THE EFFECTS OF IMPLEMENTING BLOCKCHAIN TECHNOLOGY IN THE CENTRAL BANK OF NIGERIA

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Approval of the Thesis

THE EFFECTS OF IMPLEMENTING BLOCKCHAIN TECHNOLOGY IN THE CENTRAL BANK OF NIGERIA

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Doctor of Philosophy (PhD) in Information Technology

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Abstract

THE EFFECTS OF IMPLEMENTING BLOCKCHAIN TECHNOLOGY IN THE CENTRAL BANK OF NIGERIA

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This study focussed on the effects of implementing blockchain technology in the Central Bank of Nigeria. The primary target was identifying the challenges and opportunities of adopting blockchain technology to resolve and significantly enhance the payment system by providing reliable cyber security and appropriate regulations. The research problem was an inefficient payments system encumbered with sluggish and unsecured funds transfer processes, manual and semi-automated practices, and regulatory challenges, which impacted the Nigerian financial system. The findings revolved around the research questions, which confirmed the use of blockchain technology to enhance the payments system, provide cyber security applications and ensure applicable regulation.

The triangulation research method was adopted vide a mix of primary quantitative and secondary qualitative approaches. Online survey questionnaires were developed from the research questions and forwarded to the target participants. The researcher used survey forms such as Google, and Microsoft Forms to create the survey questionnaires, collect data from randomly selected respondents and perform data analysis using the Jamovi and Qualitative Data Analysis software.

The outcome of the research triggered the launching of the Central Bank Digital Currency by the Central Bank of Nigeria, through which secured payment transactions are currently being made in a regulated financial ecosystem. This study tossed the prospect for relevant academics, researchers in the financial industry, universities, and research institutions to conduct future studies, improve blockchain payment applications and boost regulatory processes.

Declaration

I declare that this thesis has been composed solely by myself and has not been submitted in any previous application for a degree, except where stated otherwise by reference or acknowledgement; the work presented is entirely my own.

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Dedication

I am humbled and honoured to dedicate this study to the Lord Jesus Christ, my God and Saviour, who granted me grace and wisdom throughout my education. Without Him, I could not have achieved this feat. To Him alone be all the glory and honour.

Next, I dedicate this work to my dear wife, Dr Chikodili Ngozi Olomukoro, Consultant Paediatrician. She stood by me and supported me by providing valuable project management tips throughout this program. I could not have gone far without his genuine love, inspiration and encouragement.

Finally, I dedicate this work to the children (Daniel, David and Salem) God gave us, specifically to the late Daniel Kenechukwu Ifanboroghene Olomukoro, on whose memory I can complete this task. He consistently asked to know the status of my work and for his valuable Grammarly support, especially in the later chapters of this dissertation. My deep appreciation to the family for all your love, support and prayers manifested differently.

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TABLE OF CONTENTS

List of Abbreviations

AI	Artificial Intelligence
ATM	Automated Teller Machine
B2B	Business-to-Business
B2C	Business-to-Consumer
B2G	Business-to-Government
Baas	Blockchain as a Service
BIM	Bayesian Inference Mechanism
BITS	Blockchain in Internet-of-Things
BPS	Bitcoin Payment System
BPCSS	Blockchain-based Payments Collection Supervision System
C2C	Consumer-to-Consumer
CBDC	Central Bank Digital Currency
CBN	Central Bank of Nigeria
DAG	Directed Acyclic Graph
DLT	Distributed Ledger Technology
DMB	Deposit Money Bank
Fintech	Financial Technology
Forex	Foreign Exchange
FSRCC	Financial Services Regulatory Coordinating Committee
GDPR	General Data Protection Regulation
IDS	Intrusion Detection System
IMTO	International Money Transfer Operators
IoT	Internet of Things

IPFS	Interplanetary File System
IT	Information Technology
KYC	Know Your Customer
LC	Letter of Credit
MDA	Ministries Departments Agencies
MSME	Micro Small Medium Enterprise
ODC	Official Digital Currency
PBOC	People’s Bank of China
PKI	Public Key Infrastructure
POS	Point of Sale
QDA	Qualitative Data Analysis
REAF	Research Ethics Application Form
RTGS	Real Time Gross Settlement
SDPS	Sensor Data Protection System
SME	Small Medium Enterprise
SPSS	Statistical Package for the Social Sciences
STP	Straight Through Process
SWIFT	Society for Worldwide Interbank Financial Telecommunications
UREC	Unicaf Research Ethics Committee

List of Tables

List of Figures

CHAPTER 1: INTRODUCTION

1.1 Introduction to the Problem

The International Payments Division in the Banking & Payments System (now Banking Services) Department of the Central Bank of Nigeria, CBN, was mandated to facilitate the management of all domiciliary accounts belonging to the Government Ministries, Departments and Agencies (MDAs) and make cross-border payments on their behalf. In addition, the division processes the conversion from foreign currency to the local currency equivalent, funds transfer, and interbank deals, including foreign exchange spots, forwards, swaps, retail auctions, and estacodes payments with the correspondent banks on behalf of the Government MDAs. These service deliverables were not without prevailing challenges accompanying the execution of payment mandates in the system. Every instruction for funds transfer, payments or conversion comes with directives stipulating how the respective office would treat it vis-a-vis the account to debit and the beneficiary account to be credited, which was strictly an accounting process.

Instances of delayed funds transfer, beneficiary's non-receipt of funds, communication gap, inadequate narration of inflows, prolonged availability of statements of account, high cost of operation and manual payment processes have often hindered the smooth flow of the payment system. Critical external factors such as incorrectly formatted files, late submission of softcopy files, provision of incorrect account details and late response time in providing additional information are part of what was affecting the payment flow resulting from these challenges. Technical factors affecting the payment workflow include network-related issues that prevent the transmission of transactions to the SWIFT server and cancellation of transactions at the correspondent bank's platform due to compliance and sanction screening policies. However, it is worth stating that these technical factors are beyond the operators' purview to provide the appropriate resolution.

1.2 Background of the Study

From the 1960s to date, technology has advanced through many phases of development, particularly in the last twenty years, which had witnessed the unprecedented growth of innovative devices even before the advent of the world wide web in the late 80s (Lobban, 2019). However, 2015 marked the advancement of blockchain technology, recognised as a distributed ledger technology in a network. Since its formation, blockchain technology has taken the global financial industry by storm through colossal investments and the development of various applications in what one can regard as a gradualist approach. Blockchain technology has attracted the attention of many international banks, including central banks of developed countries, where experimental programs are being tested and implemented with their numerous clients (Guo & Liang, 2016). The Central Bank Digital Currency (CBDC) has become a phenomenon to drive blockchain technology in global central banks. Leon (2022) stated that the CBDC adoption mainly depends on the end-user's satisfaction and its benefits over the traditional form of money vis-a-vis the prevailing payments system. Sad but true, he opined that implementing the CBDC would determine if the end-users were the main stakeholders the product was supposed to satisfy.

The current payment process, as it were, was quite frustrating to the payment operators and the beneficiaries. In some cases, the delay for some funds to impact the accounts of the beneficiaries has taken days or even weeks to take effect due to avoidable challenges. The manual payment aspect was tedious and riddled with the lengthy entry of accounting details for a single process to execute entirely. It took a lot of time for the banking applications to process these payments, and the luxurious cost of operations and crass inefficiency in the payments system. Adopting blockchain applications was believed to eradicate these challenges with needless resistance (Lipton, 2018).

1.3 Rationale of the Study

The rationality behind this study was to explore the prospect of using blockchain technology to address these payment challenges in the Central Bank of Nigeria. Automation of payments is a primary task to ensure that manual labour and hours are not spent unnecessarily without achieving optimal output. Some critical aspects of the office processes were still manually driven, and introducing blockchain technology would go a long way in achieving that purpose. Blockchain technology unlocks the potential for transforming traditional banking activities into more innovative, cost-effective, and efficient payment systems (Camera, 2016; Cocco et al., 2017). Providing an efficient payment system by becoming a model central bank is one of the strategic themes of the Central Bank of Nigeria. So, to deliver on this strategy, Apex Bank must be abreast of global technological development and use it to enhance its payment process (Del Río, 2017). Due to the challenges of the current payments system and the opportunities of using blockchain technology to stimulate payment capability (Bundesbank, 2019; Mills et al., 2016), this research study has become inevitable in the scheme of the recent development in the payments industry.

As a regulatory body, it beholds the Central Bank of Nigeria to release a policy guideline on how to regulate the blockchain process, which this research study would be able to propose. The regulation of the conventional monetary policy by central banks worldwide is well-known to financial populists. Therefore, by approving the implementation of blockchain technology, it was pertinent to regulate the blockchain network must be factored into the monetary policy (Claeys et al., 2018). Ward and Rochemont (2019) posited that each central bank must devise the means to control the blockchain process while taking cognisance of the nature of the decentralised network process (Rosner & Kang, 2015). However, regulating the decentralised network that blockchain technology drives is a complex issue for the central banks to tackle by leveraging the conventional regulation process to achieve this new model (Lazcano, 2019).

Blockchain technology was implemented as a form of the central bank digital currency, CBDC, to provide alternative digital currency to the stakeholders by many central banks of the world. Apart from the introduction of another option of digital cash, it was perceived by Leon (2022) that the CBDC would stimulate payment efficiency and severance, digital financial inclusion, monetary independence and gain insightful surveillance of the market players to reduce their power. Room for improvement would always necessitate a step up in technological development as Soramaki (2022) implied that the role of digital currency would shift from the norm to the disruptive new normal due to the innovative money of the now, no more of the future. The technological landscape is dynamic, and as such, there will always be the improvement of system revolution intermittently. The dynamism could also be due to cyber security measures triggered by cyber-attacks. Appropriate safety measures must always be ahead to ensure a seamless operation in the blockchain network.

Operational tasks are routine activities that are cyclic with no room for exceptional results. Since the recurrent tasks produce the same results, innovation is the only way to break out of the cycle and provide excellent outcomes. Alonso et al. (2021) posited that the degree of CBDC implementation varies from country to country, so the outcome would also vary. They emphasised that the benefits could be less or more to the end-users depending on the scale of implementation, though they admitted that it was a step in the right direction.

Blockchain technology implementation goes with the attributes of the CBDC as posited by Shah et al. (2020), which include universal access to the payments process app through a smartphone and some peculiarities for physically challenged users with any intellectual, vision or ability impairments. They implied that end-users, without the appropriate devices, could also transact cash-related peer-to-peer transactions as the universal access supports digital accessibility that promotes financial inclusion, which any bank can provide. Regarding regulatory conformity and privacy, they postulated that the CBDC offers alternatives. However, it could be very challenging as there were options provided by new technological development for end-users to explore. They implied that regulating privacy may be difficult to attain, especially when Banks were mandated to simplify the degree of confidentiality in tandem with regulatory establishments and other external stakeholders to ensure appropriate disclosure when necessary. On the other hand, a consortium of companies could be licensed by the central bank to regulate the digital currency platform.

The issue of interest payment is very vital in CBDC implementation. However, much attention is being focused on the non-interest amount for now as issues of interest payment are complicated, perhaps, except in areas where interest rates and transaction time stamps are already determined on the systems (Shah et al., 2020). The perception of interest payment would vary from one regulatory policy to another and, depending on the economic operating environment and the available options, would require further research.

Resilience is critical for all payment systems. The applications are vigorous, with multiple organically distributed data centres worldwide. With this approach, no data centre failure would impede the flow of data systems are expected to function continually, although with some deprivation of service delivery to failed data centres. The high-end system engineering level would facilitate resilience in the CBDC process even when a system lacks power or network access. However, such a system would function at a reduced level such that it would not be able to add or update CBDC records from the Bank since it requires a connection to the network.

The net settlement transactions are complete when no debit or credit item is hanging within a specified time, as the transactions are irrevocable. It is very pertinent for users to be aware of the schedule as significant stakeholders in the settlement process. The transactions between CBDCs may be settled with immediate finality even though it still depends on the timing of the transactions vis-à-vis that country's clearing and settlement system (Ward & Rochemont, 2019). CBDC system would require system designers to apply policy guidance with clear communication channels and support to end-users on the revocation of transactions. This process would simplify what would seem as complicated in the distribution channels. Introducing a digital currency is vital for the Nigerian economy to facilitate enhancement in payment transactions.

The involvement of service providers in the digital payment landscape would enable them to provide services to the end-users and reduce barricades to financial inclusion.

Most organisations have visions and missions upon which they operate, but an idea aims to work towards its implementation for the betterment of any organisation. This study would achieve an efficient payment system by implementing blockchain technology.

1.4 Statement of the Problem

The critical research problem is the inept and inefficient payment system in the Central Bank of Nigeria as a government institution and a regulatory body that oversees the operations of financial institutions, including the banks. The current payment system is characterised by many challenges, such as delayed payments and funds transfer, risk of cyber-attacks, non-receipt of payment to beneficiaries, high cost of operations, payment system congestion, lack of proper regulation and supervision, etc., some tedious manual operational processes and slow operating procedure. The Apex Bank strives to be a world model bank where an efficient payment system would be one of the core functions of good service delivery. Though these problems have necessitated the automation of some of the manual payment processes, however, there are still critical challenges surrounding the payment system. Another crucial problem is the absence of a digital currency to make payments.

While assessing the "***As-Is***" problem with the current payments system, it was pertinent to consider the scalability challenges to accommodate growth and regulations of the entire blockchain process to ensure operator compliance(Artemov et al., 2017).

1.5 Purpose, Aims and Objectives of the Study

The purpose of this research study was to proffer the strategy for the implementation of blockchain technology as a priority and paradigm shift to make the payments process efficient in the Central Bank of Nigeria (CBN), thereby spanning into other organisations in the Nigerian financial industry. This research study would facilitate two main perceptions: a model to implement the blockchain applications and automate due manual processes, enable cybersecurity, and promote speedy and cost-effective payments and transfer of funds. It was pertinent and insightful to devise the means of regulating the entire blockchain transactions from end to end (Lobban, 2019). It was also appropriate to recommend a broad knowledge acquisition of blockchain technology through robust training to all relevant stakeholders across the board, stimulating specific management decision-making processes (Syed et al., 2019).

This research study recommended the feasibility of implementing blockchain technology to enhance the payments system in the CBN.

1.5.1 Objectives of the Study:

1.5.2 Automation of manual payment processes to optimize the functionality of the blockchain platform. This is pertinent to ensure a holistic performance of the system devoid of program deadlock.

1.5.3 Implementation of suitable blockchain **cyber security** applications to protect the integrity of data from cyberattacks using cryptographic techniques (Wust & Gervais, 2018) thereby ensuring that transaction data are reliable and confidential (Signorini et al., 2018);

1.5.4 Furthermore, it would also serve the CBN's purpose to facilitate and enhance the **payments system** including the foreign exchange transaction process along with the payment notification system (Cocco et al., 2017) as well as overhauling the current trade financing process, improve financial market dealing and to expedite the interventions of government through the issuance of group loans for economic diversification (Lipton, 2018);

1.5.5 It would empower the regulator to provide a remote **regulation** and ensure policy compliance within the entire blockchain network (W. Li et al., 2017) and this perception was collaborated by (Guo & Liang, 2016);

1.5.6 Achieve the improvement of the CBN **funds transfer**, cheque clearing and net settlement transactions (Mills et al., 2016; Swan, 2017) with a robust and secured funds transfer process (Zhong et al., 2019).

It was vital to achieve the study's objectives and complete the process. Most of the functions are ongoing despite the challenges bedevilling smooth operations. However, it is the firm view of the researcher that to break the regular cycle of operations; there is the need to introduce a change from outside that would ensure the efficiency of the payments process.

1.6 Nature and Significance of the Study

This research study was centred on a quantitative and qualitative triangulation approach. The quantitative method would be the primary mechanism for an online questionnaire survey to connect to the target participants (Palinkas et al., 2015). In the qualitative scheme, the online focus group would be adopted by prospective respondents, reach out to them through the WhatsApp forum and retrieve their feedback. The target participants from both methods would be financial payment professionals, blockchain operators, and investors, including those enthusiastic about blockchain technology. The general perception was that so many people have heard about cryptocurrency but know little or nothing about it, and others are interested in blockchain technology. Still, they do not know how to approach getting the relevant information.

One of the benefits of implementing blockchain technology was to sensitise the population about the nature of the technology through seminars, workshops, conferences and road shows that would provide general information. In the online survey composition, a brief about blockchain technology would form part of the introduction to enlighten the participants who will participate in the survey. It was the researcher's perception that blockchain technology would better many stakeholders and the system in general. It was perceived by Park and Park (2017) that the benefits of deploying blockchain technology would alleviate the current challenges and achieve the aim of the study. The crux of this study was to propose the implementation of blockchain technology to take advantage of the benefits that include secure authentication, hash value production, virtual cash encryption, and fraud alert through the provision of cyber security against potential cyber-attacks (F. Dai et al., 2017). They opined that fortifying any system with cyber security features was the way to prevent cyber-attacks as there are various means of hacking into systems using modern technology, which in most cases was comparable with the same innovation adopted in the first place. On the enhancement of the payments system, which is one of the benefits through the transformation of funds (*securities, derivatives, assets*) transfer, clearing and settlement transactions, Mills et al. (2016) posited that the smooth process of funds transfer, and the net settlement system after the clearing session gauges the payments system. They implied that the efficiency of the payments system indicated the overall proficiency of any operational system.

On the regulation of blockchain technology by the central bank, W. Li et al. (2017) expressed that this could be made possible through non-centralised remote supervision that accelerates policy compliance across the entire blockchain network and proposes appropriate applications to resolve paramount issues such as foreign exchange transactions, payment messaging system, (Cocco et al., 2017) trade financing, financial market dealing, government interventions through collective loans for economic diversification (Lipton, 2018) and foster collaboration with external stakeholders, identify research gaps and proffer future research directions of the blockchain technology. The essence of future research on blockchain technology is for academic and professional researchers captivated by the study's outcome to review and continue with it simply because of the profound implication on the Nigerian financial system and the impact it would permeate society at large. Therefore, the researcher should complete this study to achieve the purpose.

The Central Bank of Nigeria initiated the implementation of Central Bank Digital Currency CBDC a few years ago, just about the period this study was started, to deploy digital currency as a means of transaction in the Nigerian economy. The digital currency tagged e₦aira was launched in October 2021 and was a project still under developmental process despite ongoing concerns. Expectedly, there were issues during the development of digital currency, including litigation cases, which the legal team should promptly handle accordingly. The main concern was the need to sensitise the usage of **digital currency**.

The importance of the research study was to propose that blockchain technology deployment would effectively and gradually replace the current payment application to ensure efficiency, flexibility and secure transactions of the payment process (Zhong et al., 2019), including the net settlement transactions as postulated by Swan (2017). The settlement of the clearing process depended on the country's clearing and settlement policy and the time of settlement. The Bank automated some manual operations to fast-track the payment flow; however, specific vital challenges persist.

Several problems of the current payment system include the manual submission of payment mandates, slow pace of the payment system operation, non-receipt of third-party payment to beneficiaries in some instances, reversal of payment as old as months or years due to reconciliation issues, archaic perception of the change syndrome and high operational cost. Based on these challenges, the proposal to implement blockchain technology was initiated as a remedy to solving the problems. The anticipated deployment of the study's recommendation would enhance the payment system through secured integrity and transparency of cryptographic dependable, and available transaction data (Wust & Gervais, 2018) within the CBN and the Nigerian financial industry. Due to its distributive nature, blockchain technology protects non-centralised networks more efficiently from cyberattacks by guaranteeing that the transaction data are tinker-proof, reliable and strictly confidential (Signorini et al., 2018).

Blockchain technology implementation is a step in the right direction in resolving outstanding issues, primarily through deploying the CBDC, which the Central Bank of Nigeria initiated in October 2021. The essence of this initiative was to address or reduce some of the pressing issues hindering the payment system, even at the basic level. The primary concern is enriching the payment system to improve efficiency and transparency. There must be a significant change when an initiative is implemented in the workplace and the society at large else it will be business as usual. It was envisaged that blockchain technology through CBDC would promote efficiency in the payment system, as was being witnessed by the stakeholders using the e₦aira initiative that enables end-users to transfer and receive funds in digital form to other beneficiaries. FNA (2022) stated that CBDC can stimulate economic activities through the money deposit banks when the platform is made available to the end-users. The essence of this service deliverable is to encourage their customers to patronise the banks' digital services without physically visiting the bank premises. It was reported by Eleanya (2022) in the BusinessDay newspaper that implementing CBDC is said to be successful when many users are utilising it. This challenge was one of the drawbacks of deploying the eNaira, where the end-users registered in the platform were few compared to the account holders in the country.

Blockchain technology, including fintech, is the driving force for innovation in the payment system as W. Zheng et al. (2019) implied that the technology has become a platform for providing services. Technology is significant in promoting change in any system hence the importance of proposing it in the Central Bank of Nigeria as a paradigm shift to stimulate the payment system in society. The involvement of numerous customers has triggered a significant data era in the banking system, which Hassani et al. (2018) believed could be processed conveniently using blockchain technology as an enabler. Chen (2018) opined that central banks can use blockchain technology to stimulate their operations hence the desire to embark on this study. To actualise the objectives of promoting an efficient payment system, enhancing cybersecurity to protect data against cyber-attacks and regulating the process through policy implementation (Alam et al., 2021) when they submitted that blockchain-backed initiatives could be achievable by an organisation that is ready with minimal challenges.

1.7 Research Questions and Research Hypotheses

The research topic has facilitated the research questions prepared to resolve the challenges and actualise the objectives of this study. The research questions were flexible, giving room for review without hassles (Saunders et al., 2019). The research questions articulated were based on the research study's purpose, aims and objectives, which would, in turn, cascade to the research study's goals, actions and possible outcomes(Thuan et al., 2019). The connotation of the research questions expressed was to limit the study to the implementation of blockchain technology while defining the scope of the study, paving the way for the boundaries, trend, consistency, importance as well as the depiction, link and contrast of the variables and help in stimulating the approach of data collection and analysis of data (Farrell, 2016; Snyder, 2019).

RQ-1: What are the current blockchain applications developed to facilitate payment and provide cybersecurity to mitigate cyberattacks?

RQ-2: How can blockchain technology be adopted for regulations and to resolve paramount issues in the Central Bank of Nigeria?

RQ-3: What are the identifiable research gaps and the future research directions of blockchain technology in this study?

The researcher developed the research questions at the initial stage to reflect the goal of the research study. However, the research questions were reviewed and amended in subsequent chapters, precisely chapter three, before developing the survey questions. The same analogy was applied to the hypotheses to align with existing relationships and variables.

The study intended to improve the current payment system of the Central Bank of Nigeria by implementing blockchain technology to be abreast of technological advancement in the global financial landscape. Besides, this proposed development would utilise the benefits of deploying blockchain applications to fast-track the payment process, automate manual methods, and secure these transactions against cyberattacks (Kshetri, 2017; Yaga et al., 2018).

Hypotheses

The research hypotheses have been mix-formulated in line with blockchain technology implementation (McCombes, 2022) and structured in such a way that they can be explored, predictive, appraised and illustrative through the online survey and focused group (Saleem et al., 2021);(Tashakkori & Creswell, 2007):

H-1: There is a relationship between blockchain payment applications and cybersecurity vis-a-vis cyberattacks.

H-2: There is a relationship between centralised regulations and non-centralised regulations.

H-3: There is a relationship between research gaps and future research directions on blockchain technology.

1.8 Structure of the Thesis

Chapter 1 of this research study provided the introduction to this study comprising the background and rationale, aims and objectives, nature and significance of the study, as well as the statement of the research problem, research design methodology and scope.

Chapter 2 of this study encompassed a comprehensive literature review of the effects of blockchain technology implementation. Detailed historical background information on blockchain technology, the current blockchain technology development, central banks and blockchain technology deployment, the payment industry and blockchain technology, blockchain technology and cyber security, and the research studies on blockchain technology, including the favourable implication of the implementation, were discussed extensively.

