternatives like Proof of Stake (PoS) have emerged, where validators are chosen based on how much bitcoin they possess and are willing to "stake" as a guarantee (Akinyele & Olayemi, 2023). Smart contracts are automatic contracts whose terms and conditions are set directly in code. As soon as certain circumstances are fulfilled, they enforce a contract's stipulations automatically without the need for intermediaries. Ethereum was the first blockchain-based platform to embrace smart contracts upon its launch in 2015 and supported a massive array of decentralized applications (DApps) (Buterin, 2014).

Decentralized finance (DeFi), providing financial services without the need for conventional middlemen, has been made possible through blockchain technology in the financial industry. DeFi platforms provide customers with more control over their financial operations through the option of lending, borrowing, and exchanging assets using smart contracts (Schär, 2021). Blockchain improves supply chain management's transparency and traceability outside the financial industry. Stakeholders can ensure the authenticity and source of products by documenting all transactions in an unalterable record book, minimizing fraud and enhancing productivity (Francisco & Swanson, 2018). In spite of its benefit, blockchain technology has a number of drawbacks. Scalability remains a relevant issue since greater blockchain size increases the cost and decreases the speed of processing transactions. Furthermore, since governments cannot cope with decentralized networks, legislative ambiguity creates challenges for broad adoption (Akinyele & Olayemi, 2023). Because of their energy consumption, blockchains, especially those using PoW consensus algorithms, have been a source of concern over their environmental impact. For blockchain technology to scale in a sustainable way, scalable solutions and the shift towards more energy-efficient models like PoS are necessary (Platt et al., 2021). In the future, the combination of blockchain with cutting-edge technologies like artificial intelligence (AI) and the Internet of Things (IoT) might lead to the development of improved and secure systems. For example, IoT devices may use blockchain to offer decentralized and secure data sharing, and blockchain combined with AI can improve data security and transparency (Zuo, 2020).

2.2 Concept of Artificial Intelligence Technology

In many industries, artificial intelligence (AI) is now an unprecedented force that is revolutionizing the manner of making decisions and things being accomplished at its heart. Artificial intelligence (AI) is essentially the imitation of human intelligence by machines that are capable of thinking and learning. This encompasses different technologies that enable computers to execute operations that, in the typical scenario, entail human cognition such as robots, machine learning, and natural language processing (Russell & Norvig, 2020). Early advocates, when they implied machines could behave intelligently by mid-20th century, set the development of artificial intelligence (AI) into motion. From rule-based systems to neural networks, and deep learning programs mimicking the interlinked neuron structure of the human brain, artificial intelligence has seen gigantic changes over time (Russell & Norvig, 2020).

Machine learning techniques, a branch of artificial intelligence, enable computers to learn from and make decisions on information. Reinforced, supervised, or unsupervised learning may be employed; each has its own unique findings and potential. An upper-level form called deep learning uses massive neural networks to process massive amounts of information, enabling voice and image recognition (Russell & Norvig, 2020). Computers can interpret and react to human language because of natural language processing, or NLP. Natural language processing connects human and computer through facilitating programs like sentiment analysis software, chatbots, and translation services (Russell & Norvig, 2020). Artificial intelligence has greatly improved patient management and diagnostic precision in the medical sector. AI-enabled pathology machines, for example, have been created to help pathologists detect diseases like hepatitis B and breast cancer. This reduces the workload on pathologists and allows for quicker processing of samples (Artificial intelligence in healthcare, 2025).

AI has also been integrated into the education field, ranging from grading computer programs to student learning adapted to students. With the rise in time and place flexibility, artificial intelligence streamlines providing course, assignments, and student services, changing educators' work into that of facilitators (Tahir et al., 2024). Despite its progress, artificial intelligence raises a number of ethical issues. Discussions around the ethical development and application of AI technology have been initiated due to issues related to algorithmic bias, privacy, and loss of jobs. For these to be overcome and make AI beneficial for humanity, legal frameworks and ethical guidelines must be established (Ethics of artificial intelligence, 2025). AI is a business approach utilised to facilitate productivity, imagination, and decision-making. Businesses implementing AI to drive business and improve customer behavior may attain a competitive advantage. The moral aspects and implications on the labor force must be extensively studied prior to implementing AI in business functions (Chukwuma et al., 2024). Artificial intelligence is likely to continue developing and as advanced systems capable of performing complicated tasks with reduced human involvement in the future. Discussion and research regarding the idea of artificial general intelligence (AGI), in which computers are able to comprehend, learn, and utilize knowledge across a variety of areas, continue (The Long Road to Genuine AI Mastery, 2024).

2.3 The Concept of Financial Technology

Fintech, or financial technology, refers to the term used to describe the integration of technology into financial services with the view to improving and automating their use and provision. This combination has transformed the conventional financial processes, resulting in financial solutions that are more efficient, accessible, and convenient today. Fintech involves innovation in a range of areas, from payments to loans, wealth management, insurance, and regulatory compliance

(Gomber et al., 2018). Its explosive growth has shaken up the established financial services industry, introducing new players—like tech startups—into markets previously dominated by established financial institutions. A portmanteau of "financial technology," "fintech" is the creative application of technology to planning and providing financial services. It involves a wide range of applications, such as blockchain technology, cryptocurrencies, and mobile banking and payment apps. Fintech's main aim is to democratize, improve, and make financial services easier to use so that more people can use them. With applications of specialized software and programs on computers and smartphones, fintech is being utilized to aid companies, businessespeople, and individuals in overseeing their financial affairs, processes, and lives efficiently, Investopedia reports (Kagan, 2023). Development of technologies like cloud computing, large-scale data handling, mobile processors, and intelligence have greatly attributed to the emergence and growth of fintech (Arner, Barberis, & Buckley, 2016). Financial services are quicker, more inclusive, and more tailored due to this technology. For example, in less developed nations with limited access to traditional banks, mobile payment systems like M-Pesa and Alipay have transformed the way individuals send, receive, and save money (Donovan, 2012).

Big data analytics, blockchain, and artificial intelligence are the building blocks of fintech. Big data is analyzed by AI and machine learning models to provide anti-fraud functionality and customized personal financial advice. Cryptocurrencies are enabled by blockchain technology, which provides secure, transparent payments without middlemen. Financial institutions may increase decision-making procedures and customer service through big data analytics to better understand consumer behavior. These new technologies are revolutionizing the financial sector, as indicated in a recent Journal of Financial Innovation article (Gomber et al., 2017). Fintech is one of the greatest advantages in that it has the ability to promote financial inclusion. Fintech has improved the availability of financial services to disadvantaged groups, such as low-income households, women, and rural populations, as observed by Ozili (2018). By allowing financial transactions without the need for physical bank branches, mobile banking, digital wallets, and microlending websites simplify access to the formal financial system for individuals. Another significant Fintech innovation is peer-to-peer (P2P) lending. By removing intermediaries through online platforms that match consumers with lenders directly, it typically leads to lower interest rates and quicker loan approval (Tang, 2019). By using creditworthiness with algorithms and alternative data, such platforms lend to people who would otherwise not be creditworthy. But they also pose questions regarding investor protection, regulation, and risk exposure.

The fintech sector faces various challenges despite its rapid growth and numerous benefits. Due to technology's rapid growth and often, it outdates existing legal standards, regulatory conformity remains a fundamental challenge. Due to the nature of financial information being sensitive, data security and privacy are most important to prevent any misuse or loss. Moreover, establishing consumer trust in electronic financial services is necessary for widespread acceptance. Researchers in the University of Hong Kong have compiled a conceptual framework where they determine that the long-term growth of fintech is dependent on having strong cybersecurity defenses and a good regulatory environment (Lee & Shin, 2018). Competition and collaboration among fintech startups and established financial institutions are the defining features of the competitive dynamics of the fintech sector. Fintech companies are seen as disruptors by some established players, while others aim for partnerships to utilize new technology and expand existing service offerings. With improved financial products and services, customers ultimately gain from this dynamic interaction, which creates a culture where innovation is fostered. These interactions are discussed in a Business

Horizons paper that offers guidelines on successful collaboration (Hornuf & Schwienbacher, 2017).