Chapter 3 of this thesis offered a synopsis of the research approach and design adopted, population and sample of the research study, materials/instrumental of research tools, operational definition of variables, study procedures and ethical assurances, data collection process, and data collection and analysis. Furthermore, this chapter will review the research questions, hypotheses, reliability test, and validated survey validity.

Chapter 4 of this research dissertation reviewed the analysis of the data collected. The chapter consisted of the trustworthiness of data, results of findings, evaluation of findings, and findings and research questions, including tables, charts, graphs and relationships of the variables, as well as the participants' demographic data showcasing the response rate vis-à-vis the size of the population.

Chapter 5 of this research project comprised the thesis conclusion derived from the analysed data and indicates the direction of future research by academics and researchers. This chapter included the implications, potential limitations and interpretation of the results, recommendations for application, future research and findings.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This study provides the theoretical and conceptual framework, including the propositions, hypotheses, and methodology. Blockchain technology's historical perspective with the definition of blockchain technology and background information on blockchain technology will be discussed. The study would also focus on the development of blockchain technology, including the current trends in blockchain technology and applications. The researchers will highlight current trends and developments in blockchain technology, financial services, supply chain and logistics, smart city and governance. The emphasis would be on other blockchain technology applications such as education, agricultural services, credit reputations, and other industry blockchain applications.

The researcher would emphasise central banks and blockchain technology deployment consisting of central banks considering and using blockchain technology. The payment system, driven by blockchain technology, including blockchain technology payment applications and cyber security made up of blockchain technology cybersecurity mitigation against cyber-attacks and different stages of blockchain technology cyber security applications, will be highlighted. Lastly, the study would stress the research on blockchain technology containing previous research studies and the future direction of blockchain technology. The concentration would be tourism, the *Internet of Things*, and other industry sectors.

2.2 Theoretical / Conceptual Framework

The research study was conceptualised based on the belief that there is always room for improvement on any existing system in life, mostly when manually driven. Change is a risky venture but inevitable (Aravopoulou, 2016). The payment system in the Central Bank of Nigeria is moribund with several payment challenges that include the inability to keep pace with technological development in the light of projections that there would be a global digital payment revolution by the year 2022 and the key to driving this is the blockchain technology (McKinsey & Company, 2019; Afzal & Asif, 2019; Morgan et al., 2019).

The study focuses on exploring a project that would add value to the payment system in the bank and have a tremendous impact on the country's financial landscape will be highlighted. Implementing this research study would facilitate a flexible and secured transaction through the payment channel process (Zhong et al., 2019) and harmonise net settlement operations (Swan, 2017). This magnitude would also promote transparency and integrity of transaction data that are secured and dependable (Wust & Gervais, 2018; Beck et al., 2016) and provide cybersecurity against cyberattacks through the provision of error-proof, consistent and trustworthy transaction data (Signorini et al., 2018). In light of these beliefs, this study made relevant research questions and hypotheses bare.

The propositions drawn from the research questions and the hypotheses will form the yardstick for proposing a resolution to the problems through design, collection and analysis to situate the theory delineations, conceptions, variables, connexions and parameters (Aung et al., 2022). The proposed theoretical framework is a mixed-method approach of primary quantitative and secondary qualitative from the research study propositions and hypotheses (Archibald, 2016). The research is an empirical experimental/statistical sampling study explored to be predictive in proffering solutions to operational problems using an online survey and focused groups on collecting and analysing data (Fetters & Tajima, 2022; Creswell & Guetterman, 2019). The researcher embraced the deductive method to arrive at the hypotheses that form the basis of the theoretical framework (Saunders et al., 2019).

Proposition-1: What are the current blockchain applications developed on cybersecurity to mitigate cyber-attacks?

Hypotheses-1: There is a relationship between blockchain applications and cybersecurity vis-a-vis cyber-attacks.

Implementing the blockchain technology to facilitate the payment system would, in turn, provide functionalities of cybersecurity such as secure authentication, encryption/decryption, hash value generation, and virtual cash transaction to line up with global digitisation and mitigate against cyberattacks (J. Dai et al., 2017; Park & Park, 2017).

Null Hypotheses-1.1: No relationship exists between blockchain technology and isolated systems not connected to the network.

Null Hypotheses-1.2: No relationship exists between blockchain technology and isolated systems attacked by viruses and malware.

Proposition-2: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?

Hypotheses-2: There is a relationship between conventional payment and blockchain-facilitated payment.

Blockchain technology can boost the payment system by transforming all categories of funds, clearing activities and net settlement processes (Mills et al., 2016). The technology would also promote the development of customised applications to handle any process such as foreign exchange (**forex**), payment alerts and notifications (Cocco et al., 2017), as well as international trade financing, financial market trading, federal government interventions through the issuance of syndicated loans to enterprises (Lipton, 2018).

Null Hypotheses-2.1: There is no existing relationship between blockchain technology and payment operations that are not in the network.

Null Hypotheses-2.2: No relationship between blockchain technology and financial institutions that the regulatory establishment does not license.

Null Hypotheses-2.3: There is no relationship between blockchain technology and financial institutions not licensed for payment.

Proposition-3: How can the Central Bank of Nigeria regulate blockchain technology?

Hypotheses-3: Does blockchain explain the relationship between centralised regulations and non-centralised regulations?

Financial institutions' regulatory function is one of the core mandates of any global central bank. So, blockchain technology would provide the proper technicalities for the central bank to continue with this role in a non-centralised and remote platform to ensure policy compliance across the board (W. Li et al., 2017; Y. Guo & Liang, 2016). However, Artemov et al. (2017) perceived that regulation of blockchain technology would be an issue to crack in a decentralised network platform.

Null Hypotheses-3.1: There is no relationship between blockchain technology and financial institutions not linked in the network.

Null Hypotheses-3.2: No relationship between blockchain technology and financial institutions that are not licensed and recognised by the regulatory body.

2.3 Historical Perspective of Blockchain Technology

2.3.1 Blockchain Technology

There have been different definitions of blockchain, as many researchers view blockchain as synonymous with distributed ledger technology. This software network protocol enables protected transfer transactions involving funds, assets, and financial information through the Internet without a third-party midway financial institution (Swan, 2017). However, Priyadarshini (2018) defined blockchain as a disseminated pool of data with relevant information showcasing the activities and dealings that have occurred among connected parties in the network. He posited that every transaction is validated and irrevocable with transparent records stored in an accrued chain of blocks based on cryptography. Engelhardt (2017) postulated that blockchain technology is the core application for driving other innovative applications in a decentralised network.

A serial grade of transactions is regarded as ***distributed ledgers*** that could be shared and sustained by other relevant parties. While citing Iansiti and Lakhani in their book "***The Truth About Blockchain***", Rooney et al. (2017) stated that blockchain technology facilitates a communal ledger where participants are recognised players in the transaction process stored in the shared register. Blockchain comprises a chain of blocks with several data groups consisting of a series or ***chain*** of data bundles called blocks and contains numerous transactions (Nofer et al., 2017). They described blockchain as a vast accumulation of blocks, representing a collective ledger stipulating the history of transactions. These blocks are validated using the ***cryptographic*** technique where each block has a ***timestamp***, the *hash* value of the parent block and a ***nonce*** which is a chance number for confirming the muddle. In layperson's terms, Atlam and Wills (2019) opined that blockchain is akin to a financial market dealing room where transaction records are stored and frequently updated as businesses occur. They added that participation is without any third-party organisation. Simultaneously, the blockchain provides an efficient and secured platform with validation by widespread consensus to update the ledger in all participants' glare (Zikratov et al., 2017). They also expressed the various definitions proffered by organisations involved in blockchain technology.

An example is Coinbase (2017), regarded as the leading cryptocurrency interchange globally, which defined blockchain from the cryptocurrency perspective as "***a distributed, public ledger that contains the history of every Bitcoin transaction***". However, the Oxford (2018) dictionary defined blockchain as "***a digital ledger in which transactions made in Bitcoin or another cryptocurrency are recorded chronologically and publicly***". Webopedia described blockchain as "***a type of data structure that enables identifying and tracking transactions digitally and sharing this information across a distributed network of computers, creating, in a sense, a distributed trust network. The distributed ledger technology offered by blockchain provides a transparent and secure means for tracking the ownership and transfer of assets***". The focus on these definitions is predicated on the fact that the blockchain is built on two prominent features: distributed technique and decentralised platform. As highlighted by Sultan et al. (2018) in their definition, a blockchain is a database loaded with serial, connected and cryptographic blocks of digital assets signed and decentralised but administered by a unanimity concept. Tsilidou and Foroglou (2015) described blockchain technology as a shared ledger in the public glare, which contains all the transactions that have taken place in the network. They posited that the technology is an ongoing cyclic process of adding block transactions to the existing record as they are completed. The block is regarded as containing the up-to-date transaction of the blockchain with descriptions of all the current transactions perpetually stored in the database.

The process generates a new block when the flow of the existing one is finalised as numerous blocks are interconnected through a hash in a direct and sequential ordered chain. The detailed information, such as the addresses and balances of every completed transaction in the block from the beginning to the end of the process, is stored in the blockchain. In plain terms, Akcora et al. (2017) defined blockchain technology as a safeguarded ***distributed database*** comprising chunks of transactions that can be validated without necessarily having a central supervisory authority or a third-party power. They alluded that blockchain is being used alternatingly with Bitcoin because it was through Bitcoin that blockchain technology became prominent. Blockchain technology is currently being used in financial services and several other areas where the technology is needed, particularly for digital experience.

According to Davidson et al. (2016), blockchain is a means of developing a vigorous, protective and visible shared ledger for all participants to have confidence in the system. They postulated that blockchain is a digital institution enabling people to transact business in a program secured by cryptography. Catalini and Gans (2019). L. C. Lin et al. (2019) defined blockchain technology as a broad drive technology that tracks and resolves business transactions and administers trade agreements related to various digital assets.

Generally, blockchain technology, as a new technology based on hashing being the foundation upon which transactions occur, including smart contracts, as opined by Di Pierro (2017), is a shared platform where consensus, replication, attribution, fixity and conclusiveness take place. Andolfatto (2018) substantiated this school of thought when he posited that blockchain is a storage-keeping system with several attributes driving the platform. According to him, the critical word in blockchain operation is the unanimity of all relevant participants that the data contained in the ledger is correct. Blockchain leverages the non-conventional way of reaching an agreement, as this is based on the reputation of the participants. Trust is also the intermediary upon which the participants and the business rules hinge to maintain the economic value and importance of the business transaction. Some researchers see blockchain as a game-changer in the consensus process of all the participants and businesses to achieve the expected value in the transactions exchange.

Blockchain technology was brought to the fore with the advent of Bitcoin cryptocurrency, which is seen as the driving force of the revolution (Vujicic et al., 2018). They postulated that blockchain technology is closely associated with smart contracts, which portray the basis of innovative cryptocurrency progression. The researcher agreed that blockchain technology would have various definitions depending on how it was and is being perceived and implemented.

2.3.2 ckground Information on Blockchain Technology

The account of history, as recalled by Benton and Radziwill (2017), revealed that feelers of digitisation date back to early 1975 when George Pake and others at Xerox PARC prophesied that paperless documents and offices were the future of business as published by Week (1975) and this was fulfilled by the 1990s when the internet boosted verification and integrity of digital documents. They believed that the fundamental principle of blockchain was birthed when a proposal by two researchers on "***computationally practical procedures for digitally time-stamping … documents so that it would be infeasible for a user either to back-date or forward-date the document***" was implemented along with an upgrade of the system to process more than one document concurrently in a solo block.

History has a way of repeating and advancing in technology as blockchain technology traces started manifesting from the 1980s through the 1990s. However, the global financial crisis of 2008, according to Nikiforova et al. (2019), may have facilitated the introduction and awareness of Bitcoin that year, even as Pilkington (2016) postulated that the basis for the acknowledgement was the fact that the system was centralised to avoid utilising a single Bitcoin for multiple transactions. However, the general perception was that this was not achievable then. However, this was when control was being done by a third party to sustain the trust and bridge the communication gap. Nevertheless, it was in late 1990 that Szabo announced ***decentralised digital currency*** and termed it "*bit gold*". It was roughly ten years after this that

Bitcoin was introduced in a paper presented in 2008 by Nakamoto (2008). He hitherto assumed widespread popularity when he proposed replacing the centralised model with the decentralised technique based on unanimity machinery. At inception, the term "***blockchain***" was coined from the words "***block***" and "***chain***", which was joined into one word in 2016. Between 2011 and 2013, blockchain technology was primarily used for digital currency transfer and payment.

The same technology is the initiative for enabling digital transactions in most applications, thus taking advantage of the unique features (Treleaven et al., 2017).
Many pundits believed that blockchain technology was made prominent in the public glare via the speedy development of the Bitcoin cryptocurrency, mainly in financial services (Polyviou et al., 2019); (Laufs & Sandner, 2019). However, blockchain technology has been extended to other vital sectors such as manufacturing, health, e-voting and legal contracts, among other critical areas (Bhardwaj & Kaushik, 2018).

According to Dragos (2017), history has it that the first digital cash was introduced in the 1980s by David Chaum, while blocks of chains secured by cryptography were also mentioned in the 1990s. During that decade, Adam Black also had other innovations of haschash as a working system, and Nick Szabo devised the "bit gold" and "smart contract" concept. However, it was not until 2008 that a group of individuals or individuals believed to be operating under an alias called Satoshi Nakamoto devised the originally recorded blockchain, which is still regarded as a "***peer-to-peer electronic cash system***". The Bitcoin program's source code and database were publicly known the following year. Bitcoin became the first digital currency used as a value for digital exchange compared to preceding efforts to facilitate digital cash, thus marking the beginning of blockchain technology as there are hundreds of other cryptocurrencies.

Records had shown that even before the advent of Bitcoin, currencies such as ***ecash*** presented by Chaum and b-money offered by Dai. Akcora et al. (2017) opined that the technical limitations in the global spread of these currencies could be due to the legal implications and regulatory inadequacy, and as such, their foundation was faulty. They perceived that these currencies' failure could propel digital minds to learn from their shortcomings lessons and proposed new initiatives for workable currencies that the world is witnessing today. It was apparent from the beginning that proponents of digital currencies came across bottlenecks and fundamental hitches in their quest to get things going.

The idea of a distributed and open ledger to track participants' balances and investments was muted in searching for a substitute for a central authority. In this case, Davidson et al. (2016) stated that the formation of a decentralised ***peer-to-peer*** digital currency system proposed by Nakamoto's elucidation was what conquered all previous challenges. However, Buterin (2015) emphasised that blockchain technology is not dependent on Bitcoin even though Bitcoin became prominent through Bitcoin. He posited that several applications are riding on blockchain technology, of which Bitcoin is just one, based on the ledger records explicitly produced by the Bitcoin etiquette (Tikhomirova & Soia, 2019); (Berentsen & Schär, 2018).

The advent of blockchain technology as a *decentralised distributed ledger* system has disrupted the traditional centralised ledger system through which governance is administered by a centralised authority (Ahluwalia et al., 2020). So, Davidson et al. (2016) asserted that blockchain technology is less dependent on a third party for validation but instead utilises a harmonised mechanism with secure cryptography to authenticate every transaction in the database to ensure the safety and confidence of the system. They recalled that the traditional ledger pattern of dual record bookkeeping of the early 15th century did not change when the digitalised system was introduced in the 20th century.

The pattern was maintained in a non-centralised platform, corroborated by Abadi and Brunnermeier (2018) when they opined that blockchain technology had provided a breakthrough from the 14th-century bookkeeping data records to a transformed and modernised digital record-keeping database system. It is natural and evident, like any other invention, that the progression of blockchain technology has been an updated and gradual process in the sense that versions of ***blockchain 1.0, 2.0, and 3.0*** generations, as posited by Efanov and Roschin (2018) had been identified based on the development of various applications (Xu et al., 2019).

The general perception from time immemorial is that modernization cannot strive without money, as it has been transformed in different practices from one age to this current digital age (Lipton, 2018). He shared the thought of Aristotle when he stated that "***Money exists not by nature but by law***", thus implying that money is associated with governance and vice-versa.

Today, blockchain technology has evolved over the years to the extent that its current advanced features, where digital currencies are being used in a decentralised and shared ledger as a means of exchange to settle trade transactions, have become the norm in financial services and other sectors (Lipton et al., 2018).

2.4 Current Blockchain Technology Development

The infiltration of blockchain technology in all facets of our functionalities is revolutionary in the current dispensation. To think that such technology could be extended from the pioneering Bitcoin cryptocurrency into the various industrial sectors is quite innovative and ground-breaking (Ahram et al., 2017). Blockchain technology has become state-of-the-art in several areas of society, spanning from the payment system, where it is used as an enabler to facilitate the efficient transfer of funds and other payment transactions (Spearpoint, 2017); as a tool for providing several health services in the medical sector (Benchoufi & Ravaud, 2017); as a means for electronic voting in elections (Noizat, 2015); (Wang et al., 2018); in intelligent energy grid and energy trading (Oh et al., 2017); (Pop et al., 2018); providing efficiency in the educational sector (Sharples & Domingue, 2016); (G. Chen et al., 2018); in supply chain management and logistics (Saberi et al., 2019); as a technological device for urban development (Shen & Pena-Mora, 2018); in engineering and construction management (J. Wang et al., 2017); to the reputation management system (Schaub et al., 2016).

In the process of researching the present state of blockchain technology, Casino et al. (2019) posited that the applications emanating from the technology have spread to diverse sectors and industries, including healthcare, smart contracts, extensive data management and supply chain, besides the *Internet of Things* (IoT), privacy and familiar business we are all used to. In the study conducted by Cui et al. (2019) on the current trends of blockchain in the *Internet of Things* (IoT), they posited that the Bitcoin system was still regarded as the benchmark and mover of the cryptocurrency market. The market fluctuates and affects other coins based on the Bitcoin price (Yli-Huumo et al., 2016). The use of blockchain technology in intelligent home systems is also a current trend in the landscape, as posited by Moniruzzamana et al. (2020) in their study "***Blockchain for smart homes: Review of current trends and research challenges***". They postulated that innovative home applications include *VeCap*, a blockchain-assisted solution that drives brilliant household activities and power systems (Di Silvestre et al., 2020). Blockchain healthcare application in handling patient care is another system developed to organise patient care in hospitals and clinics (Durneva et al., 2020).

One of the most critical challenges for the financial landscape concerning the use of blockchain technology and cryptocurrency as the world's primary digital currency is the expansion of a novel and suitable ***global financial architecture*** that will guarantee the stability of the financial apparatus being initiated and the ability to stimulate acceptable monetary policy. The objective of cryptocurrencies developed on the tenets of ***decentralization*** undermines and conflicts with the ***values and principles*** of the current financial setting. The authors discovered certain aspects of the enthusiasm surrounding cryptocurrency actors. This discovery permitted the authors to articulate the rudiments for the global propagation of cryptocurrency after the global financial crisis between 2007 and 2008. – This development led to total decentralization in the public arena, complemented by rising "***public fatigue***" from the burden of centralization mechanism, taxation, and regulation, which will prohibit the operations of market regulators, among others. They surmised that otherwise, blockchain technology is an innovative venture.

Alternatively, its innovative, practical application in finance led to the creation of a ***local monetary system*** formulated on ideal competition and a free market's tenets. However, cryptocurrency allows participants to enjoy a total lack of control and non-intervention by the authorities in the financial system. In its initial recapitulation, the cryptocurrency world moved to financial mayhem. In this arena, ***economic entities*** can be ***anonymous***; participants chase their respective profits, avoid paying taxes and operate in an environment different from society (Dorofeyev et al., 2018). X. R. Zheng and Lu (2021) opined that despite blockchain being a distributed ledger database and decentralized system, it would stimulate the centralized platform to make a broad ecosystem. Raikwar et al. (2020) expressed that the current trend in blockchain technology is the collective impact between blockchain and databases regarding the new functionalities in some novel databases. Since Bitcoin is driven by blockchain, all its features, such as transparency, public ledger attributes, decentralized transaction environment and visibility to all participants, contribute to the current financial development (Yli-Huumo et al., 2016). This school of thought was corroborated by Holbrook (2020) when he posited that blockchain development is focused on ***Quorum, Hyperledger Fabric, Corda and Ethereum,*** while intelligent contracts are mainly developed using Java tools that include ***Corda, NEO and NEM***. He emphasised that Ethereum is pitched towards applications that promote group routines in its decentralized network (Shrivastava et al., 2020).

2.4.1 Trends in Blockchain Technology

The current trends in blockchain technology development have been world-shattering since Bitcoin was invented. As earlier mentioned in the definition of blockchain technology, blockchain is strictly a distributed databank of transaction activities categorised by an irrevocable process without any definite third-party authority (Rossi et al., 2019). They implied that blockchain had become the norm apparently because of the simplification and transmutation of the ease of doing business, specifically in transaction cost reduction and the needless of having a central authority, as also expressed by Nowiński and Kozma (2017).

The world is presently observing a transformation in the global financial system, in the background of the emergence of thousands of virtual coins, which are unregulated by the appropriate domestic, regional and continental authorities even though some of them have released policies on the risk of using these virtual coins (Manta & Pop, 2017). They opined that these unregulated coins had exposed the funds behind them to be used for money laundering and possibly terrorism financing. In light of this development, continental central banks such as the **European Central Bank** (ECB) have initiated bills in the European parliament to curtail the use of these dark funds to launder and finance terrorism due mainly to its inability to regulate the process.

With the spread of financial transactions on the Internet, many people have elevated obligations for financial services, as posited by (W. Zhang, 2022). He deduced that the internet was the basis upon which transactions thrive in the economic landscape and that the rapid development can be ascribed to the impact of the internet. As a result of this, the blockchain has been broadly applied in many areas. The conclusion of his study showed that blockchain technology is being used extensively in many fields, both at home and abroad, especially in the financing supply chain, where the trend keeps increasing astronomically. W. Yang et al. (2018) opined that the current trend is that blockchain technology has brought about significant growth in the financial landscape with diverse applications to various sectors of the economy. These sectors include but are not limited to **agriculture, supply chain, smart city, finance, healthcare, aviation, leasing, vehicular tracking system and accounting**, to mention but a few. This trend continues as more areas are being implemented using blockchain technology, particularly in the fields with financial implications.

Smart contract finds solace in blockchain technology simply because of the agreement between parties that must be documented in the system. The intelligent contract process leverages technology protocols to stimulate validation automatically, apply the agreement on the agreement and implement accordingly without any intermediaries or key central authorities (S. Wang, et al., 2019). They opined that smart contracts could discover a broad continuum of future application developments in the intelligent industries and digital economy, including healthcare, management and financial services. These initiatives have been integrated into conventional blockchain-based platforms like ***Hyperledger and Ethereum*** (Teng et al., 2021). Blockchain adoption is spreading, especially in the energy sector, where transparency, verification, security, tracking and data exchange are guaranteed. They opined that "***energy blockchain***" has become a phrase used when blockchain-based energy applications are implemented, mainly when it can develop digitized, decentralised and decarbonized energy information management systems. They surmised that government-backed and multinational organizations have the potential to unleash large-scale implementation of energy blockchain applications. Government involvement ensures that the appropriate standards and regulatory mechanisms are adhered to in the industrial application.

Prospects in the use of blockchain are extensive, and many sectors have started having a feel for the functionality. Besides the healthcare sector, other areas, such as 5G ultrasonic devices, privacy, security, big data, pharmaceutical domains, clinical trials, and sharing processes, have greatly improved (Hussien et al., 2021). The weaknesses and strengths of cryptocurrency transactions compared to cash were assessed by Dorofeyev et al. (2018). They illustrated that because of the prolonged use of regular money, it is still the best way of exchange and transaction in business, which has successfully allowed every stage of social development and improved financial services. They observed that the regular money supply and electronic money overwhelm the precious metal and digital currency because of the preference of consumer usage. They assumed that when the number of digital currency users exceeds the regular money, it will curtail the monetary policy authority's ability to ensure economic growth and macroprudential stability may arise. They argued further that systemic shock of the economy would set in once a sizeable number of the population are transacting in Bitcoins. However, if most nationals conduct their Bitcoin transactions, it would be difficult for the central banks to use the monetary policy mechanisms to accelerate the economy, primarily through the discount rate. Besides, the inconsistent rate of Bitcoin can stifle monetary policies and gradually transcend to asset depreciation within a short period, which may result in the inability of consumers to meet their payment obligations and insolvencies and liquidations.