The global reach of fintech can be seen with the immense growth experienced in many regions. An example is the UK's fintech industry, which is thriving in the face of economic hardships, with some UK-based businesses among Europe's fastest-growing businesses. The success has been attributed by a myriad of factors, including early monetization of money, catalytic regulatory environments, and rising venture capital investment (Arnold, 2024). But sustaining growth and profitability is becoming more difficult in the wake of the changing economic environment, characterized by rising interest rates. Adoption of fintech also has high potential in emerging economies. Fintech products provide a way to facilitate financial inclusion in places where access to traditional banking services is poor. For instance, mobile money platforms that allow individuals to make transactions, save, and access credit services using cellular phones have revolutionized financial interactions in various regions of Asia and Africa. According to a Journal of Payments Strategy & Systems study, fintech can help improve financial inclusion in emerging nations (Demirgüç-Kunt et al., 2018). With more companies and individuals relying on digital platforms for financial transactions during the lockdowns and social distancing, the COVID-19 pandemic further sped up the use of fintech products. This transition was a testament to the flexibility and resilience of the fintech services, reflecting their important role in the contemporary financial environment. According to a McKinsey & Company report, the pandemic has sparked a digital revolution for financial services that will leave a lasting legacy on the industry (McKinsey & Company, 2020).

The future for fintech consists of its constant cooperation with classic financial institutions as well as complementarity with incoming technology. Currently, fintech companies are capable of offering products on banks' infrastructure and APIs thanks to banking models like Open Banking and Banking-as-a-Service (BaaS) (Haddad & Hornuf, 2019). Collaborations like those can support long-term development by Fintech while upholding legal requirements. In the long run, fintech can change global finance so that it will be more consumer-oriented, productive, and more inclusive.

2.4 Relationship between Blockchain Technology, AI Technology, and FinTech in the Financial Ecology of Nigeria

The way financial services are created, distributed, and consumed in Nigeria has been revolutionized because of the intersection of blockchain technology, artificial intelligence (AI), and fintech. Each of these technologies has the potential to be revolutionary on its own, but combined their effect is exponentially multiplied. FinTech offers the digital infrastructure for enabling smooth financial interactions, blockchain offers a decentralized and transparent financial transaction ledger, and artificial intelligence (AI) offers intelligent automation and customized services. The trio is especially applicable in Nigeria because of the nation's large number of unbanked citizens, infrastructural challenges, and growing use of digital technology (Adebayo & Abdulhamid, 2020). In Nigeria's FinTech industry, blockchain technology is starting to be applied, especially in the areas of secure transactions, remittances, and digital identity verification. With its decentralized nature, through minimized fraud and enhanced transparency in transactions, it provides a solution to the absence of trust in traditional banking. Blockchain is being used more and more by Nigerian startups in supply chain financing, cryptocurrency exchange, and peer-to-peer lending. However, poor public awareness and unclear regulations continue to slow down the implementation of blockchain (Olatunji, 2021). Nevertheless, the introduction of the eNaira, a

blockchain-enabled digital currency, by the Central Bank of Nigeria (CBN) suggests an incremental institutional move in the direction of adopting the technology.

By allowing financial institutions to tap into big data, tailor consumer experiences, and automate processes like fraud detection, loan approval, and customer service, artificial intelligence (AI) technology supplements blockchain and fintech. Artificial intelligence (AI) is being integrated more and more into digital banking apps and mobile payment systems in Nigeria to anticipate consumer behavior and improve the provision of services (Okoye et al., 2023). AI is also essential for credit scoring, particularly for small businesses and individuals without formal credit histories, a significant deterrent to financial inclusion in Nigeria. In spite of these innovations, algorithmic bias and data privacy are key ethical issues that need robust governance structures (Binns, 2018). FinTech is the underlying technology that connects AI and blockchain to create substantial financial solutions. Nigeria's FinTech sector has expanded quickly due to the country's young population, smartphone penetration, and need for conveniently accessible financial services. Investment, lending, and payment services have been transformed by platforms such as Carbon, Paystack, and Flutterwave. These platforms are increasingly using AI for smart consumer interactions and blockchain for secure transactions (Ogunleye, 2022). Besides improving operational efficiency, this convergence improves the access of underserved segments to finance, especially in rural regions where the banking infrastructure is weak.