2.4.2 Present Blockchain Technology Initiatives: Blockchain technology's potential has enticed many private and public investments from society, particularly in the capacities of "financial markets, smart contracts", significantly enhancing existing cybersecurity efficiency processes.

The recent alliance between IBM and Maersk to use blockchain in the movement of goods across the world was jointly contracted (Rossi et al., 2019). Blockchain is likened to the latest technological innovation globally, even as Gartner consulting company ranked it among the top ten (10) 2018 tactical technologies. Its adoption has spread to several societal sectors (Marsal-Llacuna et al., 2020).

However, W. Yang et al. (2018) pointed out that blockchain technology has advanced over the last few years with various cryptocurrencies being introduced since the emergence of the Bitcoin generation, followed by the "***Ethereum***" platform in the second phase; thus, the progression from blockchain 1.0 through to the current blockchain 3.0 and the imminent blockchain 4.0 where blockchain technology is being used in several sectors from health care (T. Mackey et al., 2020) to energy power expenses and beyond. They perceived that blockchain 4.0 would project a new age of significant internet value with "***Seele***" (a blockchain) hoping to promote modernised unanimity algorithms grounded on what he termed "*Neural Networks*" that stimulate the error forbearance of a new network system, standard data mode, internet link protocol to facilitate interface with other web resources such as Artificial Intelligence (AI) for blockchain-centred evolving services. Z. Zheng et al. (2017) opined that blockchain technology is being combined with financial technology (Fintech) and the *Internet of Things* (IoT) to develop robotic applications where there is little or no human intervention in the operations of the processes. The technological path is through innovation and data worth modernisation of intense integration.

Currently, the finance scope focuses on raising attention and control from the authorities even as the appropriate legal framework and regulatory procedure of cryptocurrency and blockchain technology are being prepared and enhanced. As time evolved, there has been a steady rise in the number of participants in the cryptocurrency platform, considering the volume of transactions and relationship requirements between the existing financial system and cryptocurrencies have been established. It is feasible to assert that cryptocurrency has been transformed from anonymous payment methods to more transparent and personalised financial resources that are visible and accessible to regulators (The Jamovi Project, 2022).

Furthermore, in the United States of America, the initial efforts were made assuredly to develop a ***financial infrastructure for tax payment using cryptocurrencies***, to offer autonomous cryptocurrencies and substitutes to decentralised cryptocurrencies such as Ripple cryptocurrency designed to enhance the payment system, thereby delivering the centralised regulation option of a proposed robust system. Dorofeyev et al. (2018) declared that the cryptocurrencies' inadequate protocol capacity has undermined the potential of blockchain technology at a point appropriate for their enormous usage in the global exchange market.

However, the author still perceived the level of cryptocurrency cannot be measurable with the traditional money being used to transact business due to the authority's rigorous legal and regulatory framework and the public acceptance as a legal tender in the global financial system. The role of cryptocurrency would be more fundamental when the optimal reality of the ***centralised economy*** is established, the appropriate financial experience on the practical application of cryptocurrency is accrued, the technological shortcomings of the blockchain protocol are resolved, and a balanced concession between the centralised and decentralised platforms. He surmised that a revolutionary reform of the global financial system and the drastic reduction of cash-based transactions would be feasible only if blockchain is a more efficient payment system globally.

2.4.3 Blockchain Technology Trends in Governance: The Government controls blockchain development in Russia since about 70% of the public sectors are government-owned. However, IT companies have shown more interest in incorporating blockchain technology with "***predictive analysis, machine learning, artificial intelligence and Internet of Things***", as expressed by Karapetyan et al. (2019). Besides, they stated that corporate organisations drive many blockchain development projects, with government regulation in the background. According to Kshetri and Voas (2018), blockchain adoption in developing countries posited that the implementation has helped reduce corruption and fraud and intensified the registration of authorised asset titles, inspiring efficiency and attracting foreign direct investments (Gratzke et al., 2017). Current events have shown that most global corporate organisations are forming blockchain syndicates to facilitate applications in financial services, industrial and consumer products, information and telecommunication, and public and cross sectors.

As posited by Kaal (2020) in his study, corporate governance enables organisations to regulate the decentralised system vigorously. Implementing blockchain technology would ensure the safety and proper use of the solution after a protracted attack on Ethereum in 2016. Much as there are no systematic standards governing the blockchain platform, Y. Liu et al. (2023) reported in their study that governance could stimulate the adaptableness and modernisation of the blockchain solution while maintaining the ethical considerations of the purpose and objectives of the project. They suggested that corporate governance should be incorporated along with the implementation process so that the roles and responsibilities of the key stakeholders would be discussed to align with the stakeholders' decision privileges, accountability and entitlements.

Researchers perceived that the volatile development of digital currency triggers exceptional opportunities and significant challenges in the regulatory process, as admitted by Jacobs (2018) in his research on the challenges of global governance. He stated that much as blockchain implementation had lowered the cost of operations and alleviated obstacles to the world movement of money, cross-border transactions, trade finance, and foreign investment portfolios; it has propelled the concealment of money launderers, tax circumvention and other illegal financial activities to thrive underground thereby liberating the possibility of regulating the economic and financial transactions form the control of central banks and governments. The emergence of global digital currencies could diminish the ability of regulators to control and supervise the process and mount significant pressure on the government to authorise relevant institutions for international best practices on governance (H. Singh et al., 2020).

The governance of the blockchain economy may drastically deviate from the norm of control we are used to since the platform is entirely different from the conventional process (Beck et al., 2018). Therefore, they proposed the three governance components "***a novel IT governance framework and a research agenda for governance in the blockchain economy***". Campbell-Verduyn (2018) is of the view that consistent assessment and scrutiny of broader ethical consequences should be adopted to tackle unethical issues in the era of a dynamic technological transformation. Mackey et al. (2019) proposed a governance framework on a syndicate of blockchain models to produce a more effective means of traversing blockchain applications. The essence of this is to ensure that organizational ethical standards are adhered to, thereby increasing transparency and accountability. Zachariadis et al. (2019) proffered that blockchain governance, in tandem with the IT platform governance, provides a crucial viewpoint on "***control mechanism, decision rights and incentives***". Their proposal was hinged on a model that would adopt shared administration and encourage the inclusion of critical stakeholders.

2.4.4 Developments in Financials Services: In the study conducted by Dorofeyev et al. (2018), they surmised that crypto devotees propose cryptocurrencies in their day-to-day lives to transform the business model in the financial industry. Letters of Credit (LCs) are financial instruments used in international trades that, according to Chang et al. (2019), were enhanced by blockchain technology, particularly in stimulating smooth process flow and trade performance. Kar et al. (2019) construed that blockchain technology has dispersed into most organisations' processes with different integration levels. In their study on using blockchain technology in financial services, Pal et al. (2021) proffered that the five principles of blockchain are "computational logic, peer-to-peer transmission, irreversibility of records, distributed database and transparency with the pseudonym", have enormous potential to release and transform the financial services of any country. Their prediction was based on the rapid growth of blockchain-based processes in the global economic landscape of insurance, banking, financial markets, cryptocurrency, and trade finance.

To avoid a situation where investors are taxed twice on the payment of their dividend and later claim a tax return, and presentation of forged documents and lack of sufficient tax information from foreign countries (Hyvärinen et al., 2017), the researchers examined the possibility of providing a viable solution through blockchain to overcome this challenge against the background of current developments in blockchain technology capabilities. They also developed a blockchain-based paradigm to eradicate the tax imbroglio regarding dividend payment. Chang et al. (2020) stipulated the four characteristics of blockchain technology namely, (***decentralization, users' anonymity, consensus mechanisms and execution***) as the basis for a successful implementation in financial services.

They went further to list the success factors needed for adopting blockchain solutions in financial services, which will also be vital for the research department: "***Enough capital and good financial management***" is a must for any organization to be successful as it is costly to embark on it. "***Align the organization's activities with the blockchain initiatives***" to ensure a win-win solution for all stakeholders. "***Sufficient energy and electrical supplies***" would be needed for adopting blockchain technology. "***Reliable high computational power***" would be paramount in acquiring high-end servers with high processors. "***Intelligent algorithms with mathematical complexity***" are required for successful blockchain implementation. "***Well-trained teams***" are a priority for the members to exhibit their skills and expertise. "***Security and privacy***" is vital to ensure a safer system environment. "***Analytics and user interfaces***" are for background implementation of system programs to ensure smooth functionality. "**Focus on product development, quality assurance, reputation and community building**" to guarantee the production of high-quality output.

Many researchers believe blockchain technology is the primary driver of financial technology (Fintech) innovation since the impact is mainly in the payment system, as postulated by (Ali et al., 2020). They remarked that blockchain technology has the potential to transform emerging markets, which is a motivation for investors to checkmate their investments where it has the versatility to keep not only financial records but storing of medical records and details of personal credit information, tracking of goods movement, verify payment among others. According to the projected market size, they predicted that by 2024, the blockchain market would exceed $7 billion, implying an annual growth rate of about 37%. This swift evolution is predicated on the increasing demand for blockchain technology across industrial and financial sectors, including infrastructure, public domain, distribution, services, manufacturing, telecommunication, transport, healthcare, and media. Overall, blockchain technology transcends every industry in society, including the possibility for investments to thrive in the social and environmental linkages.

2.4.5 Blockchain Technology in Trending Services: Ablyazov and Petrov (2019) inferred that the current trend of blockchain applications in construction management is overwhelming, particularly in the extent of real estate investments and global monitoring, protection of the environment, object construction design, maintenance of road construction and improved collaboration between construction managers and financing institutions.

The logistics sector is one area that X. Li et al. (2019) gathered has made a tremendous mark lately, especially in the entire logistics that includes supply chain taxonomy. These industries include manufacturing at the embryonic stage of knowledge acquisition while public administration is at the persuasive phase; communications, transportation, electricity, oil and gas, and hygienic services have reached the level of affirmation while the service sector is at the deployment stage.

They singled out insurance, real estate, and finance to be pacesetters of the blockchain technology applications currently in the adoption phase, where they are being used to provide services. Strobel and Dorigo (2018) deduced that robotics performance would be enhanced when integrated with blockchain technology which can be achieved in the shared algorithms and Kindles reputational management system for the group robotic applications such as "*machine learning"* algorithms. Bell et al. (2018) postulated that blockchain adoption in the healthcare sector would enhance medical device monitoring and drug traceability to the concerned patients from the supply chain and medical care patient information interchange.

Many research pundits believe that blockchain, coined from the Bitcoin cryptocurrency process, has attracted deep interest from the technological and financial world, including the research and academic society, simply due to its unique features, including decentralization, doggedness, obscurity, and transparency. A few years after the advent of blockchain technology, it has developed and become worthwhile for several applications besides the finance domain. However, owing to the sophistication of blockchain technology, it is typically complicated and expensive for most software players to develop, sustain and assess the blockchain platform that supports their systems. In this line of thought, W. Zheng et al. (2019) explained that most software developers lack the necessary skills to ensure dependability and, often, security of the blockchain platform, which to a particular degree, obstructs the quality of their blockchain functionalities. Their study proposed and developed a blockchain as a service (BaaS) application labelled "***NutBaaS***", which offers blockchain-related services in the cloud, such as deploying network configuration, intelligent contracts and system tracking and testing. Based on these service deliverables, web developers can concentrate on coding the program to explore the applicability of blockchain technology to their business. The essence is to align the blockchain to their business to achieve desirable deliverables without little or no human intervention.

Blockchain technology is virtualised as a predictable tool for future sustainable development, as posited by Nguyen (2016). He implied that the global financial crises of 2008 could have been avoided if blockchain had been implemented during that period. Unfortunately, blockchain technology was not in vogue during that financial crisis period. However, he opined that adopting the blockchain in transparent and liberal ways could play a significant role in sustaining global development goals, believing that blockchain technology could benefit the customers of the financial system and society.

2.5 Blockchain Technology Applications in Other Financial-Related Sectors

Blockchain application transcends all aspects of society where processes occur and drive old and new initiatives. ***The beauty of blockchain technology applications is in the financial services component that is related to other relevant sectors***. Recent statistics have shown that blockchain adoption extends to various segments of the economy. Many blockchain technology applications, mainly financial services, have been developed in multiple global economic sectors that rank number one in the assessment. Syed et al. (2019) maintained that blockchain discussion in the industrial and research community has transcended into implementation in numerous areas of society, including fields that are aurelia in their processes. They proposed the key areas that blockchain technology would be widely adopted in the foreseeable future, such as business comprising vehicular and healthcare and the *Internet of Things* (IoT). Rawat et al. (2019) opined that the blockchain adoption of its prominent features on various use cases and applications has been brought to the public's attention in the past few years. Financial services occur in all sectors of society where blockchain technology can also be applied.

2.5.1 Application in Supply Chain and Logistics: Blossey et al. (2019) and Nguyen (2019) stressed that blockchain is presently used for supply chain and logistics management through the provision of ***accountability, validation, automation, transparency,*** and what they called "***tokenization***", The blockchain technology is applied in the financial aspect of the supply chain and logistics channel where payment is transacted, which implies the adoption of tokens for treasured asset claims and means of exchange among registered participants. Mattila et al. (2016) suggested blockchain technology could be a product-centric approach to perfect the supply chain process and other blockchain-based applications. Blockchain applications have been developed to manage the supply chain network from end to end (Dujak & Sajter, 2019). However, Wang et al. (2019) stated that using blockchain technology for the supply chain process is gaining impetus as trust is the fundamental factor pushing the adoption. They surmised that the impact of blockchain on the supply chain rests on four key spots: "***extended visibility and traceability, supply chain digitalisation and disintermediation, improved data security and smart contracts***". Esmaeilian et al. (2020) emphasised that the sustainability of the supply chain in blockchain technology extends to the "***Internet of Things (IoT), which facilitates the management of energy in the smart works, smart logistics and transportation, and smart business models***".

They expanded the scope by revealing the capabilities that blockchain technology presents for improving sustainability in the four groups of ***design of incentive mechanisms and tokenization to promote green consumer behaviour, enhance visibility across the entire product lifecycle, increase systems efficiency while decreasing development and operational costs; and foster sustainability monitoring and reporting performance across supply chain networks***". Casado-Vara et al. (2018) asserted in their new blockchain study on improving the current supply chain process using the blockchain system. They suggested that their research lies in the capability of blockchain to store all supply chain transactions by adopting a "multiagent" approach using smart contracts to oversee the supply chain efficiently. This analogy was made because of the hypothetical belief that smart contracts eliminate mediators and stimulate spherical economy market operations. The proposed model concentrated on the agricultural sector by improving safety and proficiency via automation by the representative system. With this development, the tracking of products prepared for shipment can be monitored and stalked with proof of payment transactions from source to destination of consignment authenticated. They claimed that their prototype further exhibits additional proficiency than other current ones. The supply chain model system acknowledges every order submitted and ranks the members' performance to reward them accordingly.

The failure of traditional supply chain systems to meet the yearnings of customers in terms of cost-effectiveness and quality of service prompted the emergence of a blockchain-based supply chain system, which is intelligent, computerized, and viable (Yadav & Singh, 2020). However, Kshetri (2018) declared that a successful implementation of a blockchain-based supply chain system would project the outcome of flexibility, cost reduction, risk mitigation, reliability, speed, and quality of service that includes accountability and transparency. He thinks that a blockchain-based supply chain system is more amiable and less complex when compared to the payment system in the sense that it is easier to implement. The use of blockchain in the supply chain process can identify the performance of every action, even down to the nitty-gritty of where and when the activities took place. It also carries the customers' trust by eliminating intermediaries, stimulating efficiency, and reducing the cost of operation since the customers can access the system on a real-time basis to monitor the business performance.

Similarly, Wamba et al. (2020) corroborated the school of thought shared by some researchers that performance and transparency are the key attributes of a successful blockchain-based supply chain system implementation. Bechtsis et al. (2017) detailed the use of a blockchain-based supply chain in an ***automated guide vehicle.*** The benefits derived from the system include adequate ***"labour cost savings, reduced energy consumption and emission, enhanced safety, and increased productivity"***. This correlation was corroborated by Tönnissen and Teuteberg (2020) in their study "***Analysing the impact of blockchain-technology for operations and supply chain management: An explanatory model drawn from multiple case studies"***. In addition, they opined that transparency and trust also typified the blockchain-based supply chain system where intermediaries have been eliminated, which resulted in a time-saving and cost-effective process.

2.5.2 Smart City Blockchain Applications: The development of blockchain technology applications in what is termed the "***Smart City***" platform (Biswas & Muthukkumarasamy, 2017) has gained ground in digitizing the mode of transportation, building a conducive environment (Li, 2018), human resources development (Zambrano, 2017), financial services, economy, governance and good quality of living, (Alessandra et al., 2018). Research pundits reported that efforts were made to adopt cryptocurrency in the United States of America's tax payment process to promote blockchain-related payment services (Dorofeyev et al., 2018). Sharma and Park (2018) specified that intelligent cities came to light with the advent of the *Internet of Things* (IoT) as a modern structure of sustainable expansion. They insisted that a smart city is built on independent and dispersed infrastructure that combines "***intelligent information processing***" and "***control systems heterogeneous network infrastructure, and ubiquitous sensing involving millions of information sources and ubiquitous sensing involving millions of information sources*** ". They inferred that due to the continual expansion of the volume of data, which is resulting in the "***Big Data***" bang and the number of devices connected to the *Internet of Things* (IoT), issues like privacy and security, high dormancy, scalability, and bandwidth constrictions are bound to escalate in the present smart city architectural network (Lăzăroiu & Harrison, 2021).

To address these issues and achieve an optimal intelligent city system with secured, efficient and scalable features, they proposed a "***novel hybrid network architecture***" smart city by relying on blockchain technology along a dedicated network. They divided their architectural model into main and point networks and proof of concept to ensure privacy and security (Evans & Horak, 2021). They went to the extent of stimulating and evaluating their model using several performance metrics, and the outcome indicated an effective prototype as proposed. (S. Singh et al., 2020) emphasised that considering the structure of a typical smart city shows that the characteristics are elements of intelligence in the adoption of evolving technologies, which had metamorphosed into an intelligent digital **city** in the ecosystem. They opined that the convergence of blockchain technology and artificial intelligence transforms the smart city landscape to build a viable and green ecosystem with an intelligent transport network (Bai et al., 2022).

Corroborating the aphorism of a smart city Li (2018) declared that besides a smart transport system, the ecosystem should also include a green energy environment devoid of pollution and governmental activities. He thinks the smart city combines big data, the *Internet of Things* (IoT), and the vitality Internet. Xie et al. (2019) confirmed that a smart city provides the opportunity to resolve the challenges of urbanization and ensure the distribution of resources meant for public use and high-level quality of services to the population to improve their way of life. To achieve this feat, they implied that a blend of blockchain technology, the *Internet of Things* (IoT) and artificial intelligence must be adopted to implement and drive a typical smart city.

He surmised that a smart city should be composed of smart infrastructure that includes an intelligent healthcare system, innovative transportation network, smart power grid, and intelligent supply chain management system to use by smart and intelligent people. Kundu (2019) in his study implied that a classic smart city should be transparent in its operations with the people adhering to corporate governance, e-commerce, and entrepreneurial schemes to grow the economy and transform the city into a digital one managed by machine learning, data analytics, *Internet of Things* (IoT), artificial intelligence backed by blockchain technology, which would facilitate trust and consensus among the citizens and the institutions. He presented the potential of blockchain technology in implementing a smart city in four classifications, including the impact of the network on trusting the governments, infrastructure and society, encouraging the citizens to boost the economy, and the liquified and shared economy. He assumed that considering the present network topology of technological innovations, blockchain is the best option to embody trust in an innovative digital city.

This analogy was substantiated by Nam et al. (2019) in their study when they emphasised without any reservation that blockchain is the appropriate technology to drive a smart city, which will also influence the tourism system. However, Laufs et al. (2020) proffered that the issue of crime prevention and security using blockchain technology is always overlooked and therefore proposed using innovative sensors to support the traditional radars to facilitate new functionalities of providing security (Kushch & Prieto-Castrillo, 2019). Siddiqui et al. (2023) proposed an appropriate security framework that would provide shared services driven by ***multichain blockchain networks*** for data protection in a collaborative environment in the smart city. Their purported security initiative is hinged on the vigour of intelligent contracts to enforce corporate governance, manage every interface protect all transactions between distinct and varied networks. As a matter of specifics, they likened a smart city to an intelligent municipality with a "digital municipal corporation" put in place to deliver holistic local management shared services based on automation and digitalization to improve the citizens' standard of living. They believed that their suggestion would ensure the reliability and privacy of data that would be crucial to the citizens and government at all levels.

The purpose of a smart city is to enhance the existing facilities to provide quality services, which include an innovative transportation network, green energy utilization, intelligent healthcare services, and intelligent education services to better the routine life of the citizens (Bhushan et al., 2020). However, as other researchers have observed, they also expressed reservations about the security concerns, providing possible protection tips to address the worries. They maintained that using blockchain for intelligent city implementation was to leverage the technology's unique characteristics, including "***auditability, immutability, decentralization, and transparency***". Esposito et al. (2021) argued that implementing an innovative city application from scratch is implausible and entirely owned by a single company. He stated that in most cases, he obtained a consortium of companies sponsoring the project in conjunction with the government and integrating some existing silos applications with a supportive and well-established platform labelled "***FIWARE***". In the computer world, a single server source is not appropriate computer-wise, mainly when such a server is classified as a distributed and multi-dimensional deployment. So, provision must be made for a parallel server and backup or fail-over server for business continuity. They also proposed a single sign-on to ensure a single login would extend to all distributed applications embedded in the platform. This approach is vital so that users do not have to have different usernames and passwords to login into several applications. The single sign-on is proficient enough to make the system user-friendly. Researchers believe blockchain technology can implement the single-sign-on utility with security policies to manage access identification.

Researchers have various hypothetical views about the smart city, as in the case of Treiblmaier et al. (2020) where they classified "smart city" as the modernization of an urban area from the traditional concept to assuage the challenges inherent in them through the application of information and communication technology as the critical driver and a term they categorized as "***smartization***" of cities. They developed a framework and manual of pertinent factors to manage, operationalise and evaluate the implementation procedure and the effect of relevant technologies. Their study underscored blockchain technology as the exclusive driver of the technological revolution comprising various fundamental techniques and communication protocols and the transformative influence on the smart city. Their presentation was based on the framework and study propositions. They identified nine initiatives: smart home, intelligent education, robotic factory, electronic voting, innovative healthcare, green energy, administration and quality services, logistics and supply chain applications.

The advent of emerging technologies such as artificial intelligence and the *Internet of Things* (IoT) can be utilised to develop a smart city, according to (Singh et al., 2022). They posited that the paradigm shift is evident when combined with blockchain technology to deliver a digital ecosystem for a sustainable, intelligent society. However, this innovation is not without the accompanying opportunities and challenges. Ghazal et al. (2022) contended that the essence of constructing a smart city is to improve the quality of services and life for the residents in that society. A smart city could be located within an estate in a town or an entire city where people dwell inside it. They preached that artificial intelligence, the *Internet of Things* (IoT), and blockchain technologies must be collectively utilized to accomplish the smart city. The features of blockchain technology must be identified and brought to bear in implementing the smart city, including the challenges and vital requirements (Dewan & Singh, 2020).

2.5.3 Application in Healthcare Services: Blockchain application in some aspects of the healthcare sector is not as straightforward as in other industrial sectors due to health-related Acts that might impede the implementation, as assumed by (Daniel et al., 2017). However, the financial services element where payments are made in the process appeared to be straightforward. Besides, they articulated the concern that part of the clinical trials did not produce matching approaches and outcomes. However, Nawari and Ravindran (2019) substantiated that blockchain had facilitated positive results through clinical trials and electronic records of healthcare activities.

The potential of blockchain healthcare in Tunisia was exemplified by Rejeb and Bell (2019) in their study when they proposed the adoption of blockchain technology to address their numerous health issues in the healthcare sector. They contextualized the capabilities of blockchain to provide improved and healthier patient care, an efficient payment system and improved patient protection and welfare. However, Haleem et al. (2021) demonstrated that applying blockchain technology to the healthcare sector would safeguard and synchronise patients' data through various healthcare segments, including clinical hospitals, pharmacy companies, diagnostic laboratories, medical doctors and medical doctors and nurses. They believed that blockchain technology could conveniently be applied to precisely distinguish acute misdiagnosis and severe blunders in the medical arena. The result of the application is expected to enhance the transparency, security and performance of medical data sharing in the healthcare sector. Besides, it would assist in maintaining and evaluating medical records and gaining insights into medical examinations.

The healthcare benefits of implementing blockchain technology were thoroughly examined by Hasselgren et al. (2020) in their study, highlighting the various enablers, capabilities and integrated workflow components of blockchain technology to strengthen the global healthcare infrastructure. They affirmed that blockchain technology is pivotal in resolving deceit and exploitation in clinical experiments as it can enhance healthcare data's efficiency and security. Agbo et al. (2019) suggested that the healthcare sector is one of the areas in which blockchain technology is targeted to make a significant impact considering the criticality of the domain. Their study was predicated on the ***Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)*** in which a dedicated design search modus operandi was adopted to explore some science-based databases to distinguish, isolate and evaluate all relevant healthcare publications and apply the blockchain technology applications. However, Bell et al. (2018) had earlier proposed that blockchain technology can be used the healthcare areas such as healthcare insurance, drug tracing, clinical trials and patient record tracking. Radanović and Likić (2018) corroborated that blockchain expansion into medicine, among other fields, is significant in that there are sensitive fields of medicine that could be explored, such as research on biomedical, which many researchers seldom study. They suggested that with ***capital investments*** in blockchain technology running into hundreds of millions of dollars, medical professionals and business moguls should take advantage of this and explore blockchain's innovative potential to transform medical practice and healthcare corporations (Siyal et al., 2019).

The implementation of blockchain technology has moved from hype some years ago to functional applications in recent times, especially in the healthcare sector, according to McGhin et al. (2019). They affirmed that implementing blockchain technology would require shared record obligations, interoperability, and rigorous authentication depending on the extant laws guiding the healthcare insurance policy. Siyal et al. (2019) stated that the incursion of blockchain technology for delivering a safe and protected healthcare information management system has been remarkable, particularly in reforming traditional medical practices to a modern and dependable way, especially in specific areas of diagnosis, treatment and prescription. Futuristically, they predicted that they foresee a situation where blockchain technology would be used holistically to oversee all healthcare-related processes in real time. Much as De Aguiar et al. (2020) concurred with this proposition; however, they specified the intricate area of patient confidentiality that should be breached under the privacy policy, believing that blockchain technology can handle this too. On the contrary, McGhin et al. (2019) believed that there are some health-related areas that the implementation of blockchain technology are being undermined, and these fields include: "***Knowledge infrastructures, Picture archiving and communications systems, Automated diagnostic service for patients, Administrative systems, Population health management system and Pharma supply-chains.***"

For a purposeful and optimal result, blockchain technology is combined with the *Internet of Things* (IoT), as posited by Farouk et al. (2020). They opined that this alignment with the implementation in the healthcare sector would ensure effective and precise healthcare record management, which is paramount. The process begins with assessing the record of the patients in real-time, performing the treatment and prescribing the appropriate medication to the patient's satisfaction and pleasure. However, they stated that implementing blockchain technology in the healthcare sector, like other domains, has pros and cons. Nevertheless, the deployment would improve the management of the application, including the security and analysis of the big data. Due to the sensitive nature of the healthcare system, it demands real-time processing, especially in emergencies, and carefully selects the appropriate algorithm, platform, and mode of blockchain technology to adopt. It is also essential to ensure that the access rights to the blockchain are implemented with the access identity management system to avoid security breaches. Gordon and Catalini (2018) proposed that interoperability is more suitable for blockchain healthcare applications regarding data exchange between hospitals and other business entities centred on the patients as the focal point. However, they stated that ***patient-driven interoperability*** comes with challenges and conditions, particularly privacy, incentives, governance, technology, and security. These areas must be considered for the exchange of patient data to be successful.

In implementing blockchain technology for the healthcare domain, they proposed five processes: patient identity, data immutability, data accretion, data fluidity and digital access policies. According to their hypothesis, the essence of these mechanisms and the challenges is deciphering whether blockchain technology can transition from ***institution-centric*** to ***patient-centric*** data distribution. Dwivedi et al. (2019) corroborated the adoption of blockchain and the *Internet of Things* (IoT) to achieve ***remote patient monitoring*** for the care and treatment of patients despite the challenges encumbered by this implementation, which could even endanger the lives of the patients in some instances. They proposed the adoption of a blockchain-based healthcare application to secure, manage, and analyse the big data in the healthcare domain, which is a novel framework of customized blockchain prototypes ideal for *Internet of Things* (IoT) apparatuses that depend on their distributive means of communication along with other security and privacy properties in the network.

However, security and privacy were the sources of concern made by Zaabar et al. (2021), which made them propose a new architecture model that seizes the advantage of a decentralised platform over a centralised network to avoid issues associated with centralised databases. This school of thought was consented to by Hölbl et al. (2018) in their study when they surmised that a blockchain-driven healthcare system is commonly used for access control, data sharing and storing health records but seldom for other circumstances such as drug prescription management and supply chain management. Janarthanan et al. (2022) introduced an already existing geospatial blockchain technology like any other geospatial application. This type of application is driven by digital tokens ideal for spatial systems, which makes the theft of data extremely complicated by adopting integration to many disseminated and highly connected versions of cooperative data with digital ***timeframes***. As with all blockchain networks, even though the data are in the glare of the public, once created in the platform, it becomes incredibly tricky to alter the information in the block. This complexity is due to the hash method composition of the blockchain structure, which consists of an alphanumeric value for exceptionality to trace the data. Adopting geospatial blockchain technology ensures that the databases are confirmed with proof of location, which will overcome privacy and security challenges.

The *Internet of Things* (IoT) uniquely resolves healthcare's most critical challenges, including medical mistakes, persistent drug shortages, and overstretched hospital processes due to the COVID-19 pandemic (Furtado et al., 2022). However, Alzubi (2021) and Esposito et al. (2018) posited that combining the *Internet of Things* (IoT) with blockchain technology will accomplish twice what a single application would have achieved when they proposed the ***Lamport Merkle Digital Signature*** (LMDS) technique as an authentication instrument to adopt "***pseudo-random number generator***" that produces random numbers distinctly for each *Internet of Things* (IoT) communication device thereby restraining the toil of keeping the signature data and plummeting the computation operating cost incurred.

It is confirmed that cloud data are always attractive to hackers and cyber attackers. Lately, there has been utmost interest in healthcare data, which could be tantamount to obliterating consequences for healthcare companies even though the decentralization feature of the peer-to-peer network could curtail the upshot of the cyber-attacks (Al Omar et al., 2019). They emphasized that leveraging the distributed utility would ensure data integrity and accountability. On record, several solutions may have been suggested to manage the effect of cyber-attacks by exploring the decentralised method. However, these resolutions have failed to ensure the confidentiality of the patient-centric system. Therefore, they proposed a blockchain-based patient-centric healthcare management information system where the profiles of the patients would be protected, which facilitates privacy using cryptography property to encrypt the data of patients and to safeguard pseudonymity.

Studies indicated that diabetes patients frequently produce extensive data on the disease and their overall health. It is always critical to share patients' health data, especially when the information is not accessible to healthcare service providers handling the patient (Cichosz et al., 2019). They explained that the ability to share the patients' data while maintaining their privacy is vital for the success of the deployment. Zhao et al. (2018) proffered that it is feasible to adopt the blockchain to utilise a body sensor utility in the design of trivial backup and effective recovery techniques to unlock the keys of a health-based blockchain system. The researchers' analysis indicated that the scheme has superior performance and security is good enough to protect private messages and facilitate the blockchain healthcare application. The confidentiality and security of the patient's information are vital for the operational success of blockchain-based healthcare applications.

2.5.4 Education Sector Applications: Also, they inferred that blockchain applications in Education result in the processing of students' certificates and publications from their records, including the payment of processing charges; The use of blockchain in the educational sector has been tremendous, particularly in the area of managing academic degrees and assessment of learning results including transcript formulation according to G. Chen et al. (2018). They highlighted that some educational institutions have started using blockchain technology to process academic certificates for students, manage degree repositories, manage the academic assessment of successful students, and issue the appropriate certifications. Guustaaf et al. (2021) posited that blockchain technology is quite pragmatic if adopted for the education sector, especially in digital certificate issuance, student record keeping and tutorial teaching aids. However, they admitted that it is difficult to identify a single study that would satisfactorily go through the educational project. However, there are limited studies on the higher education sector that adopted blockchain technology to address the challenges educators are currently going through.

Although Alammary et al. (2019) admitted that little research is recognized about the practice and knowledge of using blockchain technology in the education domain, however, some blockchain-based educational systems focus on educational apps that blockchain technology was adopted, the benefits accrued from the educational blockchain applications and the several challenges emanating from the implementation of blockchain in education. In their conclusion, they surmised that the incursion of blockchain technology in the educational domain is still in the early developmental stage. However, opined that blockchain-based education applications were developed to verify and issue certificates, distribute learning and competencies achievements of students and appraise their professional abilities even though a broad range of several applications on education are evolving swiftly. The benefits are not different from the features of blockchain technology, which include reducing **operational costs**, boosting transparency and trust, and securing the distributed students' information.

The researcher consented that blockchain technology in education is still embryonic, and education applications developed using blockchain are rare. However, Steiu (2020) noted that blockchain in education enhances the learning and teaching processes across vital dimensions, such as energizing the students to learn independently, improving efficiency and security for the learners, businesses and educational institutions, and incorporating transparency and trust to the extent that students are given the leverage to have access to their degree certificates and transcripts unaltered thus ensuring the integrity of their skills to the prospective employers. He proposed two blockchain-based applications in identity and certificate management in education, innovating and improving an enduring learning initiative. However, he stipulated the challenges of implementing the blockchain in education as security of data and privacy to be extremely difficult to optimised, lack of trust and knowledge may impede or slow market adoption, scalability due to sluggish operation of transactions may enforce unnecessary constriction when the grading of the application comes to bare. Lastly, legislation may be an impediment and contradiction to existing laws.

The global pandemic made 2020 a year of learning the new normal where meetings and training were being held virtually, and this has served as a mechanism for stimulating three pertinent needs in educational institutions, which are the value of delivering online training and courses, the necessity to participate in concerted global ventures; and the prerequisite to advance systematic inter-disciplinary problem-resolution tactics (Düdder et al., 2021). Chen et al. (2018) stated that "***learning is earning***", in which blockchain technology can stimulate and motivate the students to learn and keep records of every student and lecturer's educational activities from enrolment to graduation, including the lecturer's performance and attitude through evaluation of their teaching sessions. In a sentence, they implied that blockchain education applications could track instructional models, conduct developmental assessments, and analyse every student, academician, and non-academic staff within the educational system (Bhaskar et al., 2020).

A blockchain-based education application aimed to develop innovative interventions to enhance the fundamental approaches of securing, sharing and delivering knowledge and private records of students and teachers (Raimundo et al., 2021). They believed the implementation would add considerable value by enriching effectiveness, improved technologies, data security management system, confidentiality and efficiency. However, these are not without the challenges of system development and implementation (Srivastava et al., 2019). Global integration between education and the stakeholders is the basis of adopting blockchain to streamline the issue of transparency and trust in the modern system, which is lacking in the traditional system, as posited by Lutfiani et al. (2021). According to them, the aim was to primarily add value by applying blockchain in education to benefit from the application's certification, financial obligations, archiving and learning curve. This analogy was corroborated by Awaji et al. (2020) when they expressed that blockchain in education has been in use in some developed countries, such as China, to achieve the benefits of blockchain technology at the same time addressing the challenges, especially in higher education (Arndt & Guercio, 2020).

2.5.5 Blockchain Education in Higher Education: Higher education is one significant area in which blockchain is being adopted since students have mobile devices to communicate and participate in educational activities, which has opened up access to higher education to many people who were not privileged to attend higher education. The students can view and print their transcripts and certificates even in distance and online learning cases including the **provision of financial services**. Rashid et al. (2020) postulated that blockchain technology is used to manage fundraisers' contributions through loans, donations or scholarships, which are sponsors, one way or the other, of students in higher education. The adoption of blockchain technology is more prevalent in higher education than in any other category. The reason is that they are more mature without any guardian to go through the system with little supervision (Kamišalić et al., 2019). The focus in blockchain education is based on two dimensions, the institution and the student. The student-centric approach revolves around the simplified process of validating students' credentials, while the ***institution-centric*** application simplifies the administration of the institution's educational and operational activities (Lizcano et al., 2020).

The adoption of blockchain in educational institutions has facilitated the accurate configuration of student certifications and profile databases to ensure their records' safety and protection, especially in higher institutions (Al Harthy et al., 2019). The goal is to set up a database where all the students' profiles contain their academic activities, including their studies, grades, results, certificates, and transcripts (Fedorova & Skobleva, 2020). Certification authenticity has been a serious concern for employers of labour and other agencies to substantiate the genuineness of the educational degrees. This school of thought was also the position of Vidal et al. (2019) in their study when the institution that issued the degree mail has been upgraded or merged with another institution or failed to maintain correct records of the students. In situations such as this, it becomes complicated to replicate the certificates when the need arises. Blockchain technology has become the key solution to this problem (Arndt, 2019). They proposed a solution developed and implemented at the University of Fernando Pessoa to resolve issues surrounding the authentication of diploma certificates.

The traditional method of storing and validating student records is through the centralised system, which has remained the same over the years. However, Sharma and Batth (2020) posited that blockchain implementation would launch a novel and fresh approach to decentralising the records and sharing experiences to gain skills and understanding (Silva et al., 2019). On the administration of academic activities, Sahonero-Alvarez (2019) proffered that blockchain applications in higher education would enable the lecturers to organise themselves and offer deliverables on content management, access and appraisal of student's data and course management. It would also allow them to harmonise their curriculum in knowledge management, shared services, and certification production. Students would be provided to make relevant **payments for services required** on the blockchain platform.

The Brazilian educational system Palma et al. (2019) stated that the issuance of degree certificates and academic credits is done semi-automated or manually, along with issuing degree certificates. The digitization of the system would reduce the bureaucratic processes such as the validation of documents, cost-effectiveness in operations and data storage. They postulated that this has become vital to eliminate the rise of document forgeries and missing records to entrench data reliability and transparency among all stakeholders. Their proposed model offered the Brazilian government to leverage blockchain technology to digitise academic credits and issuance of degree certificates in a transparent manner where registered students in higher institutions and their academic activities would go through the process in a chain of digitised records utilizing the Brazilian **public key infrastructure (PKI)** for access and identity management. They surmised that the application would be interfaced with the intelligent contract system to guarantee decentralised issuance of all certificate forms while validating legacy database and data reliability. Dash et al. (2022) advised governments to take advantage of blockchain technology to implement it in their educational system to promote transparency and data integrity.

2.5.6 Application in the Agricultural Services: On using blockchain technology for food supply and traceability, Yiannas (2018) conferred that Walmart had introduced transparency and trust in the food supply chain to sustain the process and reduce the cost of operation as well as waste. This assertion was corroborated by Yadav and Singh (2019) in the agricultural food supply chain but added that other agriculture areas include agro-trade financing, agro-drill sustainability, crop accreditation and insurance (Kamilaris et al., 2019). Blockchain technology is already being adopted in the distribution of food production and **payment for services**, where relevant stakeholders are incorporated into the agribusiness supply chain; however, like other applications, challenges and issues emanating from the implementation in the agricultural sector. They affirmed that these challenges, including the technical ones, need to be resolved to give room for improvement in the agribusiness process. Food is the basis for all human beings' sustenance, especially regarding suppressing global hunger.

Universally, the agricultural sector is believed to be the foremost employer of labour, considering the vast number and array of key stakeholders spanning diverse sectors, including consumers, farmers, retailers, and distributors, which form the multifaceted supply chain administration (Sajja et al., 2021). The complexity of the agricultural products supply chain causes the challenges of efficient traceability, payment, and transparency, which tends to stagnate the growth and sustainability of the process (Demestichas et al., 2020). They posited that traceability, or "***one step back, one step forward***", is recollecting all the data regarding particular food products. In other words, this is the method of tracking the drive of agricultural products vide the ***production, processing and distribution*** phases. Therefore, the challenge lies in the workflow once there is an infraction on the movement of the products in the various stages (Lei et al., 2022). They surmised that implementing blockchain technology in agriculture should be user-friendly and attract benefits, including time-saving, risk mitigation, cost-effectiveness, improved productivity, and enhanced transparency (Xiong et al., 2020). They suggested implementing blockchain technology should be gradual and procedural, with effective communication with the key stakeholders across the food supply chain (Saberi et al., 2019).

Agribusiness has been thriving since ancient times, and it was opined by Bermeo-Almeida et al. (2018) that blockchain technology would enhance the safety and security of food in an effective time management way. They affirmed that applying blockchain technology to agriculture would stimulate the food supply chain process with improved data transparency, payment obligations and integrity (Ge et al., 2017). Krithika (2022) stated that the incursion of blockchain technology in agriculture was not to reinvent the wheel but to sustain and improve the traceability and quality of food, optimize the yield of products, thwart fake foods, and modernise the process. Furthermore, he affirmed that the latest developments and progressions in blockchain technology have a variety of essential qualities that are idyllic for the agriculture sector advancement (Zhao et al., 2019). A blend of the *Internet of Things* (IoT) and blockchain technology would generate a secure and innovative agricultural domain compared to a smart city, including intelligent traceability, quality production and food security, especially in livestock and supply chain commercialization and industrialization management (Kamilaris et al., 2021). He stated that blockchain transactions in agriculture would be transparent and devoid of third-party organizations, including the central banks. The benefits would comprise smart farming, distribution of grants and subsidies, agricultural financing, e-commerce, **payment**, and insurance (Stranieri et al., 2021). Hang et al. (2020) postulated that adopting blockchain technology in animal husbandry, exclusively in fish farming, would go a long way in the evolution of the agricultural domain. They believed that the data emanating from agriculture was full of manipulation. As such, blockchain would ensure data integrity and transparency with the possibility of high output, privacy scalability and off-supply chain stowing (Sendros et al., 2022).

Electronic agriculture, e-agriculture was devised by K. Song and Li (2021) to imply the simulation of intelligent agriculture where innovative agricultural technologies and smart devices are copulated in the food production process to enhance productivity and sustainability (Antonucci et al., 2019). They postulated that blockchain technology, along with the *Internet of Things* (IoT), would facilitate the emergence of its features in the e-agriculture, which would promote a more intelligent production system that involves the integrity of data, quality assurance, management of records and effective tracking (Menon & Jain, 2021). It is believed that when blockchain and the *Internet of Things* (IoT) are applied to the product traceability process, it will engender a well-organised, open, organic and trusted system for various products such as grain, rice and soybean (Awan et al., 2021). However, Hong (2021) stated in his study that the grain supply chain, when automated with blockchain and the *Internet of Things* (IoT), would transform the process with smooth, suitable and quicker circulation to the benefit of the critical stakeholders in the supply chain including grain producers, suppliers, processors, distributors and the end-consumers (Demestichas et al., 2020). He affirmed that this would be a learning curve for the stakeholders in terms of grain information dissemination and pest detection data on a real-time basis, which will improve transparency in the product market, encourage corporate collaboration, diminish unwanted outcomes, enhance the steadiness of the process, and resolve the incongruity between the demand and supply of the product (Hidayat & Mahardiko, 2021).

Indonesia is prone to agriculture, and the Semarang Regency region is famous for producing chilli products. Supply chain management is convoluted because the product is being traded in the stock market, as researched by (Putri et al., 2020). The complications arise in the process flow from the product demand prediction to the payment to farmers through the stock analysis, cost of raw materials, and price to the distribution chain through the collaboration links among the consumers, farmers, and the district authority. They proposed the *Internet of Things* (IoT) and ***Hyperledger Blockchain*** to facilitate the business process to ensure simplicity, transparency, cost-effectiveness and speedy operation of the ecosystem, which in turn will provide potential benefits to the consumers and farmers through the structure of a ***trusted distribution network*** that will promote transparency and a suggested prototype to the Semarang District Agriculture Service. Friha et al. (2021) corroborated this analogy by proposing seven types of typical smart agriculture using the *Internet of Things* (IoT) as disease management, agrochemical applications, intelligent harvesting, supply chain management, smart monitoring, smart agricultural practices, and intelligent water management (Galvez et al., 2018). However, they proposed further comparative analysis of the technological methods concerning supply chain management through the agricultural *Internet of Things* (IoT) adoption of blockchain technology Yang et al., (2021); Pakseresht et al., (2022).

Blockchain uses information and communication technology techniques to develop specific applications, particularly in agricultural production (W. Liu et al., 2021). They posited that information gathering for decision-making and production enhancement are some of the deliverables of the affiliation (Ren et al., 2021). Others include supply chain, logistical traceability, process efficiency and enhanced transparency (Zhang et al., 2020). They surmised that blockchain implementation in the agricultural domain delivers low cost of operations and increase in product consumption, **payment for services**, provides room for scalability and interoperability, privacy protection and security, and policy and regulation formulation for the stability and sustainability of the market (Bagwasi & Chinnaperumal, 2020). ***KRanTi*** is a model Patel et al. (2022) proposed to revolutionize the agricultural food supply chain using blockchain technology by delivering trust and authentication systems for all relevant stakeholders to facilitate the supply chain 5G network of agricultural products. The blockchain application enhances the credit management information system, enabling allied and fish farmers to pay for essential agricultural raw materials on credit (Bikoro, 2022). Traceability, trust and transparency are among the system's utilities where there is a shared database of innovative contract domains distributed using the blockchain ***Ethereum*** to preserve relevant data for all stakeholders (Bechtsis et al., 2019). The outcome of the ***KRanTi*** system indicated a significant improvement over the traditional manual process, similar to other blockchain applications (Torky & Hassanein, 2020).

Digital transformation in the agricultural sector, according to Dayioğlu and Türker (2021), was propelled by the *Internet of Things* (IoT) and blockchain aftermath of the Covid-19 pandemic that affected the food supply chain due to the numerous global challenges such as climate change, environmental pollution, global warming, and weather catastrophes (Song & Li, 2021). They opined that digital opportunities abound for researchers and technologists to resolve these global calamities that intertwine water, food, energy, and climate connexion to transform the digital from the traditional (Cao et al., 2022). They proposed that digital agriculture is underpinned by digital technologies, including blockchain technology and the *Internet of Things* (IoT), under four domains: control, motoring, logistics and prediction (Ehsan et al., 2022). The process covers a range of other technologies such as cloud computing, artificial intelligence, big data, and real-time monitoring support systems with an expected output of efficiency in digital irrigation, tracking of animal husbandry and the fertilization process that boosts the whole electronic agriculture ecosystem (Kumari & Santhi, 2021). With this development, fertilizer losses, water minimization, and robotic and drone applications would be reduced, which allow systematic moderation of pesticide and herbicide, including improved crop quality and productivity, environmental protection, and provision of effective resource management with reduced operational cost (Ferrag et al., 2020). They believed that these measures would undoubtedly combat the global challenges of food insecurity and improve the sustainability of the global food supply chain system (Klerkx et al., 2019). This analogy was corroborated by Cao et al. (2022) and Song et al. (2021) in their study on "***Blockchain-based agricultural supply chain platform****s*" and "***Blockchain for consortium: A practical paradigm in agricultural supply chain system***", respectively.