Nevertheless, the Nigerian ecosystem will also face significant challenges from the convergence. Some of them include limited digital literacy of the citizens, cybersecurity risks, absence of digital infrastructure, and regulatory ambiguity. Although they are starting to dream up the prospects of emerging tech, Nigeria's regulators have not yet offered an extensive framework to govern their deployment. Furthermore, active legislative action is warranted considering the issues surrounding data privacy along with the possibility of job losses through automation (Zetsche et al., 2017). To establish a sound digital financial ecosystem, these gaps must be filled.

3.0 Opportunities for Financial Inclusion in Nigeria

Financial inclusion, also known as inclusive finance, is an essential component of sustainable development, economic growth, and poverty reduction. In recent years, the impetus for inclusive finance has been on the increase in Nigeria, a country that has a vast population of the unbanked and underbanked. Over 40% of Nigerian citizens still have no access to formal financial services, and over 1.7 billion people worldwide—mostly in developing nations—do not have a bank account, according to the Global Findex Database (Demirgüç-Kunt et al., 2018). In an effort to close the access gap and encourage financial activity among underprivileged segments, this fact has heightened the demand for new financial strategies and technological solutions. Artificial intelligence (AI), blockchain, and FinTech have entered with revolutionary promises for enhancing Nigeria's financial inclusion. These technological advances provide more cost-effective scalable, and even safe platforms by which financial and related services would likely be scaled to low earners, informalists, and distant communities that in the past found no space or avenues in accessing traditional banking setups (Ozili, 2018). Technology is being used to remove decades-old financial exclusion barriers in the nation, such as digital lending, agent banking, mobile money services, and biometrics-based identity platforms. The financial inclusion environment has also been significantly shaped by government policies and regulatory reforms. The financial service providers have greater opportunities to develop and make existing financial products accessible because of policies like the Central Bank of Nigeria's National Financial Inclusion Strategy and the establishment of digital identity (BVN and NIN integration) (CBN, 2022). Although there has

been progress, limitations like cybersecurity risks, digital literacy, and infrastructural deficits persist. However, at the confluence of policy, technology, and market innovation, there lies hope for a more inclusive financial system in Nigeria.

3.1 Financial Inclusion for the Unbanked and Underbanked Locations

Financial technology has great potential for the underbanked and unbanked, or individuals who lack formal bank accounts or have restricted access. Such people tend to turn to informal financial systems, which not only expose them to insecurity but also restrict their savings ability, credit access, and wealth building. Fintech firms are rapidly utilizing digital wallets, agent banks, and mobile banking to reach these underserved segments. Digital financial products have the ability to reach places where it is difficult for traditional banks to reach, as seen through products like Paytm in India and M-Pesa in Kenya (Jack & Suri, 2016). They avoid the requirement of physical banking networks by enabling customers to send, receive, and hold money on mobile phones. Fintech has the capability to bridge the financial inclusion gap effectively by riding on the deep penetration of mobile phones.

Another key aspect that makes financial inclusion possible is digital identification. Digital identification and biometrics have enhanced the onboarding of unbanked individuals, particularly in rural regions where identification documents are scarce (Gelb & Metz, 2018). In a bid to ensure that access to finance is no longer a prerogative of the privileged few, governments and fintech companies have collaborated to offer Know Your Customer (KYC) compliant services with minimal inconvenience. Millions of people find entry into the formal economy because of these innovations, which minimize entry barriers. Furthermore, the emergence of alternative credit scoring methods makes inclusive financing possible. People who lack credit histories tend to be excluded from formal banking. Fintech comes in to overcome this by evaluating creditworthiness using alternative data like social behavior, payment of utility bills, and mobile phone bills (Balyuk, 2019). These have proved to work towards making it possible for informal workers and small entrepreneurs to access loans for expansion and maintenance. Despite these breakthroughs, challenges continue to face these initiatives. Access remains impeded by infrastructural constraints, lack of digital literacy, and mistrust of formal institutions. Fintech, in turn, possesses transformative potential to improve the access and equity of financial institutions through consistent investment, public-private collaborations, and backing by the regulatory framework (Ozili, 2018).

3.2 Enhancing Security and Fraud Prevention

Because fintech is digital, there are numerous weaknesses, and hence security and fraud prevention are paramount for inclusive finance. When more people start using internet applications and mobile applications, there is a greater chance of fraud, identity theft, and cybercrime. Cyber risk is ranked one of the greatest deterrents to financial institution digitalization, according to PwC (2020). AI and machine learning can be used to detect fraud in real-time. These systems will automatically flag suspicious transactions, detect anomalies, and analyze patterns of transactions (Bussmann, 2020). In order to keep out unwanted users, anomaly detection systems, for instance, can determine when a Nigerian account user logs in from an unexpected continent for the first time. This technological innovation is particularly important to guard new customers who are not familiar with online banking.

Biometric verification through iris scan, fingerprints, and facial recognition is a prevalent security feature now. Biometrics have been discovered through studies conducted by Jain et al. (2016) to

be fraud-resistant with strong capabilities as well as better the user experience by doing away with passwords. Biometrics reduce identity theft, which was the prevalent scenario under traditional banking, and reduce user authentication across the areas with low literacy levels. Blockchain plays an important part in fraud prevention as well. Unauthorised access and manipulation of data are minimized by its immutable and decentralised ledger structure. In the view of Swan (2015), blockchain's open nature makes it easy to audit and verify, and this helps to foster trust between users and agencies. These aspects are necessary to make a secure and welcoming financial environment. Technology, however, is not enough. Useable data protection legislation, user-centered design, and internet safety education are essential. Only with safety and stability offered by the ecosystem along with access will inclusive finance thrive (Zetzsche et al., 2020).

3.3 Cost Reduction and Operational Efficiency

One of its key benefits is the ability of fintech to minimize costs of operations and enhance the efficiency of financial service delivery. Banking operations, because of the infrastructure, people, and logistics required, tend to have a high fixed cost. Fintech, however, uses digital platforms, which facilitate scalability and cost-effective operations. Philippon (2016) asserts that in economies that have adopted fintech, the cost of financial intermediation has decreased. Transaction processing for banks is now a percentage of the conventional cost because of automation and cloud computing. Artificial intelligence and robotic process automation (RPA) are used more and more to handle back-office tasks like risk assessment, loan approval, and compliance review (Deloitte, 2020). The client experience is improved by this automation because it accelerates decision-making and reduces errors.

Financial services can now be offered without physical branch presence because of digital platforms. This is very useful in sparsely banked rural and remote areas. Suri and Jack (2016) posit that mobile money systems reduce transaction costs substantially, which promotes increased financial activity and savings rates. Additionally, digital platforms have much lower marginal cost of serving an additional consumer. In addition, smart contracts on blockchain remove administrative loads by automating processes like paying insurance claims and loans (Catalini & Gans, 2016). There are increased efficiency and transparency created both for the producers and consumers. Thus, fintech companies can lower their rates without losing profitability, hence lowering the cost of service to the poor. However, cost reduction must not be at the expense of security or service levels.

3.4 Microfinance and Alternative Lending Models

Historically, microfinance institutions (MFIs) have been providing small loans and saving schemes to meet the financial requirements of the poor. Fintech's creation of new modes of financing that utilize technology and data has upended this industry completely. It is argued by Morduch and Armendariz (2010) that conventional MFIs tend to struggle with high costs of operations and constrained scalability. Fintech offers options to circumvent these obstacles. By cutting middlemen and saving costs, internet-based peer-to-peer (P2P) lending sites bridge borrowers and lenders directly (Tang, 2019). People who lack formal credit profiles are now able to borrow loans because of such websites, which frequently employ non-traditional data for scoring. In underserved neighborhoods, this lending democratization fosters economic resilience and entrepreneurship. Another alternative lending innovation is crowdfunding platforms.

They enable people and businesses to obtain funds from various investors, in many cases, without collateral or credit checks (Belleflamme et al., 2014). By providing money for ventures that might

otherwise fly under the radar of traditional finance systems, for example, startups and shadow businesses, this process promotes inclusive finance. Mobile-based microcredit services have gained wider acceptance, particularly in Asia and Africa. Smartphone data is used by platforms like Tala and Branch to evaluate creditworthiness and offer instant loans (Chen & Mazer, 2016). The services help in everyday life and consumption smoothing through availing quick loans at times of need. Issues of too much borrowing and repayment defaults persist despite the assurance. In order to make alternative lending promote rather than undermine financial inclusion, regulation, financial education, and careful lending are imperative (Carpena et al., 2018).