2.5.7 Blockchain Agricultural Insurance Application: Kosior (2021) postulated that blockchain technology in the agricultural sector would enhance the insurance of the food supply chain as long as there is the integrity of the registered data and the validation of all the network nodes strengthens the transparency and certainty of the transactions in the insurance arena and simultaneously span to the decrease in data disproportionateness, which in most cases is the leading cause of the agricultural insurance sector fiasco (Xiong et al., 2020). He opined that the insurance of solutions and smart contracts with **automated compensation payment** could improve the relationship between the vital insurance stakeholders and reduce the cost of transactions. As a fallout, he believed that blockchain technology has the potential to facilitate the improvement of insurance and exposure in the agricultural domain, especially insurance that concentrates on the risks involving climate change and weather. There are other associated risks and specific challenges that blockchain technology can mitigate against its functionalities, such as corrupt and unverified data, regulation uncertainty, litigation of innovative contract transactions and disruption of the blockchain network (Menon & Jain, 2021). However, Kosior (2021) firmly believed that the enthusiasm surrounding the blockchain-based agricultural insurance system will continue to grow, which would be influenced by the upsurge of weather disasters caused by the mounting cost of working with outdated insurance tools and climate change for agriculture-related risks.

It is supposed that blockchain technology offers diverse solutions that can simplify the valuation of insurance risk management and advance the implementation of the insurance contracts process, which is perceived as a business opportunity in the agricultural insurance sector (Song & Li, 2021). However, this achievement is dependent on the critical factor surrounding the profundity and integrity of the digital data generated by several systems and devices, including footage positions of weather data, programs for digital maps and geospatial data, isolated satellite sensors and strictures agricultural production performance, entail access identity management and apt security configurations (Cao et al., 2022). This protection is due to consent algorithms and disseminated registers adopted by the blockchain technology, which ensures data safety and data access reliability in the value chain of the agricultural insurance domain and triggers opportunities for new product development and services in the insurance sector (Pincheira et al., 2021). The public sector would support the insurance sector digitization, especially in agricultural insurance, through their active participation against uncertainty in the insurance market. Recent developments in the digital world have thrown up the issue of regulations in the financial landscape as the European Union (EU) is currently working on the possibility of overseeing blockchain technologies.

Digital agricultural democratization was a concept devised by Chen et al. (2020) to establish the Beijing Liuminying Ecological Farm as a case study and project a framework termed "***blockchain-based electronic agriculture***" for the development and challenges of the entire ecological and agricultural model using blockchain technology. They posited that the blockchain platform uploads the captured data via several intelligence devices designed to access the shared portal on the internet and resolve challenges such as irregular information, payment, untrustworthy intermediaries, and a vulnerable traceability process of agricultural products, which have proved to be a prevailing example and novel impression on the dependable pathway for accomplishing "***digital agricultural democratization***".

2.5.8 Blockchain Governance Applications: In the Greek financial setting, Tsilidou and Foroglou (2015) gathered that blockchain technology is transforming the shipping process by tracking all containers that arrive at the ports to prevent fraudulent or undercover activities like tampering with container information. They also opined that blockchain land title application is another part where the reduction of officialdom and bribery in the real estate sector had manifested with efficient and real-time asset information management systems in vogue. Through electronic management of identification, electronic voting system (Khan et al., 2018), disaster, notary and law submissions (Alexopoulos et al., 2019); However, Miraz and Ali (2018); Jaoude and Saade (2019) affirmed that beyond cryptocurrencies, blockchain technology had effectively been used for shared storage application, a decentralized voting system as well as proof of locating anyone at a given point in time.

A novel system of organizational restructuring designated ***decentralized autonomous organizations (DAO)*** by Beck et al. (2018) was proposed to situate a blockchain platform with explicit rules of governance in the ***blockchain economy***. They postulated that the global governance in the blockchain economy is drastically different from the norms of traditional governance, where they proposed a new information technology-related governance concept coupled with a governance research agenda for international business (Hooper & Holtbrügge, 2020). Atzori (2015) corroborated this analogy when he argued that governance in a blockchain decentralised platform to varying notches confronts the orthodox bureaucratic mechanism of social responsibility, democracy, and a central authority. He opined that there is an extent to which the blockchain platforms can be well-thought-out as a revolutionary tool and means of managing social activities and **provision of financial services** on a large scale while at the same time dismissing the central authority model. However, he believed that the central authority still has a role in state harmonisation with the decentralization approach in society (Rikken et al., 2019).

It is perceived over the years that governance has aligned due to improved technological evolution, functional diversity, globalization and, lately, innovation and digitalization of payment, especially in blockchain technology (Zwitter & Hazenberg, 2020). They analysed three modes of governance, with mode-1 being a ***hierarchical command-and-control policymaking*** vide the state. In this mode, the state is autonomous and legal in issuing policies and regulating societal financial stakeholders as the power network is vertical from the top down under the control of the government (Yeung, 2019). The mode-2 implies that policy decision is relegated to the societal stakeholders who have superior sovereignty in controlling their realm of influence. In that case, the state oversees the roles assigned to the societal actors by integrating them into implementing the policy process, which has become an essential power standpoint in governance development. The oversight function is accomplished by the central bank, which oversees the constraints set by the state (Kondova & Barba, 2019). The third governance mode focuses on the decentralized network and blockchain technology. The state has limited authority in the digital domain, with more power ceded to the digital providers who are emerging technological actors. The new players administer other stakeholders through the blockchain network in various, consistently dynamic relationships. In this scenario, individual proprietorship of governance is restricted while governance is holistic and segregated.

The decentralised network governance provides for the notion of novel ways of regulating the digitalised economy as demonstrated by the various uses of the blockchain for **financial services**, supply chain, contractual and logistic functions, which recognize the flexibility of roles of players in the blockchain platforms (Loorbach & Wijsman, 2013). It acknowledges the opaque role the traditional governance has played over the years and the limitations in the decentralised platform given the radical digitalised networks (Rhodes, 1996). The conception of decentralised network governance facilitates solid signals of the social network utility concerning the policy decision and pattern of governance instruments in the digitalised landscape (De Filippi et al., 2020). It is generally believed that blockchain is a trusted technology and a confidence or reliance machine that strengthens the users' confidence in the system's operations. As such, the level of confidence depends on the inherent governance structure, which requires trusting a decentralised web of players believing that a polycentric and democratic governance method can stimulate blockchain network governance. He surmised that the governance of the blockchain network is not influenced by an individual player but by a decentralised trusted multitude of actors along with a variety of preferences and interests. The presence of an intermediary or third-party authority does not arise in this setup.

The blockchain-based governance system is an intelligent application proposed by Balcerzak et al. (2022) through the deployment of visual analytical devices, smart linked devices, automated data capabilities and distributed ledger technologies would necessitate public rendezvous from the society for efficient and scalable data. They posited that implementing a decentralised intelligent contract application would harness machine learning tools, spatial mining data and visualization data techniques to facilitate an upsurge in trust in the blockchain network urbanization. Decision-making is critical to the governance of a decentralized system through the use of analytical data, predictive algorithms, artificial intelligence and spatial technology to amplify the urban blockchain technology in the societal governance of the smart city and extend the usage of transaction data of innovative contract system (Fiorentino & Bartolucci, 2021); (Marsal-Llacuna, 2020). Lafarre and van der Elst (2018) believed that corporate governance would impact the blockchain platform, which is significant in the disruptive technology and the attention it has attracted over time (Akgiray, 2019). However, Reijers et al. (2016) opined that new governance models had been justified with the advent of blockchain-based social contract concepts while focusing on the assumption of independence and a decentralised system. The issue of blockchain governance abounds due to the network's distributive nature and control perspectives posited by Zachariadis et al. (2019) in their study. They expressed concern about the critical administrative glitches of the blockchain platform. They proffered information technology platforms to govern the blockchain network through incentives, rheostat mechanisms and verdict rights for the stakeholders. Schulz et al. (2020) posited that prophylactic blockchain governance requires a forte and innovative solution to align with the technology, promoting decentralised governance measures and mitigating risk management in the blockchain network, including the effective administration of foreign aid (Reinsberg, 2019). Filippi (2021) postulated that trust is the determining factor for effective global governance of blockchain technology with the belief that it would stimulate confidence between stakeholders devoid of risks and ensure the effective cost of operational centralization through privacy, control and security. To resolve the issue of blockchain governance, (Reijers et al., 2021) proposed "***on-chain***" and "***off-chain***" governance systems, where they explained that there are legal implications for the operations of the automated machines without human involvement. They referred to the on-chain governance of blockchain-based applications and expressed the concern of coalescence of intrinsic vulnerability and isolated personal interests of the blockchain network (Dursun & Üstündağ, 2021). As pointed out by De Filippi (2019), blockchain technology provides the means to research various decentralised governance models and several novel organizational structures, which are, to a lesser extent, hierarchical and more transparent than the traditional governance we are familiar with over the years. He argued that much as the present governance of the blockchain applications is centrally based on the blockchain exchange conglomerates and wallet service providers that are in control of the process and proposed that the future of internet governance should commence such that the outlook of the blockchain governance can be spelt out in the preservation of the distributive nature of the infrastructure (Zwitter & Hazenberg, 2020).

Governance defines how the decentralised platform should be used in terms of access and how the various stakeholders are operating in the system deprived of the control of any individual owner (Anthony Jnr, 2022). He implied that a set of statutory rules governs the processing so that all the stakeholders must adhere to system regulations which were substantiated by (Bernards et al., 2020). The rules are focused on control, decision rights and accountability as a context of facilitating access to data through initiation, verification, and approval of financial transactions, which consist of the metrics, standards, policies, and processes that promote the effectiveness of the system in accomplishing the objectives of the organization (Bustamante et al., 2022).

The development of the governance model is to stimulate and fast-track the adoption of the blockchain digitalization process based on the hi-tech, political, economic, and social considerations that impact distributed ledger technology in most organizations (Balcerzak et al., 2022). However, Oberhauser (2019) admitted that the impact of blockchain technology on the governance of environmental topographies would not be reflected as such due to the complexity of the geographies. Zachariadis et al. (2019) argued that the challenges of distributed ledger technology are intricated with the system's decentralised nature, where privacy would have to be maintained and subject to certain constraints, which requires further in-depth studies (Shan et al., 2021). They proposed collaborative governance where the cost would be controlled in the blockchain-based intelligent system believing that the decision rights of the stakeholders impact the stability (Lin et al., 2022; Singh & Chopra, 2020).

The ***Ostrom*** model for blockchain governance was conceived by Rozas et al. (2021) in their study on exploring the options available in decentralised networks. They perceived that the blockchain potentials are not being harnessed to produce the new governance structure with two encountering viewpoints dominating the nascent debate surrounding the blockchain-based application governance: ***treatises branded by the existence of techno-fatalist and market-inspired ethics, which inclined to overlook the complication of the societal organization; and complex versions of such dissertations which, while contributory to recognising limitations, ponder the position of old-style centralized establishments as innately essential to empower democratic methods of governance*. **They drew inspiration from ***Ostrom's principles for the self-governance*** of societies to investigate the innovative capabilities of blockchain ahead of such stances. It is interesting to note that they approach blockchain technology via the conceptualization and identification of six potentials that the system may afford to the communities: "***decentralization of power over the infrastructure, increasing transparency, codification of trust, tokenization, autonomous automatization, self-enforcement and formalization of rules***". For each affordance, they carried out a comprehensive analysis positioning each in the framework of Ostrom's principles, bearing in mind both the capacities of ***algorithmic governance*** (DuPont, 2018) and the pertinence of integrating societies' social exercises into blockchain-based devices to stand-in forms of self-ascendancy. The interactions discovered between these characteristics and Ostrom's principles permit them to deliver a viewpoint centred on blockchain-based parks of governance.

The blockchain governance study by Liu et al. (2023) identified significant findings, including that blockchain governance is a developmental process of blockchain operations, which can enhance the scalability and adaptability of the blockchain while ignoring the ethical considerations of blockchain governance. The proficiencies and responsibilities of the blockchain network were also isolated without considering the entitlements of the blockchain stakeholders in terms of incentives, choice rights and accountability. Cerf et al. (2020) posited that adopting the benefits of blockchain technology for the good of society promotes a governance culture in the areas of allowing distributed decisions from the stakeholders, promoting synergy between the individual's rights and the orientation vis-à-vis the needs and outputs, the utilization of feedback and curative contributions, the isolation of inherent prime qualities such as covetousness, wish for justice. The objective was to deliver services for the public good through blockchain governance.

2.5.9 Application in Financial Services: Blockchain in financial services is more prominent than any other sector in the global industry. This perception could be due to the spread of economic amenities in every organization, aiming to profit. The application of blockchain technology in trade financing, banking and financial marketing is more pronounced in most countries, especially developed and emerging countries (Tama et al., 2017; Kumar & Mallick, 2018).

Ripple is a blockchain financial application used for Real-Time Gross Settlement (RTGS), remittances and foreign exchange (forex) in the financial market. It has all the features of blockchain technology and ripple protocol (Tasatanattakool & Techapanupreeda, 2018; Huckle et al., 2016).

Similar blockchain financial applications include "***Billion, Stellar, Kraken, Coinbase and CryptoSigma***". Mining is a term used by end-users called "*miners*" to authenticate transactions in the blockchain process. The validation entails adopting a security mechanism and proof-of-work to authorize every transaction (Rennock et al., 2018). The intrusion of blockchain into the accounting segment has positively disrupted the accounting standards through innovation and manual practices automation (Woodside et al., 2017). They postulated that blockchain could directly record all accounting entries in a string of shared ledgers with electronic validation of all accounting records to eliminate any falsification attempt. (Fanning and Centers (2016) stated that financial services are the most significant area in blockchain technology and would be the most impactful in terms of the benefits associated with the technology. However, Ali et al. (2020) detailed the role of blockchain technology in the financial sector since trust is a crucial implication that the process is transparent and immutable. They affirmed that the decentralised, peer-to-peer cryptography, critical public infrastructure and encrypted nature of the blockchain technology deliver the potential of novel digitization services, especially as the driver in the fintech transformation services for **the payment** system. This analogy was substantiated by Trautman (2016) when he affirmed that previous initiatives such as the traditional retail, pay telephone and travel agencies processes have become almost archaic in the light of the digitalization systems.

The blockchain technology revolution in financial services has relegated previous modes of payment in the financial landscape to the dynamic sea of changes in the current realities of how transactions are conducted and regulated (Cermeño, 2016). The Bitcoin phenomenon opened the digital possibilities of adopting blockchain technology in the financial industry, considering the vast implications and fundamental ramifications (Trivedi et al., 2021). Electronic finance, aka e-finance, provides financial services to customers through electronic means such as information and communication technology and the web (Sharma et al., 2018). E-finance saves the use of numerous papers, time and efforts exerted in making transactions from one party to another, notably in the electronic commerce (e-commerce) platform (Zhu & Wang, 2019). The paradigm shift from the physical world to the virtual realm has become practicable through the emergence of e-banking and e-insurance, among others, in the electronic network. Wang et al. (2020) opined that credit is the underlying value of any transaction in the financial system, as without it, there would be no debit whatsoever. They added that blockchain technology is applicable in various financial services through smart contracts, distributed networks and consensus mechanisms to financial inclusion, cross-border financing, intervention funding, credit analyses, peer-to-peer lending, and electronic and supply chain payment (Gad et al., 2022). Blockchain technology implementation depends on the scope of tasks to be applied, including the user requirements.

Blockchain technology is being applied to anti-money laundering due to the possibility that some participants would use the privacy process to abuse the system. for that purpose. Peterson (2018) believed that the custodial of funds and financial services are likely the banks and investment brokerage organizations; they are in the best position to adopt blockchain technology to suit the process of providing these services to their customers (Gan et al., 2021). The blockchain application is also being extended to postal services, which are expected to streamline the schedule of parcels and letters according to their routes (Jaag & Bach, 2017). It is perceived that millions of people are unbanked in Nigeria, and over two billion in developing countries have inadequate or no access to official financial services, thereby generating cause for serious concern in the financial inclusion process (Larios-Hernández, 2017). He maintained that blockchain is among the digital financial technologies that could energize radical entrepreneurship that seeks to embrace the unbanked populates and improve their economies in many countries (Zhang et al., 2020). He expatiated further that monetary policy authorities do not capture many informal financial services, which contributes to the exclusion of the unbanked people by prescribing the need for blockchain entrepreneurship to accommodate them. Bringas et al. (2020) opined that several financial services are being driven and supported by blockchain technology even though some transactions are not based on virtual fund exchange. They gave an example of a smart contract where the technology implements the process without human intervention (Hughes, 2018).

Service providers in the financial sector have proven that blockchain technology enhances risk mitigation, security and authentication as various organizations, including the financial industry, have adopted blockchain technology in several domains, such as smart contracts built on trade finance systems between parties to improve transparency and efficiency as well as provide opportunities for new business as proffered by (Javaid et al., 2022). They listed the financial services supported by blockchain technology, including user identification, clearing and settlement systems, fraud prevention, efficient service deliverables by the financial industry in lower-cost operations, and fraud minimization (Hughes, 2018). Accountants are fascinated by the use of blockchain in the communication, measurement, and analysis of financial data. The computation of credit score management by financial institutions for their customers has greatly helped ensure system transparency (Patel et al., 2022).

Maintenance of confidentiality and privacy are attributes of blockchain technology, spanning efficiency and trust among all stakeholders (Caldarelli & Ellul, 2021). The system also helps track all transactions and provides security assurance for the network. Under blockchain technology, funds are transferred from one party to the other without any intermediaries or third-party mediators, thereby boosting the confidence of the stakeholders in the process (He, 2021). It facilitates the customers' affordability through the transparency of the transaction and decline of risks in their transactions as well as the enablement of international payment, which saves cost and time. This approach minimises or avoids any cost by accelerating the transfer process, enabling the stakeholders to receive credit or debit for their transactions.

Blockchain technology enhances the digital currency process through the flexibility of the conditions for participation, including the auditing process and stimulating the seamless transfer of cryptocurrencies in the network (Karim et al., 2021). Tokenization is a process whereby tokens are formulated on the blockchain network to replicate tangible and intangible assets as they align with the central bank's digital currency (Tian et al., 2020). In addition, funds administration is being managed by financial service providers through blockchain applications to simplify smart contracts to reduce the expenses and time of financial organisations. Blockchain technology enhances access and identity management, enabling customers to structure their digital identity with dependability and security as the basis of encryption and confidentiality. Blockchain identification is projected to substitute the traditional username and password, which are vulnerable to hackers. This process will enable users to perform single sign-on and even sign digital documents and store them securely and permanently on the system. The stored transactions and digital documents can easily be traced at any time as the blockchain has the potential to stimulate improved efficiency of the process.

A capital market is a trading place where blockchain technology would be very effective, especially in cross-border and trade financing. These transactions involve numerous variables and produce many paper documents when information is being shared among the stakeholders. It will alleviate the cross-border process and trade finance operations beyond any geographical or regional frontiers (Liu et al., 2021). The essence of this cross-border transaction is to ensure that all relevant stakeholders consent to any transaction before it is consummated. Any party can scrutinise the revised ledger after the blockchain transaction since safety is guaranteed. The sovereignty and autonomy of a country or institution, such as the central bank, lessens the risk of local currency devaluation or inflation, as the case may be. The role of the central authority is eliminated in implementing blockchain technology for financial services as accessibility for the completion of any transaction is transparent.

Blockchain technology is believed to facilitate the "***private regulatory compliance***" process and assist regulators through transparency and disclosure of every transaction by the regulated organizations to the auditors and examiners (Ross, 2016). The auditors would have unhindered access to complex transactions and assets through a specific source less expensively and more simply. Communication between the parties involved in a transaction can be facilitated by blockchain technology, a "***distributed ledger***" through the dissemination of transaction evidence as synchronised by the ***decentralised*** network, which is the basis of the blockchain (Hilary & Liu, 2021). Access to blockchain apps is through a specialised icon or a browser connected to the internet.

Collaboration and knowledge sharing are part of the features of blockchain technology, particularly in accounting and finance management, as these are magnetic catch to the professionals in that discipline (Yu et al., 2018). Operations of a secure local and international payment system with blockchain technology require no third-party intermediaries as a straight-through process is the modus operandum of its operation. The same approach is applied to blockchain technology in the transactions of supply chain applications, as transparency and traceability are part of the potentials derived from the implementation. With this development, there would be a significant improvement in cost reduction, elimination of error-prone documents, and faster delivery of fewer papers to customers. The monitoring of the supply chain process by blockchain technology is forthright.

Besides these service deliverables, blockchain technology is endowed with improving security, ensuring transparency, enhancing productivity, reducing costs, and stimulating other innovations in the financial landscape. The management of digital assets through blockchain technology is comprehensive, traceable, automated, reliable, and can forecast return on investments (Chen & Bellavitis, 2019). The blockchain's security feature is exceptional because every connected “block” is safeguarded with encryption. The unique security propels the flexibility of processing international payment speedily, firmly, and at reasonable cost by adopting the encoded distributed ledgers, which provide dependable real-time validation of transactions without intermediaries such as clearing houses and correspondent banks that are not needed as trust compellers in the financial ecosystem (Bosco et al., 2018).

2.5.10 Beyond 5G Networks Industrial Automation: Traditional methods of operations are gradually giving way to automation using blockchain technology. Tanwar et al. (2022) postulated that the manual procedure's low operating efficiency and high menaces fuelling the automation of processes using blockchain technology (Aloqaily et al., 2021). According to them, the *Internet of Things* (IoT) is being extended to the industrial sector through the integration of a ***fifth-generation*** (5G) network, where it has been proven that the development of software applications using machine codes in a real-time and integrated environment would propel what they termed "Industrial Internet of Thing (IIoT) (Zhang et al., 2019). However, they admitted that the automation process would trigger side effects such as security challenges and customisation issues, which would affect the functionality of the systems. Despite these challenges, they proposed that blockchain technology is still a credible solution to alleviate the issues associated with the conventional process by reducing the cost of operation. They even proposed the emergence of the **sixth generation** (6G) network to fast-tract a reliable communication process in the industrial sector.

Blockchain has blended with 5G to advance the potential of transforming high-tech evolution in the technology landscape as 5G promotes quality of service and faster rates to consumers. In contrast, blockchain ensures security and high-level trust among the stakeholders, especially their peers (Praveen et al., 2020). They opined that most applications adopting the 5G have specific services they target for their users, particularly in increased bandwidth, expectancy, velocity and several other relevant factors. Amplified experience, automated self-operating vehicles, and other *Internet of Things* (IoT) related applications tend to adopt 5G for fast and dependable communication. An efficient and dedicated approach would be mandatory to ensure the blockchain-based 5G functionality works securely and impeccably.

They proposed a 5G ***Multi-Operator network slicing*** model utilizing blockchain technology to achieve the purpose of the proposal (Backman et al., 2017). Mistry et al. (2020) emphasized that 5G is an enabler of data collection and processing in the industrial domain and is propelled by the *Internet of Things* (IoT) connection of billions of entities at the high-speed transfer of information. They explained that the data retrieval time-stamp from several devices, access management technique and protocols utilised would probably not be fit for subsequent applications as the protocols are predisposed to centralised design, which may have a specific moment failure in tandem with the computational operating cost. They implied that a new architecture was designed for an effective access power mechanism for a decentralised communication platform between various devices in several industrial and *Internet of Things* (IoT)-based automation.

In the centralised platform, Azzaoui et al. (2020) asserted that there are vital concerns in nearly all privacy and security preservation solutions. To mitigate these matters, they proposed a decentralised 5G-based *Internet of Things* (IoT) platform to support industrial applications, including smart agriculture, smart cities, supply chains, smart homes, innovative healthcare, and automated vehicle management. However, Dai et al. (2019) proposed that artificial intelligence (AI) and blockchain are promising technologies for the ***next-generation wireless system***. When integrated, both can promote energy consumption reduction, decentralised security, resource flexibility, shared services, and innovative applications that can solve complex issues and enhance the functionality of the network through the activation of system utility. Nour et al. (2019) preferred a piece network where the service provider would need a brokering technique, which permits it to hire resources from several providers privately and securely. This design is built on blockchain technology, which provides a technique that ensures anonymous and secure transactions. However, in reviewing a blockchain-based 5G network, Tahir et al. (2020) explained those various applications, including ***network function***

virtualization, cloud computing, machine learning, and software-defined networking, were being interfaced into the 5G wireless networks to stimulate the demand for disparate requirements. They posited that these technologies triggered various challenges related to transparency, decentralization, privacy, interoperability, and security, which the blockchain technology is readily available to address since it had appeared as a prospective solution owing to the several capabilities such as auditability, transparency, distributed design, immutability and data protection (Nguyen et al., 2020).