3.5 Regulatory and Compliance Innovation

Financial technology is developing at a rate that frequently exceeds the flexibility of regulatory frameworks. To make sure that fintech solutions foster inclusive finance with reduced systemic risk, there has to be regulatory innovation. According to Arner, Barberis, and Buckley (2017), "RegTech" has emerged as a necessary solution to the problem, allowing data-driven and automated compliance procedures. RegTech solutions simplify compliance, lower expenses, and deliver real-time reporting by leveraging technologies like machine learning and big data analytics. Making AML and KYC operations automated, say, can save human errors and improve onboarding speed (Zetzsche et al., 2017). Startups and small financial businesses with no behemoth compliance offices will gain highly from this.

The Financial Conduct Authority of the UK developed sandbox environments, through which fintech companies are able to test ideas under the tight watch of regulators (Jenik & Lauer, 2017). This kind of safe spaces promotes innovation without exposing customers to risks. Similar strategies have also been used by nations like Nigeria, Kenya, and India to encourage financial innovation involving underprivileged communities. The regulatory frameworks should also be adaptive and participatory. Policies should provide for prioritizing consumer protection and facilitating interoperability among digital financial service providers. In the opinion of Lagarde (2018), what is needed is a balanced approach guaranteeing innovation, stability, and fair competition. It is particularly crucial in developing nations since, more often than not, people first encounter formal money through fintech. In the end, inclusive finance rests in an environment where regulation and innovation go hand in hand. Fintech firms, development institutions, and regulators can work together to make fintech products responsible and transformative (Gates Foundation, 2020).

4.0 Challenges and Risks in the Convergence of Blockchain, AI, and Fintech

In addition to potential innovations, the ongoing innovation of the financial services industry spurred by the intersection of blockchain, artificial intelligence (AI), and Fintech also presents several serious threats and concerns. Although these innovations promote financial inclusiveness, efficiency, and transparency, they also pose new dangers to consumers, regulators, and institutions. The incorporation of such disruptive technology into financial environments is still in its nascent stages, particularly in developing nations like Nigeria where digital aptitude, infrastructure, and policy might not be aligned towards supporting their sophistication. Consequently, to guarantee that their acceptance and integration are well-balanced, greater cautious investigation into the issues at hand is needed. Apart from typical financial risks, the use of such technologies entails a number of multifaceted issues. These include the lack of strong legal frameworks, the moral questions about data use, blockchain scaling effectiveness, and higher susceptibility to very advanced cyberattacks. Regulators, developers, and financial service providers are some of the

parties that must get together to counteract the specific challenges each of these presents to wholesale adoption of digital banking innovations.

4.1 Data Privacy and Ethical Concerns in AI-Powered Financial Services

Much transactional and personal information is needed by AI-powered financial services in order to create insights, make independent decisions, and improve customer experiences. However, this data dependence presents humongous tasks around permission, ownership, and data privacy. Data protection regulations are yet to be developed in most developing economies, such as Nigeria, and customers, therefore, are exposed to abuse and unauthorized use of their personal information. When algorithms make decisions that influence credit scores, loan applications, or investment advice—frequently with little transparency or recourse—moral issues are more urgent (Binns, 2018). Furthermore, algorithmic prejudice, which occurs when AI systems inadvertently discriminate against wealth, gender, or ethnicity, may result in systematic exclusion as opposed to inclusion.

In addition to consent and bias, there is the issue of data security. Because AI models possess and process sensitive biometric and financial data, it matters that the security and integrity of such data be preserved. Weak security measures or insufficient oversight result in breaches that damage trust and have far-reaching financial consequences. Banks and tech companies must implement privacy-by-design principles and ethical AI practices because the absence of AI governance standards and ethical AI development guidelines increases these risks (Cath, 2018).

4.2 Scalability and Adoption Challenges of Blockchain-Based Solutions

Blockchain has a variety of possible benefits, including decentralization, immutability, and transparency, but financial services sector adoption and scalability are major challenges. Most blockchain systems are constrained in throughput, power-intensive, and have bad transaction rates, especially those using proof-of-work consensus algorithms like Bitcoin. These constraints make them less applicable to high-traffic financial systems like payment systems and remittance systems that demand processing data in real-time (Croman et al., 2016). Scalability of Blockchain is a major challenge to its widespread implementation as financial transactions continue to increase in quantity and complexity.

The incompatibility of different blockchain technologies with existing banking infrastructures only adds fuel to adoption issues further. The technical and cost barriers to using blockchain solutions may prove prohibitively expensive in certain areas, like sub-Saharan Africa, where digital infrastructure is yet to be established. There is also reluctance and disapproval based on the general public's and even many financial sector professionals' ill-informed attitude towards blockchain potentialities and capabilities. Apart from technological advancements like interoperable standards and more scalable consensus algorithms, solutions to the above adoption issues will need continued investments in digital infrastructure and education (Casino, Dasaklis, & Patsakis, 2019).

4.3 Regulatory Uncertainties and Policy Gaps

The absence of precise, uniform, and dynamic regulatory frameworks is perhaps the biggest hurdle to embracing blockchain, AI, and Fintech. These new technologies tend to change faster than the respective legal infrastructures put in place to control them, generating regulatory vacuums that give rise to investor and inventor uncertainty. Nigerian regulators, for example, have issued conflicting signals as to the standing of cryptocurrencies and AI-based financial services; some efforts have been commended while others are in restriction or even ban (Zetsche et al., 2017).

As businesses do not want to operate in a murky legal environment, this ambiguity discourages investment and innovation.

All these - market integrity, competitiveness, and consumer protection - are impacted by policy loopholes. In the absence of strict regulation, it would be possible that the biggest digital players are turned into monopolies or oppress people through predatory means and the misuse of data. While regulatory sandboxes and pilot programs are fashionable today as short-term solutions to encourage innovation in the hope of evaluating risks, they are no substitute for long-term strong legal frameworks. Therefore, states and global institutions need to work together to craft adaptive, principles-based regulations that advance innovation without undermining consumer rights and financial integrity (Arner, Barberis, & Buckley, 2017).

4.4 Cybersecurity Risks and Resilience Strategies

Complex cybersecurity challenges are ushered in by the intersection of blockchain, AI, and Fintech, which also increases the attack surface for attackers. The reliability of AI systems' decisions can be compromised by adversarial attacks or poisoned datasets. Similarly, while blockchain is commonly lauded for its built-in security features, application layer vulnerabilities do and can occur, including phishing attacks targeting users, smart contract vulnerabilities, and wallet security weaknesses (Conti et al., 2018). What may seem like a trivial breach can lead to widespread financial and reputational loss as financial systems grow increasingly data-reliant and interconnected.

All internet banking solutions must incorporate resilience into their design and deployment to combat these risks. This encompasses complete incident response strategies, ethical hacking, threat monitoring in real-time, and multi-layered security protocols. Regulators must also encourage cross-sector cooperation to share threat intelligence and enforce stringent cybersecurity requirements. In order to mount a successful defense against the adaptive threats in the digital banking ecosystem, capacity building through training, sensitization, and investment in cybersecurity research is also required (Bussmann, 2020).

5.1 Conclusion

Blockchain, artificial intelligence (AI), and financial technology (FinTech) are put together to present a revolutionary opportunity to expand financial inclusion, especially in emerging economies like Nigeria. These technologies hold the capability of increasing access to financial services, improving operational efficiency, lowering the cost, and increasing transparency and trust in the financial system if well integrated. The unbanked and underbanked segments, being disadvantaged, can be empowered by the digital finance revolution by surmounting age-old hurdles like geographic inaccessibility, identity verification issues, and the lack of the traditional banking infrastructure.

5.2 Recommendations

From the research the following are recommended;

- i. In order to promote innovation, minimize risks, and bring clarity to new technologies like blockchain and artificial intelligence, policymakers need to craft flexible and clear policies.
- ii. Banks and other financial institutions need to implement ethical AI principles, with data privacy, transparency, and fairness to all AI-powered financial services.

- iii. To spur the uptake of FinTech solutions, members of the public and private sectors must join hands to improve digital infrastructure, prioritizing poor and rural communities.
- iv. Financial institutions must adopt strong cybersecurity procedures and real-time monitoring systems to defend against data breaches and cyber attacks on AI and blockchain systems.
- v. To support inclusive financial innovation, cooperation between development organizations, financial institutions, digital companies, and regulatory institutions should be encouraged.

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