Most notable is the secure design capability of blockchain to deliver underlying security concerns such as authentication, integrity, availability, and trust in a distributed platform. The 5G blockchain technology can also facilitate smart contracts that stimulate end-to-end resource distribution, generate various new business models, reduce network stress, seamless processing, service delivery, and administration of instrumentation (Chaer et al., 2019). Lee and Ma (2020) amplified this analogy by stating that the essence of blockchain integration with 5G was to enhance the structural defects discovered in the 5G wireless network applications. A notable production was the key derivation scheme on 5G with the separation in-between the forward and backward keys. The principle behind using blockchain was to ensure that the base station initially generated the unique keys impracticable for any means other than the designer to obtain it while streamlining the conveyance process to improve performance.

The sixth generation (6G) wireless network is a futuristic mobile network projected to be deployed worldwide across the next decade, as experience has shown preceding mobile generations. In line with the prediction of Kalla et al. (2022), it is practicable to presume that 6G will surface in about 2030, improving the deficiencies of 5G. It is expected that the 6G network will spin around the provision of heterogenous devices, proactively meet advanced traffic requirements, offer a universal communication platform whereby integration of space, underwater, air and ground networks would be made possible, offer a stringent quality of service, pave the way innovative and unnoticeable fleet of artificial intelligence and real-time powered applications, and open a novel landscape of several business opportunities with robust consideration for industry and vertical renters. The 6G network is powered by a diverse and extensive hyperconnection of every existing thing, which will activate the rise of business possibilities and novel use cases. Considering the Renaissance, research focused on 6G; it is believed that various benefits can be accomplished when integrated with blockchain technology.

2.5.11 Blockchain for the Real Estate Sector: The entrance of blockchain technology into the real estate sector was not surprising, according to Saari et al. (2022), as they believed that blockchain could provide valuable benefits to the sector even as an "***add-on***" in a hybrid setup. Their study first identified the areas in the real estate sector where blockchain can be applied through the systemic evaluation and thematic experimentation of relevant documents. Furthermore, the study also explored the administration of land, real estate, renting and leasing, property acquisition and investment in real estate. However, they connoted that blockchain technology was not extended to the devolvement and maintenance of real estate. In future, there is no doubt that this initiative will be accommodated by blockchain technology, especially in the financial services of the real estate sector.

The impact of blockchain technology in the real estate sector is still vague as many inferences have been drawn to the relationship with no certainty in implementing the application as posited by (Veuger, 2018). He implied that the transaction process is expected to be captured, including the objects of the real estate sector. At the same time, trust is the basis for transparency and completeness in any system, much as the real estate intends to stay sustainable. He surmised that when blockchain technology is adopted for the real estate process, there are potential prospects for exploiting the disruptive characteristics to deliver novel services. Wouda and Opdenakker (2019) stated that transactions ride on data, and blockchain technology is needed to process the data to achieve the expected outcome. They proposed a blockchain-based real estate with two essential components, physical-technical and contractual, which relate to financial, commercial and legal documents. The contractual and physical data can be keyed into the blockchain application centred on the consensus technique and secured by the ***cryptographic or hash-chain*** mechanism. The hash chain is the audit trail that tracks the transaction process in the form of an attachment. They maintained that data validation is the first phase of generating ***digital real estate transactions***, focusing on solving the system's pain point (Morena et al., 2020). For example, improving an office building transaction process commences with the quality and structure of available data.

An experience by Yu et al. (2020) has shown that blockchain-based real estate applications are cheaper, safer to use and faster in operation. However, Nijland and Veuger (2019) opined that a typical real estate asset consists of two primary attributes: ***immobility and heterogeneity***. These two characteristics contribute to the real estate market in terms of illiquidity, localization and high segmentation, along with elevated transaction prices and private negotiation proceeds mainly due to the participation of a substantial number of ***trusted*** intermediaries (Veuger, 2018). The technological trend could influence blockchain's prospect and the factors considered above, the business deals of real estate commercialization and participating stakeholders (Nijland & Veuger, 2019). The potential of blockchain technology has made it a game-changer in the real estate sector to provide transparency, digitalization, and low transaction costs, indicating that the due diligence and pre-marketing phases are most feasible for blockchain implementation. The deployment of the blockchain-based real estate application is mainly due to factors of blockchain, the elements of the stakeholders and the characteristics of the various phases (Hoxha & Sadiku, 2019).

The legal implication of blockchain-based real estate application was suggested by Garcia-Teruel (2020) when he proposed that the blockchain could be with permission or without permission and could also have a different mode of consensuses such as proof of authority, work and consensus and attached to the user identity or made anonymous. He reiterated that to offer a protocol that enables a holistic real estate process, which can provide the slightest warranties for both the intermediaries and signatories of actionable procedures, he suggested that the blockchain should be configured to grant permission by the controlled authorities and the blockchain should be connected to every user through the official digital identification credentials.

2.5.12 Credit Management Application: They postulated that blockchain adoption in fundraising and reputation (credit) systems would engender transparency and trust, making the process reliable. These are part of the features of blockchain technology. "*Micro, Small and Medium Enterprises"* (MSMEs) are low-income generation organizations that target society's poor. Applying blockchain technology to MSMEs' social businesses will arouse trust in the business relationship among investors, debtors, and financial institutions (Mukkamala et al., 2018). Chang et al. (2019) proposed that blockchain technology can be effective in international trade finance, particularly in processing letters of credit payment. The blockchain-based trade finance application enhances the overall trade process workflow of the application through an international trade system model proposed by them. They expressed that using blockchain technology would undermine the challenges inherent in traditional trade finance, such as trust, intermediaries, data latency and transparency, promoting cross-border processes across several industries.

Energy distribution resources are pertinent to resolving the challenges bedevilling the energy consumption process. To achieve the network distribution process, Tan et al. (2022)

anticipated using blockchain technology to improve the distribution of power transaction process through the credit management information system. The credit management process enables power users to benefit from credit facilities to enjoy the power supply. (Zhou et al., 2022) corroborated this analogy with their proposal of a peer-to-peer credit-based power trading model showcasing six phases of order generation, default query, order picking, trading execution, trading verification, and payment; credit management is the focus of the system (Zou & Xue, 2020). Tan et al. (2020) posited that the supply chain management system rides on the credit management process to provide credit facilities to participants in the supply chain network (Mao et al., 2018).

2.5.13 Other Blockchain Technology Applications: Blockchain **access control applications** are adopted to control access to precarious computer systems to protect valuable information (Maesa et al., 2017). They affirmed that accessing sensitive information is granted through access regulator policies to approved users. Chavali et al. (2018) and Yli-Huumo et al., (2016) specified that blockchain applications have emerged in biotechnology, pharmaceuticals, life science and blockchain transactions involving contracts, bonds, licenses, certificates, registrations, reservations, passports, and titles, among others. It has gained ground in the power system sector, where blockchain is used for energy trading through swapping electric automobiles, and managing energy load shedding and energy storage capacities (Di Silvestre et al., 2020; Mylrea et al., 2017).

The **music industry** has significantly improved through blockchain technology's effect on prevailing designs (Adams et al., 2017). There are salient processes where blockchain technology has been adopted (Rawat et al., 2019). They stressed that blockchain in applying the vehicular cyber system where the system carries out artificial intelligence and independent driving would enhance efficiency and safety in the traffic process and ensure privacy and security. They also implied that the aviation industry's blockchain application would enhance human cooperation and the system's services. Blockchain technology in architecture, engineering and construction management, including real estate, has gradually gained ground (Wang et al., 2017; Turk & Klinc, 2017).

The digitalization and enormous implementation of sophisticated technologies in the **automotive business** are changing the paraphernalia of the producer’s operating style and altering the existing business prototypes, as posited by (Sharma et al., 2019). It is believed that the rapidly expanded implementation of independent cars is projected to interrupt most sectors, including insurance, regulations, maintenance customer services and production services deliverables. Furthermore, the provision of customised, integrated and pre-order request services has set off the attributes of connected, mutual and independent vehicles in an intelligent city system for an organic ecosystem. Their study proposed a blockchain-driven distributed framework to address these concerns and promote the smart city’s automotive industry. Their intended framework incorporated a “***novel miner node selection algorithm for the blockchain-based distributed network architecture***”. In evaluating the viability of the planned framework, they simulated the purported model on a confidential “***Ethereum blockchain platform***” applying a “***captured dataset***” related to excavated blocks from “***litecoinpool.org***”. The simulated findings revealed in the proof-of-concept the anticipated model that can be utilized for a broad scope of future smart city applications.

2.6 Central Banks and Blockchain Technology Deployment

Blockchain technology's inroads into financial services have made most central banks of the world consider its implication in their economy, especially in the light of its adoption by some famous global banks. Their central banks have downplayed the influence of cryptocurrency on the economy of many countries. However, with the rapid development in the global financial landscape and the fact that no central bank can operate in isolation, some have gradually reviewed their initial hard stance to accommodate the flow (Krivoruchko et al., 2018). According to them, most central banks are cautiously shunning guidelines and frameworks relating to monetary policy and payment systems to which blockchain technology is rightly connected. They suggested that the central bank's position should be guided by its conservative legacy, direction to the public and significant sensitization on the meaning of blockchain technology.

In the past, the Central Bank of Nigeria (CBN) has disassociated itself from the blockchain imbroglio pending when proper regulatory modality is enthroned. However, recent events have shown that policies are being developed to streamline the implementation when the green light is provided to kick-start the process. The CBN's move to facilitate the *cashless* or *cash-lite* policy across the country is still a work in progress. This initiative will undoubtedly give credence to the implementation of digital currency when awareness has spread all over the country. However, blockchain technology would significantly improve the payment system and ensure an effective payment service delivery to all financial industry stakeholders. This innovation would stimulate transparency, efficiency and, most importantly, trust in the system.

2.6.1 Central Bank Digital Currency (CBDC): The Central Bank Digital Currency was introduced as a reaction to the entrance of digital currency and what it portends to the central banks (Fernández-Villaverde et al., 2020). They posited that CBDC tends to unravel the central banks from their conservative role to model banking's modern and digital pace. With CBDC, the wall of partition between the central banks and the public would be broken since they have never been their customers but the commercial banks. Garcia et al. (2020) presumed that when CBDC becomes operational in many economies, especially in relationship with bank deposits, it will shrink the commercial banks' profit. At the same time, it would increase the central banks' profit since printing cash would tremendously reduce operational costs. They gave reasons for the reduction in yield could be the decrease in the number of transactions or the implementation of non-interest transactions. However, Yermack (2018) postulated that implementing CBDC is how central banks would regulate issuing their blockchain digital currencies.

Many central banks are currently researching this approach. He opined that the proposals of "***Fedcoin***", which the Bank of England is seriously considering, are to allow their citizens and corporate organizations to open accounts directly with the central bank and deposit their cash rather than doing so with the commercial banks. With this development, the central bank would take up the retail banking responsibilities hitherto reserved for the commercial banks and deal directly with the account owners based on digital currencies only without cash. The monetary implication would give the central bank firm control of linear policy interpolation in the financial system.

In a research study conducted by Carapella (2022), he posited that many central banks are considering the provision of retail services in light of CBDC implementation as the public would be mandated to use electronic CBDC money related to retail payment. However, Barontini and Holden (2019) cautioned that central banks should implement CBDC in the conceptual stages of short, medium and long term. Retail transactions are not the core functions of central banks. However, the implementation of CBDC has opened the prospect of engaging in retail transactions as they must ensure accessibility and resilience in the process as well as *peer-to-peer* transactions (Bibi & Canelli, 2023).

2.6.2 Official Digital Currency (ODC): was introduced (Bindseil, 2020) as a proposed cryptocurrency to be issued and supervised by the central banks. ODC could be likened to CBDC as they postulated that both features are not different.

CBDC was introduced independently of private cryptocurrency to stimulate the payment system despite several private providers' involvement in the financial sector (Gnan & Masciandaro, 2018). They posited that the CBDC was an avenue for the central banks to introduce their cryptocurrency among the available options to reach out to the numerous unbanked customers, primarily in developed countries which will eventually reduce, if not eliminate, the cost of currency storage. Maniff (2020) suggested that research on CBDC has been ongoing for many years as a fallout of the emergence of the Bitcoin cryptocurrency and the need to adopt the technology for the payment system, which may weaken the traditional process of the central banks to ensure price stability and appropriate monetary policy (Wong & Maniff, 2020).

This supposition was corroborated by Siebenbrunner and Gross (2019) in their study of how intervention loans would be processed in the CBDC. They postulated that the existence of many commercial banks might be faulted due to the digital-based monetary policy that the central banks would adopt in the sense that physical cash processing would not be different from the digital currency approach. However, Fernandez-Villaverde et al. (2020) expressed that the central banks can conveniently replace deposits in the commercial banks with CBDC while maintaining the conventional monetary policy regulating those practices using a digital monetary policy that would permit both sides of the divide to share the risk associated with liquidation and still maintain financial stability in the system (Beniak, 2019).

2.6.3 Experimenting with Central Bank Digital Currency (CBDC): CBDC is regarded as a monetary asset with a digital value akin to the traditional currency issued by central banks and circulated in a non-centralized way to make payment as stipulated by Opare and Kim (2019) and Agur et al. (2019) in their research study on the central banks that are disposed to using digital currency in various ways. They posited that the reasons that motivated the central banks to adopt CBDC are using cryptography to secure transactions, safeguarding data privacy and promoting trust in the business, thus eradicating risks associated with third parties. Others reduce operational costs, using an audit trail to monitor clearing and settlement transactions, efficient performance, and transparent transactional workflow processes to curtail fraudulent dealings. They listed nine central banks: **Japan, Germany, Canada, Singapore, South Africa, Hong Kong, Thailand, Brazil and the European Union** that have implemented CBDC in different customised ways vis-à-vis the purpose and Digital Ledger Technologies adopted.

However, Bordo and Levin (2017) affirmed that there are possibilities that CBDC could change the traditional monetary policy to a more translucent and digitised economic structure where financial stability would remain the principal mandate of the central banks while still achieving the expected benefits of blockchain technology such as a CBDC process without the cost of operation, as a means of the acceptable medium of exchange and a continuous piece of an interest-yielding account which Engert and Fung (2017) provided details about in their study. They opined that interest-bearing CBDC could not be processed without the depositors' identity, which may diminish the customers' curiosity and trigger political risk. They surmised that interest-bearing CBDC would be the central focus of customers' attention due to the monetary benefits and broader repercussions in the financial landscape, as also substantiated by Meaning et al. (2018) and (Mohammad & Davoodalhosseini, 2018).

The Central Bank of Nigeria launched its **central bank digital currency** tagged **(e₦aira)** in November 2021. The objective of the digital currency was to implement micro-payment, especially among small, medium, and enterprises (SMEs), serve as a platform for low-cost transactions and instant transactions with low or no risk and be a promoter for the digital economy. A user must download the app and be registered to access the digital app by entering the user profile and bank account details as a consumer or a merchant. After that, the

eNaira wallet is created and registered. The public reaction to digital currency has been quite interesting. However, the usage rate is currently meagre as the awareness has not measured up to the society as expected. The utilization is still confined to mainly the Central Bank of Nigeria staff and a handful of other participants. To improve the awareness process, the Central Bank of Nigeria engaged more telecommunication service providers to sensitise the public to onboard any users who operate bank accounts (Thisdaylive.com, 2023). The digital currency was part of the survey questionnaires derived from the research questions.

2.6.4 Implications of Central Bank Digital Currency (CBDC): They see no difference in how monetary policy is operated between broad and narrow money between physical currency and cryptocurrency (Judson, 2018). However, they perceived that the uncertainties surrounding the implementation of cryptocurrencies by central banks might be overwhelming. The financial implication might be a complete disruption as far as the economy is concerned. In a survey conducted by Barontini and Holden (2019) to assess central banks' implications of adopting CBDC, they affirmed that most central banks cooperate to practically implement it with great caution so as not to rock the financial boat. This perception was boosted by Andolfatto (2019) and Raskin and Yermack (2016) when they implied that CBDC would benefit the system and the participants. The aim was to minimize monopolised banking's influence by the big commercial banks, stimulate financial inclusion with a reduction in currency demands, and promote financial stability (Fung & Halaburda, 2016).

According to Yao (2018), the interest in currency-by-currency practitioners is based on the genuineness and value of the currency. He inferred that the Chinese version of CBDC labelled Digital Fiat Currency, should also be concerned about these two factors considering that China operates a developed electronic payment system (Amstad et al., 2019). The Chinese digital fiat currency's objectives are not different from the CBDC, including a stable currency value, improved data security, effective regulation, and payment financial inclusion for the citizens. However, Williamson (2019) and Dong and Xiao (2019) posited that apart from the interest generation aspect of the application and the substitution of physical currency with cryptocurrency, which tends to limit fraudulent activities, the CBDC role of the central banks in taking over the deposits of the commercial banks' customers remains a source of concern, particularly on the welfare of the depositors as corroborated by (Keister & Sanches, 2023).

The **implication of the e₦aira** is to provide an alternative for payment transactions, which include the movement of funds from a user bank account to the e₦aira wallet, person-to-person transactions, e₦aira to bank account fund transfer, eNaira to cash dispensation.

2.6.5 Central Banks' Consideration of Blockchain Technology

It was stated by Krivoruchko et al. (2018) that the central bank of Sweden recognises cryptocurrency as a means of payment, while the central bank of Luxemburg regards it as an approved currency. While Canada and Israel's central banks approve of using cryptocurrency as taxable assets, most developed countries have recognised the operation but have no regulation policy. Some developing countries’ central banks have placed implicit bans or restrictions on blockchain technology, whereas others have granted permission or partial permission for the operation in their domain.

Considering the digital uprising in the global financial industry, Shi and Zhou (2020) stated that the People’s Bank of China (PBOC) had commenced research on the CBDC with an emphasis on using blockchain technology to enhance the payment system as soon as they are through with the study. However, the digital payment system development circumstances are still being kept in top-secret as the features and modality have not been known to the public. Digital currency is perceived as a strong competitor to the traditional currency issued by central banks, though with novel potential risk (Skeie, 2019). He deduced that central banks are promoting the possibility of issuing their digital currencies to mitigate liquidity risk and lower the inflation rate.

The fact remains among central banks that much as blockchain technology would promote efficiency and lower the cost of operation in the payment system, many are sceptical and concerned about the perceived challenges outside of technology (Casey et al., 2018). However, Bech and Garratt (2017) asserted that central banks are testing their processes with digital ledger technology using what they coined as central bank cryptocurrencies even though uncertainties surround their proposal's implementation. They argued that owners of central bank cryptocurrencies could only participate businesswise if they operate accounts with the central banks, which they do not see as feasible.

What would be the commercial banks' fate when their customers operate digital accounts with the central banks, though the benefits outweigh this possibility? However, much as Grym et al. (2017) agreed that digital currency is the currency of the future, they surprisingly posited that blockchain technology might not be appropriate for central banks' retail payment due to their inability to process a vast number of monetary transactions in their current form which was tacitly supported by (Bindseil, 2019). It was reported (Shirai, 2019) that some central banks have considered the prospective implementation of blockchain technology and even produced their digital coins for financial institutions. However, he believes that technical issues have hindered the distribution of digital coins. In the future, he refused to doubt the possible application of blockchain technology.

The Central Bank of Nigeria's consideration of Blockchain Technology: The Central Bank of Nigeria considered implementing a digital currency, hence introducing the central bank digital currency labelled the **e₦aira** in November 2021. The consideration for a digital currency was borne out of the importance of catalysing and transforming to the digital economy albeit on a gradualism basis. The stakeholders, especially the banks, have been enrolled on the digital currency system and are expected to drive the process for their numerous customers. Digital currency offers an exceptional way of money designated in **Naira**. This local currency operates as a store of value, a medium of exchange and a better payment experience, especially in retail business transactions as against cash payment. The operational base of the digital currency is astonishing and outstanding as the eNaira App showcases and reveals trademark value focusing on efficiency and ease of use while taking cognisance of the security of data. The path of implementing the digital currency was carefully thought through, bearing in mind the knowledge of the Nigerian financial industry's payment landscape and the digitalisation process's dynamic insight (enaira.com, 2021).

The benefits projected for the stakeholders, especially the end-users, include the enhancement of economic activities, financial inclusion that would target the unbanked, trade financing and cross-border transactions, economic growth through tax collection and remittance, facilitation of the digital economy, ease of social intervention targeted at Nigerians in the rural areas, and a reliable, cheap, fast and payment channel availability. The Nigerian Government recently approved the implementation of the National Blockchain Policy.

2.7 Payment Industry and Blockchain Technology

2.7.1 Payment Industry:

The payment system is the most crucial aspect of the financial sector, mainly when trust is a pertinent factor in exchanging money (Holotiuk et al., 2019). It is worthy of note that the payment system is so significant that it is part of the research questions. It was estimated by McKinsey & Company (2019) that the payment industry constitutes about one-third of worldwide banking. Apart from being the source of proceeds and a critical factor for customers' financial data, it is also the repository of all customer profiles (Dolinski, 2018). He projected that as the global payment system continues to improve, the high volume of transactions and account figures show significant healthy financial developments. The payment system is part of this study's research questions to emphasise blockchain technology's importance.

The Nigerian economy is predominantly cash base, and the Central Bank of Nigeria is making an effort to implement a cashless policy whereby alternative modes of transactions such as mobile transfer, automated teller machine (ATM) and point of sale (POS) would be adopted ahead of the cash transactions perceiving that the approach would promote the low cost of operation, faster fund transfer, transparency and currency digitalization (Bott, 2017). Khiaonarong and Humphrey (2019) stressed that the press for cash can be lessened by implementing digital currency, which would be regarded as another form of virtual cash transaction and medium of exchange. They emphasised that transacting in digital currency is more suitable and convenient than physically visiting an automated teller machine (ATM). They predicted rightly that digital currency usage would be ineffectual in countries where the acceptance of cash is overwhelming. I think this is the challenge we are currently having with adopting a digital currency, as the acceptance rate is meagre despite the sensitization and program of awareness.

Preserving users' privacy in the blockchain platform is as vital as permitting them to make their transactions, as posited by Androulaki et al. (2020). They implied privacy would be intact and confidential in a system without permission. However, without permission, a platform would not be suited for an enterprise system. As such, they proposed using tokens linked to the user’s identity against pseudonymous address labels. Their model was to ensure the security of every payment in the platform while the financial institution would generally operate as a bank in the background. Banks' many payment applications or their customers are shadowy as they reflect the core banking services, they provide in the background (Awrey & van Zwieten, 2018). Chiu (2017) maintained that the payment system had to be regulated by the central banks for the protection and benefit of the customers in an era where competition among the banks has come to the limelight, particularly in the context of digitalized payment. He suggested that the management of the public interest should be paramount to the regulated establishments (Simon, 2009).

Payment for goods and services was the hallmark of business transactions in ancient days; the transaction was mainly physical, even with the barter approach to exchanging goods. Over the antediluvian, the payment agenda was transformed from one process to another, better than the previous approach (Holotiuk et al., 2019). However, Proença (2018) indicated that the payment ecosystem has evolved over the years with innovative payment such as blockchain technology taking centre stage. So, the urge to digitise financial services motivates many banking and other financial institutions to re-strategize their business vision, mission and models as the payment industry is experiencing a radical payment revolution like never before (Slagmulder et al., 2018).

2.7.1.1 Electronic Commerce Payment: With the emergence of electronic commerce or e-commerce, improving the payment method became imperative. The advent of cryptocurrency has increased the pressure to do things in the new normal. The COVID-19 pandemic has taught the world that more things can be done differently and still achieve the expected results with greater intensity than before. Kim and Kim, (2020) implied that the cost of maintaining a payment gateway in e-commerce transactions is fuelling cryptocurrency adoption to eradicate the payment gateway and other intercessors. As corroborated by Jonker (2019), they implied that a simplified payment methodology using the rudimentary features of blockchain technology coupled with data integrity could revolutionise the e-commerce landscape through a minimal cost of e-commerce operations and services.

Even though Bott (2017) argued that the cost of implementing blockchain technology could be high with relatively little capacity. However, it promotes virtual currency in concrete form as an acceptable window for an innovative transaction that will gradually translate to digitization. He postulated that several central banks are committed to exploring blockchain technology's potential to stimulate the market and payment infrastructures. He emphasised that the digitization of any business process is hinged on trust. Zhou et al. (2021) submitted that the database of the e-commerce transaction is stored on a centralised platform that is prone to forgery, errors and fraud in some instances. To resolve the issue, they proposed using blockchain technology to enhance the e-commerce platform in a decentralized fashion; they termed an ***interplanetary file system*** (IPFS) where all the corresponding and returned addresses are stored in the blockchain platform. In Indonesia, Ismanto et al. (2019) stated that the development of innovative technology had compelled the emergence of many initiatives, such as e-commerce, which had thrived through the delivery of beneficial services to the country's citizens despite the challenges it faces, such as high charges, data manipulation, communication gap and fraud. They believed that blockchain technology has the potential to address the challenges with strengthened transparency and security of data in Indonesia.

The blockchain-based e-commerce application has the propensity to process the supply chain from the development of the product to the acquisition by the consumer. The system would suit e-commerce products ranging from food products, electronic appliances, and healthcare medication to security appliances (Kumar et al., 2020). They proposed a blockchain model labelled '***PRODCHAIN***' to track and monitor the complications associated with e-commerce products' traceability. Treiblmaier and Sillaber (2021) affirmed that the implication of adopting blockchain technology for e-commerce applications is far more than other initiatives due to the complex supply chain of their products. Given the capability of the decentralised technologies, including blockchain, to produce a "***trust-less system***" with eccentric properties, several business models and identified processes that have surfaced over recent years to guarantee reliability, trust, and applicability of ***business-to-business (B2B),***

business-to-consumer (B2C), business-to-government (B2G), and consumer-to-consumer (C2C) relationship in the business world, Blockchain can transform the e-commerce application through the facilitating exchange relationship that is trust-less and manage without central authorities or dedicated mediators in the situation where the blockchain platform is permissionless. Moreover, the collaboration of information and value between corporations and customers might vary significantly by allowing an integrated approach to incontrovertible data and the whole supply chain. They proposed a framework to encourage researchers to thoroughly scrutinize the prospective effect of blockchain technology on e-commerce with the major categories including ***consumer issues, technical issues, legal, quality, and organizational issues***.

2.7.1.2 Inter-Bank Payment: The Real Time Gross Settlement (RTGS) system is an application operated by the central banks and used predominantly to transfer considerable funds between banks at a spontaneous time conclusively. The RTGS is securely developed with a high level of irrevocability and straight-through process (STP), predominantly localised within countries but has the features of making a cross-border transfer when needed, as expressed by (X. Wang et al., 2018). They opined that modern RTGS systems had adopted blockchain technology in inter-bank transactions to derive the benefits of delivering disseminated financial services based on confidentiality and trust.

They added that implementing blockchain technology is not without the attendant challenges due to the decentralized nature where a central authority is inconsequential. However, the advantages over conventional RTGS outweigh the challenges and benefits. The decentralized process will engender improved privacy, settlement irrevocability, liquidity redeemable mechanism, and resolution of gridlock and reconciliation among the banks, including international payment (Wust & Gervais, 2018). Wang et al. (2018) restated that inter-bank transaction is the fulcrum of the RTGS system due to the large volume of payment, which has pushed many financial organizations to provide stability, security and, most importantly, the direct throughput process without any manual intermediaries. They opined that adopting the blockchain technology to orchestrate the inter-bank payment process had exploited the blockchain features to provide confidentiality, transparency and distributed trust for the disparate financial service process. However, the process is not without some challenges sustained by large value transactions when they stated, among other things: ***"Financial institutions expect not only a simple migration from traditional RTGS to a blockchain platform, but a decentralized system with better confidentiality, instruction settlement finality, liquidity saving mechanism, and more efficient methods of gridlock resolution".*** This analogy was corroborated by Wu and Liang (2017).

2.7.2 kchain Payment Applications

2.7.2.1 Bitcoin Digital Payment System: With the dawn of cryptocurrency through the Bitcoin revolution, the payment process is expected to improve with decentralization and digitization to enhance efficiency (Luther, 2016). In line with this approach, he proposed that a central clearinghouse and central authority would not be necessary as it is now. The cost of processing payment using blockchain technology would be reduced dramatically, as witnessed in the Bitcoin payment process. Huberman et al. (2019) stated that the Bitcoin Payment System (BPS) operation is hinged on intermediation between computer protocols in the computer servers and the users as the platform owner cannot be ascribed to any entity.

A ledger of registered accounts' functions is based on an electronic payment system, with each account linked to a user and the transaction balance. Users can debit and credit their accounts through domestic and international transfers in any blend of currencies from one account to another, as the Bitcoin payment system operates without a trusted authority. However, the ledgers are regularly updated with transactions by computer servers labelled miners in a *decentralized consensus protocol* at the ***back end*** (Beer et al., 2016). So, the Bitcoin ledger is an open blockchain database that third-party operators can validate through cryptography functionality (Shrier et al., 2016); Papadopoulos, 2015).

2.7.2.2 Impact of Blockchain Payment Process: It was reported by Holotiuk et al. (2017) that a group of forty-five researchers conducted a study that cut across several European countries to identify the impact of blockchain technology in the payment process. The study's outcome showed that blockchain technology would affect the existing business model based on four critical areas: Innovation of new payment services, thereby making the present services archaic. Two, through this paradigm shift, the appropriate effect on the structure of the payment service providers would be realised.

Three, the impact stimulated the development of fresh business models in the financial market, and lastly, the payment industry is agog with new blockchain payment service providers among the stakeholders. Mills et al. (2018) and Sanel et al. (2019) confirmed that blockchain has the perspective, in the context of impacting payment, to provide use cases in payment transactions, including cross-border payment, trade finance clearing and net securities settlement, to harmonise operational and transactional abrasions around current financial services. However, Sulik-Górecka et al. (2018) claimed that blockchain technology would impact when used in a mix with other technology mechanisms in all financial services as far as payments are concerned loan disbursement.

2.7.2.3 Blockchain Cross-Border Payment: The cross-border Bitcoin payments are believed to inspire blockchain cross-border payment as the transaction is borderless. It does not matter where the Bitcoin transactions are initiated, provided the transaction is cost-effective and without friction (Isaksen, 2018). He posited that the Bitcoin transaction is devoid of trust and mediators and the use of exchange rate schedules which reflect the efficiency, safety, ease, transparency, speed, and low cost of cross-border operational transactions. Cross-border trade is akin to a national interbank market. The only difference is that the transaction involves banks in several other countries, making it even more complicated (Dolinski, 2018).

However, the correspondent banks' intermediary role still suffices as they are needed to consummate cross-border transactions among themselves (Mehrländer, 2018). She maintained that for banks to fully participate in the blockchain payment process, they should operate as nodes with ledgers for private and permitted customers in the blockchain network. Tier III certified data centres would take up the mining responsibility and all the transactions processed on the blockchain network. Interbank payment would be directly transmitted between banks, including the regulatory bank, with the impact extended to the banks' various beneficiaries. For all transactions posted in the blockchain network, the ledger accounts exposed in the network, which mirror the settlement accounts, would be debited or credited. The account principle of every transaction

2.7.2.4 Blockchain Customised Payment: It is believed that traditional physical bank coins and notes will one day be replaced with virtual currency in the foreseeable future, considering some central banks' adoption of blockchain technology worldwide. However, (Avital et al. (2017) believed that the emergence of customised '*smart money*' means a digital exchange value for secure payment. They declared that smart money would align with the conventional monetary policy mechanism with transitional platforms that will assist critical players in the financial industry without circumventing payment policies and guidelines.

They suggested that smart money should be implemented as a corresponding currency, parallel with the traditional currency, to get the public's buy-in and align it with the global financial view. Chen et al. (2017) proposed a cloud-based database application called ***Blockchain-based Payment Collection Supervision System (BPCSS)*** to provide financial services, including cost-effective payment transactions and monitoring every payment between the merchants and the customers. ***B-Ride*** is a customised and decentralized trip-sharing and payment service developed using blockchain technology. It empowers drivers to provide services by sharing rides without involving a reliable third party (Baza et al., 2019). Creating a customised blockchain payment service in the construction sector to address malpractices, despite contractual agreements, and facilitate secure and transparent peer-to-peer payment is entirely feasible (Das et al., 2020).

2.7.3 kchain Payment Channels and Potential Challenges

2.7.3.1 Blockchain Payment Channels: Payment channels are workflow network routes for consummation transactions. Rohrer et al. (2017) proposed that a protracted push-relabel algorithm would stimulate payment transactions to flow in the payment channel network and promote a dispersed and simultaneous implementation without breaching capacity constrictions. They opined that the payment channel network's current solo path routing configuration is a frost of many deficiencies simply because network capacities are inefficient utilisation, ultimately destabilising the payment channels' flow. They projected that developing a flow network algorithm to address the downside by utilizing the total capacity in multiple routes is more feasible than a single path (Piatkivskyi & Nowostawski, 2018).

With this development, sizeable, valued payment transactions would be allowed, suitable enough to correct the current setup encountered in the virtual payment channel networks, provided the cost is comparable with other fees (Avarikioti et al., 2018). However, Hu et al. (2019) projected an activated payment gateway channel labelled ***Near Field Communication*** to facilitate ***delay-tolerant*** payment transactions in rural and remote areas where the network is an issue since they are unreliable. In the same light, Werman and Zohar (2018) proffered that deadlocks in a blockchain payment channel can be avoided through the adjustment of the network protocols to ensure that ***pre-lock edges*** are arranged in an order that would certify a free process flow while still safeguarding the ***protocol's privacy*** necessities.

2.7.3.2 Blockchain Challenges in the Payment Industry: With every critical technological development, there are potential challenges to adopting blockchain technology in the payment industry (Holotiuk et al., 2018). They posited that the six crucial blockchain challenges in the payment industry are the importance of adopting real-world use cases against the hypothetical theories in vogue. They stressed that the only way blockchain technology could get the buy-in of the stakeholders and prospective users in the payment industry is for the technology to be proven to have the edge over the current payment infrastructure through use cases in the delivery of services such as speedy performance, low operational cost, and efficiency.

The second challenge is the critical case of integration between new blockchain systems and their legacy applications and interfacing with other financial institutions' systems. The third challenge is vital as it revolves around ***interoperability, standardization,*** and fusion of blockchain technology policies across several internal and external stakeholders, particularly in the financial industry. Standardization would stimulate interoperability and unification of various infrastructures and blockchain technology's benefits. Fourthly, a high level of system availability devoid of downtime and robustness of the application is a crucial challenge for the blockchain payment system, which is ideally supposed to be up in real-time and running 24/7 to enable users to transact business any time of the day and every week of the year.

The fifth challenge is the scalability of attaining very low dormancy that would trigger a speedy reception of transactions at a very brief response time. They implied that the Bitcoin processing throughput is in the range of 6-8 transactions every second. This mechanism could be decisive in consummating payment transactions as distributed systems configured to utilise single-path transactions and batch transactions could slow down the system.

Lastly, extensive collaboration among key market players and regulators would be a non-technical challenge in the blockchain payment system. A consensus would be needed to set the appropriate framework and regulatory policies of international best practices that all stakeholders should comply with within their jurisdictions and purviews (Wadsworth, 2018). Collaboration of all relevant stakeholders is vital to the success of the blockchain technology implementation. All stakeholders, including the regulators and the regulated, must be on one page regarding the implementation.

2.8 Blockchain Technology and Cyber-security

Cyber-security is critical to the successful implementation of blockchain technology as there is every possibility that any cyberattack would render the transaction flow vulnerable and compromised. Cyber-security is also fundamental in this study; it is part of the research questions. Security professionals perceive that the secure nature of the cryptography in the blockchain system is adequate to resist any cyberattack (Hasanova et al., 2019). However, they posited that security concerns have been building up daily due to the rapid request for cryptocurrency worldwide and attracting considerable attention, thereby creating vulnerabilities for hackers to capitalise on the network.

The rapid development of blockchain technology due to the intrinsic vigour to cyber-attacks has attracted a lot of organizations to the fray. Asuquo et al. (2020) posited that blockchain technology amid the *Internet of Things* (IoT) vis-à-vis the relationship with cyber security technologies has provided a fortified ecosystem to ward off the challenges. They provided insight in their study on the security of privacy disputes and significant turnaround in the blockchain network. Parizi et al. (2020) opined that cyber security is a forcing need for every participant on the internet due to the recurrent cyber threats. They stated that there are numerous proposed cyber security solutions to alleviate the ever-dynamic security obligations, and blockchain is one of those solutions to address the threats. The features of blockchain technology, such as immutability and decentralization, can stimulate the accomplishment of data reliability, consistency, and integrity. Their cutting-edge study was to reveal from the industry and academia the cyber security prospect of applying blockchain cyber-security applications that would flag the route for the digital future. The future of the digital is bright, provided the blockchain platform is reinforced with cyber security to protect data and ensure transparency and privacy.

All web-based transactions are currently stored in the cloud data platforms. So it is expected that blockchain functionalities would strengthen cyber security and privacy protection (Kshetri, 2017). He implied that the decentralised attribute of blockchain tends to reduce the network's vulnerability and forestall any exploitation propensity by mischievous players. It is believed that the identity and access management of the blockchain is unique in tackling crucial security breaches on the internet generally. Regulatory bodies should supervise the deployment of blockchain applications along with relevant enforceable policies and legal precision to protect the participants’ privacy, ensure smooth smart contracts and sensitization training to essential stakeholders and improve the investment climate.

Global financial crime is replicated with fraud, theft, threat and data disruption, among others, in the financial landscape. Strategically, Hasham et al. (2019) proffered a prevention policy to tackle the threat by predicting the risk instead of being reactive whenever there is a cyber-attack. They proffered a strategic prevention plan where the possible threat would surface through the design of processes, customer engagement and core operations based on a constant and holistic appraisal of factual cases of financial crime, fraud and cyber threats. They also proposed the management of fraud-risk initiatives with an emphasis on the value of independent oversight and delineation of duties. In addition, integrating teams across operations, business, security, and risk would no doubt stimulate good intelligence gathering and sharing against cyber threats. The security operating model should comprise a unified platform that includes cyber security, fraud, financial crime and a threat that must investigate and ask questions about the activities and processes, organization and people, technology and data, and corporate governance.

Financial institutions should ensure information collaboration and harmonization among silos systems to mitigate risk and promote organisational efficiency. Leading banks incorporate the fraud unit with the cyber security section to ensure end-to-end and holistic decision-making. It is said that "*prevention is better than cure*", so the flow should be from prevention first to ensure there is no incident to the investigation once there is a case of fraud and finally to the recovery process. The issue is that every financial organization must step up the fight to prevent a fraud incident as hackers become more sophisticated in breaking through what used to be traditional strongholds so that they do not become less efficient and more expensive (Latino & Menegoli, 2022). However, despite the robust features of blockchain technology immutability and hashing, there are still some vulnerabilities and cyber security threats that hackers take advantage of in the blockchain platform (Alkhalifah et al., 2020). They researched a study that built on the previous research papers investigating about sixty actual cyber security occurrences in the blockchain networks through their identified vulnerabilities *between 2009 and 2019*.

The incidents were categorized against the critical cyber security susceptibilities by Alkhalifah et al. (2020) in the blockchain networks through the development of a taxonomy that traps about five kinds of cyber security vulnerabilities and threats based on five main participants. The result of their study triggered concerns, and research focused on creating counter procedures to assuage these critical risks. For them to identify the cyber threats and vulnerabilities was an outstanding achievement, and being able to proffer appropriate measures to counter those exposures was an added accomplishment. It is said that “***a problem identified is half solved***”.

2.8.1 kchain Technology Architecture

The security feature is part of the blockchain technology's architectural design despite the decentralised nature of processing transactions without a third party's involvement. The blockchain technology database system is immutably designed to store historical data in the digitalised ledger form of nodes regarded as users who can manage the ledger in the blockchain network. Blockchain technology architecture comprises blocks organized in chains with the root block regarded as the base, linked to every previous block in a pile, and identified by a hash generated by the cryptographic algorithms. It means a block should have a unique hash header linked to the parental block with many upsprings of blocks as children.

The blockchain technology network process is built on an add-on-only data structure where every transaction implemented is stored in the database like a parent-child relationship. All successive blocks are mined when a new block is validated and appended to the blockchain network.

An intrusion detection system (IDS) is a device used to detect malicious and malware traffic in the computer network platform. However, it is tricky to detect coordinated assaults due to the availability of a specific vantage spot (Ajayi et al., 2019). They proffered a solution to combat this challenge as the nodes exchange attack signatures have the propensity to re-detect previous attacks that a different node in the system may have bypassed. They opined that attacks vary from one system and location to another. Though the IDS can respond to previously identified attacks, there are malicious cases of data manipulation, deletion, forged data infusion and **inconsistency** that may not be detected and would threaten the system. They proposed a critical solution leveraging blockchain technology's distributive features, including ***data immutability and tamper-proof capability*** to prevent and detect impish activities facing the intrusion detection system while focusing on storage, extraction, and distributive phases of the process.

Their proposed solution provides a secured extraction of signatures, complements additional validation steps, and offers signature storage of data as well as distribution of shared data, which precludes malicious data infusion, data deletion, low latency, and manipulation against stored data to the public service (Franciscon et al., 2019). Cao et al. (2019) noted that much as the central bank digital currency underpins the imminent digital society and economy, most available digital currencies sacrifice performance standards instead of decentralization and focus on technical architectural creativity while disregarding the social effect implication. They proposed a **parallel distributed architecture** based on a hybrid blockchain technology system, combining unspent transaction output and corresponding accounts for the central bank digital currency. They amplified that social inferences must be considered to achieve better performance through centralised management. They claimed that the system architecture should be designed for optimal outcome of the process as the results they projected were indeed what they realized in terms of the processing speed, which was faster than the traditional approach.

2.8.2 kchain Technology Potential Vulnerabilities

Vulnerabilities in blockchain technology are security breaches that cyber attackers leverage to attack systems. In plain language, vulnerabilities are weaknesses or loopholes manifested by application systems and hackers taking advantage to infiltrate them. Despite the locking of blockchain blocks by cryptography and the stog position held by various experts, this measure is enough to resist persistent hacking and threats. Hasanova et al. (2019) emphasised that several applications have fallen prey to positive cyber-attacks. The outcome of their previous studies indicated that several vulnerabilities were investigated to isolate the types of potential cyber-attacks (Saini et al., 2019). Blockchain has fortified security features that ensure data synchronization through connected blocked formation, which validates and stores transaction data and trusted consensus algorithms. It is not a secret that despite blockchain technology's prospects, there are still concerns about its vulnerabilities and potential attacks, which facilitate the exploitation of new solutions and methods of protecting the system (Averin & Averina, 2019).

Vulnerabilities abound in any system, no matter how secure that application could be, because there would always be several attempts to hack into any domain residing in the cloud, even if it were not intended to be (Kushwaha et al., 2022). A smart contract can harbour millions of dollars, attracting interests, including negative ones that may lead to several vulnerabilities and subsequent losses. They highlighted the security vulnerabilities surrounding the Ethereum blockchain, including real-life attacks, detection tools and prophylactic mechanisms. Amiet and Security (2021) mentioned that the blockchain is not invincible or invulnerable, as there are well-known vulnerabilities in several components of the blockchain ecosystem. Alkhalifah et al. (2020) stated that there have been several cybersecurity vulnerabilities over the past decade. They categorised the incidents into the leading players according to vulnerabilities and cyber security threats in the blockchain network, particularly those associated with the intelligent contracts where dollarization is hugely involved (Singh et al., 2020). König et al. (2020) listed over twenty vulnerability risks and structured them into four main domains, which are ***"Application Oriented Attacks", "Attacks on the Peer-to-Peer***

System", "Blockchain Structure Vulnerabilities", and "Attacks on the Consensus Mechanism". However, there have been speculations about the possibility of the cryptographic device in the blockchain to withstand security threats and relentless attacks, as previous studies have shown on the privacy and security of the blockchain that many applications are becoming prey to efficacious cyber-attacks.

2.8.2.1 Cybercrime: Cybercrime has become a significant business for hackers and collaborators in many countries (Huang et al., 2018). Cybercrime can no longer be considered a leisure activity as hackers have regarded it as a profession worth pursuing. They opined that the cybercrime ecosystem had developed to embrace a global network supply chain syndicate that thrives on valuable processes and reconstructed to a state of specialism, marketability, and collaboration system (Lazarenko & Avdoshin, 2019). Hasham et al. (2019) itemised the ***new cyber prole of fraud and financial crime is well illustrated by the Carbanak attacks*** to be: "***spear phishing, backdoor executed – credentials stolen, machines infected in search for admin PC, Admin PC identified, - clerk screens intercepted, balances inflated, and the inflated amount transferred, ATM programmed to dispense cash, cash moved through channels by wire transfers, e-payment***".

Cybercrime is evolving to adjust to the domain of the hacker's pillage. Cybercrime can be classified as financial crime and fraud, which have become complicated and impassive due to the digitization of currencies and the automation of financial applications. Hasham et al. (2019) confirmed that cybercrime is an organized attack at the organization's highest level involving mostly banks where the hackers explore vulnerabilities or introduce malware into the system. The cyber attackers take their time to seek information concerning the "***siloed***" organization and corporate governance they intend to plunder as they study the controls and bank processes in the case of banks and explore possible vulnerabilities in the system. The hackers delve into all possible channels, including credit and debit cards, wire transfers and automated teller machines (ATMs). Most attacks are without distinction among cyber-attacks, financial crime and fraud in their nefarious activities. Sadly, many banks have yet to grasp these incidents and the new inter-sections beyond the traditional lines.

2.8.2.2 Double Spend and Goldfinger Attack: In the case of blockchain technology, some vulnerabilities were evident right from the inception of blockchain 1.0, such as what is termed "***double-spend***", or the process of making multiple payments instead of one in a peer-to-peer network platform (Hasanova et al., 2019). However, a hacker with high hashing privilege can intrude into an invalid block transaction, thereby gaining full access right into the network to cause havoc and denial of service to the legal users, which blockchain technology security specialists regard as a ***Goldfinger attack***. This situation occurs when an attacker can hack into the network and control, through the mining pool, approximately 51% of the hash proportion (Storsveen & Veliqi, 2020).

2.8.2.3 Wallet Security Breach: It is well known that wallets are storage facilities where funds and cryptocurrency values are kept through private/public keys to access the wallet users. Like any other storage, the wallet can be hacked and relocated to other platforms when users compromise their access codes. When such a thing happens, the users are denied access to their profiles through phishing and ransomware. An unsecured private identification number (PIN) or a software bug could result in the exploitation of the cryptographic application to cause a fundamental security breach of the network's unencrypted edition (Bordel et al., 2020).

2.8.2.4 Network-Base Attack: In terms of the blockchain architecture network, worrisome issues are bothering security, ***availability, sustainability, and scalability***. This circumstance is due to the increase in the cryptocurrency transaction market activities and the increase in cyber-attacks primarily experienced in the ***distributed denial of service*** (DDoS) attack. An attack in the decentralized network is more complicated than in the traditional distributed platform. As such, DDoS will remain a potential avenue for dangerous attacks on the blockchain network (Alkhalifah et al., 2020).

2.8.2.5 Blockchain Features Vulnerabilities: Some blockchain experts perceived vulnerabilities through the benefits of blockchain technology. Madnick (2019) claimed that the *transparency* that blockchain is known for could also be its undoing since a public-viewed software code that is available could be used by an intelligent user to hack into the network. On the decentralised structure, he posited that once a problem shuts off a server from one location while other servers could function, a shrewd user could capitalise on the shutdown server to cause havoc through the functioning server of the network (Singh & Singh, 2016). On the anonymity feature, he opined that a ransomware attack could thrive when a blockchain key is stolen under the guise of an anonymous user (F. Dai et al., 2017).

2.8.2.6 Other Vulnerabilities: Alkhalifah et al. (2020) acknowledged that other vulnerabilities include client-related ones such as digitalized signatures, mining malware, hash functionalities and software identifier addresses. They also mentioned the consensus mechanism vulnerability, such as ***Alternative History and Finney Attack***, besides the 51% vulnerability mentioned above. The mining pool vulnerability includes ***Block Withholding (BWH) and Bribery*** Attacks, while the intelligent contract vulnerability comprises the ***Ethereum Virtual Machine*** *(EVM)* ***Bytecode and Solidity*** Attacks. The prospect of a devastating cyberattack is likened to the next Pearl Harbour (Trautman, 2016) especially considering the ***frequency, scale, sophistication, and severity*** at which hackers perpetrate cyberattacks as a global threat against some "***superpower***" countries. Averin and Averina (2019) broke down the vulnerabilities and attacks associated with the blockchain network comprehensively into four categories, each comprising several attacks and vulnerabilities. The four main classifications are "***Blockchain Structure Vulnerabilities, Attacks on the Consensus Mechanism, Application Oriented Attacks and Attacks on the Peer-to-Peer System***". Under the blockchain structure vulnerabilities, there are two kinds, namely ***Blockchain Forks*** consisting of the ***Hard Fork*** and ***Soft Fork*** while the other is the ***Staled and Orphaned Block***.

The attacks on the consensus mechanism comprise ***Majority/51% Attack, Reward for Uncle Blocks, Proof of Work Vulnerabilities, Proof of Stake vulnerabilities, Practical Byzantine Fault Tolerance, Finney Attack, and Race Attack. There are eight vulnerabilities in Application-Oriented Attacks, including Smart Contracts consisting of Forcible Balance Transfer, Short Address Attacks, Overflow Attacks, DoS Attacks and Re-entrancy Attacks. Others are Replay Attacks, TimeJacking and CryptoJacking. The "Attacks on the Peer-to-Peer System" include the Wallet Attacks, Sybil Attack, Block Withholding in Private Network, Fork after Withholding Attack, Classical Block withholding Attacks, Selfish Mining and Eclipse Attack***.

These vulnerability attacks are like serial malware that self-generate in some cases in the network with severe consequences on the system. There are more than what has been specified above due to how the attacks are perpetrated on the internet.

2.8.3 tential Blockchain Technology Countermeasures

Blockchain, an emerging technology with remarkable features, including transparency and decentralization, has obtained widespread interest and in-depth studies over the past few years. However, despite the unique security characteristics of persistence and immutability, the blockchain is still vulnerable to several attacks (Wen et al., 2021). Many organizations have fallen casualties of these attacks due to ignorance and obliviousness (Hasanova et al., 2019). Some of these attacks were highlighted in the previous section, which is often ignored in most instances. The researcher has underscored the resultant countermeasures to these attacks. Shan et al. (2015) opined that there are numerous countermeasures, some designed to conceal information leaks through the sluggish reconfiguration of processing factors to execute bogus operations. They posited that various kinds of universal countermeasures and encryption-related initiatives could be assembled as the security concentration can be tweaked by performance trading.

A *"**Software-defined network**"* is a vigorous contemporary networking method used to accelerate innovations of the network process. It is vital to address software-defined network vulnerabilities to guarantee the implementation of exclusive data centre networks on cloud performance and beyond (Abdelrahman et al., 2021). They expressed that several security applications leverage the built-in characteristics of the software-defined network to protect the system.

2.8.3.1 Blockchain Security Mechanism: According to Kshetri (2017), the architectural design of the blockchain network is sufficient to protect against any cyber-attack since there is no room for third-party transactions and validation is processed by other participants in a distributed database. He also posited that security and privacy facilities would be enhanced even when targets are attacked if permission is not granted in an authorised network. The data is encrypted with cryptographic hash functionalities and inundated only to the envisioned recipients.

2.8.3.2 Blockchain Security Features: On blockchain's current security features, Le et al. (2018) maintained that the technology is still being used for authentic devices, which may eventually replace the password and eradicate any form of human involvement due to the decentralised structure and the promotion of non-repudiation. However, Demirkan et al. (2020) posited that blockchain technology is designed to be secure, tamper-proof and provide lasting data or irreversible business transactions since the network does not allow alteration of data without the consent of all relevant participants. Blockchain technology is currently being used to prevent hackers' connections by adopting a rigorous setup that unauthorised users cannot manipulate (Matthew, 2019).

2.8.3.3 Blockchain Cybersecurity Tool: Mkrttchian et al. (2019) proposed a new blockchain cybersecurity tool called the Avatar-based management technique to control and protect transactions in the blockchain technology network against cyberattack issues. The cybersecurity tool rides on blockchain technology qualities to ensure security in the network (Wang et al., 2019). Jensen et al. (2019) confirmed that the blockchain technology application of ***Hyperledger Fabric*** was being used to provide security against malicious cyberattacks for remote aerial vehicles technology to preserve the provision of its features such as inspection of infrastructure, management of traffic and adopting search and rescue mechanism (Decusatis et al., 2017; Kim, 2018).

2.8.3.4 Cyber Defence: Different approaches are being proposed to improve cyber defence way out of hostile situations to protect the data from unlawful entrée (Gulati et al., 2020). They proposed a countermeasure strategy labelled the ***cyber defence protection cycle*** comprising ***prevention, detection, reaction and forensics***. These are components linked to resolving any issue through continuous system monitoring to identify potential vulnerabilities and take the appropriate steps to strengthen the system (Ajayi & Saadawi, 2020; Lee & Kim, 2022). Cybercrime targets are not limited to the private segment, as states and countries have also become targets, demonstrating that cyber threats can endanger significant national activities (Cybenko & Hallman, 2021). This development prompted some countries to upgrade cyber threats to the national security level and was regarded as ‘cyber defence’. They affirmed that blockchain technology offers robust security attributes devoid of a centralized control platform. Cyber defence applications are also applied to the music and education industries to curtail copyright abuse and ensure trust and protection of educational data (Zhang, 2022; Rahman et al., 2022). Wang et al. (2019) proposed using blockchain to store data related to the incident of aviation missile events surrounded by encryption techniques. Security pundits in developed and superpower countries have proved that blockchain applications can protect and store security data in military formations (Lilly & Lilly, 2021).

2.8.3.5 Blockchain Decentralised Detection Framework: A framework proposal by Ramanan et al. (2020) to detect cyberattacks in a blockchain decentralised network through synchronised repeat attacks with complete privacy device data has been developed. The tailor-made blockchain framework is labelled the ***Bayesian Inference Mechanism*** (BIM), which coordinates locally informed attack possibilities to detect the inception of an all-out rerun attack in an accurate and timely fashion for decision-making. The BIM capitalises on global attacks' speculation by developing global “***computation, addition, and multiplication***” to align with the broadcast conjecture. The performance analysis would forecast the prospect of specific attacks on the blockchain network (Singh et al., 2018).

2.8.3.6 Combatting Cybercrime through Governance: The ecosystem involves governments, financial systems, software/hardware providers, internet service providers, security companies, infrastructure operators, intelligence service providers, individuals and corporations. Huang et al. (2018) proposed that the governments drive the process of battling cybercrime, considering the regulatory role they play in their country's economy through the constitution of a crack cybersecurity team and the implementation of policies and strategies to combat the activities of cyber criminals (White & Daniels, 2019).

2.8.3.7 Blockchain Technology Secured Cyber-attack Signatures: The global spread of cloud databases has contributed to their weaknesses, from which hackers have taken undue advantage to attack their systems despite the efforts of protection, and cruel impostors have succeeded in exploiting the system to gain access to their data. Based on this development, Ajayi et al. (2019) proffered a model which was corroborated by Farion et al. (2019) to promptly detect any signatory that has been attacked through the circulation in real-time and secure them in a database while leveraging on the ***tamper-proof capabilities, data immutability and distributed ledger technology*** and latency of the blockchain technology network. The signatures are scrutinised on the system to ensure no infiltration of any form.

2.8.3.8 Possible Vulnerabilities Countermeasures: Hasanova et al. (2019) offered various countermeasures to some vulnerabilities stated above. For the double-spending, they proposed the use of ***the Slasher approach algorithm, CASPER protocol, punish validators, Tendermint protocol, POS/POW hybrid protocol, using a listening period, Inserting observers and Efficient detection technique*** while on the Goldfinger or 51% attack, ***the slashing conditions and CASPER protocol*** were also recommended and *SMARTPOOL* algorithm. Password-protected secret sharing and hardware wallets were recommended to countermeasure private key security. Many countermeasures were recommended for the network-based attack, including ***gas technologies, proof-of-activity (PoA) protocol, fee-based and age-based MEMPOOL, using a small pool, use white list, network time protocol, restricting the block size, multiple confirmations for large transactions and AI base anomaly detection technique***.

2.8.3.9 Distributed Blockchain Protection Framework: Liang et al. (2019) proposed a ***distributed blockchain-based data protection framework*** to enhance the modern power system's data security against cyber-attacks. This mechanism sustained the power system's self-defence capability against cyber-attacks by coupling the blockchain technology features (Mylrea & Gourisetti, 2018). A. Kim and Kim (2020) opined that they developed a blockchain-based music framework to manage and ratify their music patent using distributed ledger technology where the right stakeholders can obtain royalties from the musical trade industry with immediate effect and automatic alacrity. Musleh et al. (2019) also developed a framework for the smart grid and the *Internet of Things* (IoT) to provide several affordable and transformative solutions to resolve the challenges bedevilling the intelligent grid sector (Alkadi et al., 2021).

2.8.4 Central Banks and Regulation of Blockchain Technology

Regulation by the central banks of the decentralised platform has always been a critical issue in light of the features of blockchain technology and the traditional centralised method. However, Scholl et al. (2020) posited that the regulation of distributed ledger technology, including blockchain technology, by less significant jurisdictions such as Malta, Gibraltar, Liechtenstein, and Bermuda were among the pioneers to commence regulation and provide guidance for the blockchain network as the usage extends to the national identification number, retail and industrial supply chain management, insurance and healthcare data storage and administration. These initiatives would require appropriate supervision, be it the new regulation or complementary control of the blockchain-based network. They observed that the regulation of the services provided by the blockchain and distributed ledger technology appeared to be ***rule-based*** as against ***principle-based***, which creates the enforcement of policies and, distinctively, ***case-based*** responsibility.

Existing blockchain technology regulations were reviewed by Afzal and Asif (2019) to include business-based regulation, where the financial authority permits some businesses by issuing licenses to regulate the digital currency in Switzerland, including self-regulated organizations. The essence of self-regulation is for the established business authority to be granted the exclusive purpose of generating performing risk management systems and compliance standards to sustain the financial system's integrity. This self-regulating approach is also being implemented in countries like Australia and Estonia. The automated system in Australia aimed to deepen distributed ledger technology's volatility and liquidity risks, including cryptocurrencies. Estonia has implemented the digitalization of government activities with the database in the cloud, which has helped them thwart hacking attempts into the system. Venezuela is searching for financial refuge in the cryptocurrency market where Bitcoin would be a legal tender in their financial transactions due to the financial crisis and deteriorating currency as they have not been able to generate bond payments.

Nigeria introduced a digital currency to facilitate the digitalization of the economy and promote economic growth. At the same time, South Africa has taken a radical approach to the digitalization process. The government has been working on blockchain-backed cryptocurrencies to facilitate a steady approach to regulating these cryptocurrencies. However, on the contrary, the Russian government has underscored the pertinence of cryptocurrency regulation but has yet to agree on the practicability. Ghana has demonstrated significant interest in the cryptocurrency market but emphasized the need to regulate the platform despite the ban placed on Bitcoin. Despite the prospects of implementing blockchain technology in India to stimulate contract compliance, reduce fraudulent activities, improve transparent transactions, and improve productivity in agriculture, the blockchain market is faced with the daunting challenges of the political and regulatory atmosphere, including the prohibition of their domestic banks from using their accounts to trade cryptocurrencies in the international market.

Peters et al. (2015) stated that there are limitations for a single authority to regularise the decentralised landscape as the focus would be on the blockchain service providers. Since the cryptocurrency market is borderless, it would be highly complicated to dissuade blockchain companies from manipulating the regulatory process and taking advantage of the arbitrage. This perception could be why some countries mentioned above decided to grant jurisdiction to companies to regulate the blockchain market.

2.9 Research Studies on Blockchain Technology

2.9.1 revious Studies on Blockchain Technology

Research studies on blockchain technology are not as common as other renowned topics due to the recent and innovative nature of the technology that commenced about eight years ago. As a result of this hindsight, researchers have not produced many journals and reports since the invention. However, in light of the rapid development of blockchain technology, tremendous reports emanated from blockchain-related conferences and gatherings. This study will focus on the previous and current research and future directions associated with blockchain technology.

2.9.1.1 Previous Studies on Supply Chain: Where past data generation of life-cycle products would be situated and stored had been a recurrent issue over the years due to the absence of a collaborative product information management platform. Mattila et al. (2016) review of previous blockchain supply chain research showed that there were challenges with accessing, updating and distributing products in the supply chain cycle, necessitating the implementation of blockchain technology to manage this process (Paliwal et al., 2020).

2.9.1.2 Blockchain Healthcare Studies: The initial studies on blockchain technology commenced around 2012 despite the gradual incursion from finance to the healthcare sector, according to Alla et al. (2018), who implied that blockchain technology had restructured the way business is being transacted in the healthcare sector as far as patient records and drug dispensation are concerned. They opined that the challenges of blockchain technology had been observed and reported by various research studies but would not affect the ongoing transformation in the health sector, particularly in specialised areas such as oncology, an aspect of medicine that deals with the care of cancer patients (Dubovitskaya et al., 2020).

2.9.2 kchain Technology of Current Research Studies

Reports indicate that blockchain technology infiltration in society is still embryonic, particularly in the healthcare sector. According to Durneva et al. (2020), many researchers are unaware of the numerous benefits. They opined that the COVID-19 pandemic had brought to the fore the need to expedite action using blockchain technology to provide appropriate services and intervene in the pandemic crisis. However, Casino et al. (2019) stipulated that the current blockchain applications include ***Education, Finance, Integrity Verification, Data Management, the Internet of Things, Governance, Health, Business and Industry, Privacy and security***. Others consist of ***social media, Environmental Management and social sharing dynamics***. They perceived that as blockchain develops, many industries and purviews would embrace the technology as projected.

2.9.2.1 Current Blockchain Technology in Tourism: Current blockchain technology in tourism has gained ground over the years, particularly in data privacy and security, as stated by Calvaresi et al. (2019). They posited that using blockchain technology had added value and guarantee to tourism business management. However, like any other venture in business, there is still vast room for improvement. The study focused on the strengths, assumptions, application scenarios, functionalities, domains, limitations and potential challenges (Liberato et al., 2018). They proposed that more research studies must be conducted to align the outcome to real-life situations.

2.9.2.2 Current Blockchain Technology in Education: As in other critical sectors, existing blockchain technology applications in education improved significantly in managing student records, and career development, stimulating trust among the students and lecturers. Others are enhancing students' interactive platform, transparency and accountability, as indicated by (Alammary et al., 2019). They also mentioned the improved data access control for learners, enhanced student assessments, low cost of operations and a well-secured learning system environment.

2.9.2.3 Present Blockchain for Industry: The current industrial blockchain encompasses most sectors mentioned earlier in this write-up. However, Bodkhe et al. (2020) expressed that blockchain technology incursion in the industry spans from "***smart farming, smart healthcare, maritime shipping, supply chain and logistics***" (Kamble et al., 2019), ***business, tourism and hospitality, energy, agriculture, smart city*** **to** ***manufacturing***. They stated that the energy sector includes the power grid and the distributed energy system, while the manufacturing consists of blockchain-based traffic management, authentication, and front-end systems (Yang, 2019).

2.9.3 ure Direction of Blockchain Technology

The future of blockchain technology looks very bright, considering the revolutionary way it has changed centralised authority's perception, especially in the global financial landscape. Atlam et al. (2018) postulated that the blockchain future would open new doors for more business applications on the Internet, particularly in intelligent contracts where flexible programs are encrypted and securely stored with restricted access to information by authorised users in the blockchain technology. They perceived that another area of future direction would be the appropriate laws to regulate the blockchain technology process, which central authorities usually formulate to stimulate blockchain technology management. They also proffered that security would always be an ongoing direction in the future, considering the threat of cyberattacks and the development of publicly distributed ledgers. An example is "Tangle", a novel database architecture designed using a ***Directed Acyclic Graph*** (DAG) to provide an open-source real-time, efficient, secure, and frothy cryptocurrency for the *Internet of Things*.

However, on the future of a sovereign blockchain technology process, Manski and Manski (2018) projected that this could be possible theoretically as autonomy may spread in various forms to individuals' social and technological worlds. According to them, these future forms of sovereignty could stem from more individual innovation, populist propensities towards improved globalisation and decentralisation, global expansion of blockchain technology, enhanced corporate development and state control of blockchain technology (Reis et al., 2018).

2.9.3.1 Future Direction on HealthCare: On the future direction of blockchain in the health sector, Durneva et al. (2020) suggested that emphasis would be placed on the usage of blockchain technology to further enhance the integration with the health infrastructures through compatibility and interoperability (Esmaeilzadeh & Mirzaei, 2019). They expressed that with the rapid development in the usage, the future direction would be expanding the storage capacity and further research studies in blockchain health information technology (Dubovitskaya et al., 2020). This assertion was corroborated by Alla et al. (2018) when they articulated that beyond the current challenges, the integration of people, processes and technology would provide a bright and universal turn-around future for blockchain technology healthcare (Tandon et al., 2020).

2.9.3.2 Future of Blockchain Technology in Education: There are proposals that the future direction of blockchain technology in education would focus on extensive partnership and collaboration among educational institutes as most academic institutions are already adopting blockchain technology in their internal activities and are in the process of extending the process to other educational establishments (Alammary et al., 2019). They also looked forward to issuing blockchain-assisted certificates to their students, academic transcripts, students' program schedules, core/mandatory/elective course requirements, educational probation, and training of students and staff on skills. They believed that adopting blockchain technology would stimulate a conducive environment where operating costs would be reduced through shared services, infrastructure, and academic curriculums. The ultimate benefit to be derived from the adoption of blockchain technology in education is facilitating quality accreditation of online programs.

2.9.3.3 Future Adoption of Blockchain Technology: The previous and current adoption of blockchain technology over the past few years was made possible through Bitcoin, which concentrated on portfolio investments. However, Lou and Li (2017) proposed that there would be an integration between innovation diffusion theory and the technology acceptance model to enhance the persistent adoption of blockchain technology because blockchain is relatively new and continues to advance rapidly. They also identified the change factor hindering the adoption. However, they proffered a unified model where data was collected from managers in Taiwan's business sector to conclude that a future adoption would be possible through the innovation acceptance model (Kolb et al., 2020).

2.9.3.4 Future Work of Blockchain in Agriculture: Shortly after the research studies by Bermeo-Almeida et al. (2018) on the impact of blockchain in agriculture, they postulated that more could still be done in the area of agricultural products supply chain tracking and traceability to improve the efficiency and scalability (Tönnissen & Teuteberg, 2018). They identified the benefits of blockchain technology in agriculture from ten major scientific and web research studies, most linked to Asian countries, particularly China. They also proposed conducting another research with a broader set of online libraries to reach out to other countries and provide a synopsis of blockchain technology's effect on agriculture (Rejeb et al., 2020).

2.9.3.5 Blockchain Technology Future Direction: The most pertinent research path of blockchain technology is to have a good perception of how blockchain impacts the financial market's efficiency and the corporate world (Xu et al., 2019). They also posited that another perspective is protecting privacy and security and the efficient management and regulation of the cryptocurrency business, as substantiated by De Keyser et al. (2019). Additional future direction is the deep integration of blockchain with *Fintech* and *cross-chain technology*. Each organisation would exchange data among themselves as this is the core attribute in accomplishing the *Internet of Value* (Yli-Huumo et al., 2016).

2.9.3.6 Blockchain for Business, Consumer and Governance Prospects: Blockchain technology prospects in business (Frizzo-Barker et al., 2020), the consumer (Boukis, 2019) and governance are very bright considering the areas that would be affected. On governance, Grover et al. (2018) postulated that global trade, intelligent contract categorisation, digital storage and payment services are the hallmarks of authority. At the same time, the consumers are entrusted with the potential provision of a real-time payment platform, user privacy and tracking of the product supply chain (Batubara et al., 2018). They posited that the business prospect hinges on appropriate accounting, independent processing, shared services, storage capacity, autonomous market, business process management, and source tracking (Hassan et al., 2020).

2.9.3.7 Blockchain in the *Internet of Things*: The advent of *Internet-of-Things* (IoT) has attracted enormous attention from global stakeholders involving the communities of academics, researchers and industries, as advocated by (Ahmad et al., 2019). IoT connotes the connection of several information and communication technology devices with storage capacity linked to the Internet, extending the implementation of various industrial and corporate social applications globally. They proposed integrating blockchain technology with IoT, termed ***Blockchain in Internet-of-Thing**s* (BITS), to deliver desirable privacy and security in the BITS network.

2.10 Summary of Chapter Two

Chapter 2 of the research study encompasses a comprehensive literature review on blockchain technology implementation. Detailed background information was provided regarding blockchain technology, and the favourable implication of the implementation was discussed extensively.

The chapter incorporated the theoretical and conceptual framework, propositions, hypotheses, and methodology. The blockchain technology's historical perspective with the definition of blockchain technology and background information on blockchain technology were discussed. Emphasis was provided on the current blockchain technology development comprising the current trend in blockchain technology and applications.

The central banks and blockchain technology deployment consisting of central banks considering and using blockchain technology were highlighted. Also emphasised were the central banks experimenting with the central bank digital currency, the implications of central bank digital currency on the financial landscape and the central bank of Nigeria's consideration of blockchain technology. The payment system driven by blockchain technology, including blockchain technology payment applications, was highlighted.

The consequent theme was on blockchain technology and cyber-security, comprised of cybersecurity mitigation against cyberattacks and different stages of blockchain technology cybersecurity applications. The last of the themes was on research studies on blockchain technology containing previous research studies as well as the future direction of blockchain technology, which surmised the current studies on blockchain applications such as supply-chain, health, education and the industry were highlighted research limitations and the impending path blockchain technology should expectedly project, particularly in governance, business, and the *Internet of Things* in the coming years were also emphasised.

CHAPTER 3: RESEARCH METHOD

3.1 Introduction

The transactional challenges with the payment system in the Nigerian financial industry are complicated. Though these problems necessitated the automation of some manual payment processes, there are still delayed straight-through processes and high operational costs. This research study proposes implementing blockchain technology to make payments in digital currency in the central bank of Nigeria and, by extension, the Nigerian financial industry. Since an existing real-time gross settlement system is being used for money transfer and third-party payment in local currency among financial institutions, there is a need to look at the functionalities to propose an enhanced blockchain application and fast-track the payment system.

Blockchain technology is taking a new dimension in my country since the Central Bank of Nigeria directed commercial banks to close accounts related to cryptocurrency investments. This temporary embargo has generated many controversies in the polity to the extent that cryptocurrency participants are in limbo about what to do next. This development also prompted the Central Bank of Nigeria to propose the implementation of Central Bank Digital Currency (CBDC) tagged ***e₦aira*** in the last quarter of 2021.

The research study aimed to identify the effects of implementing blockchain technology in the Central Bank of Nigeria and propose a way forward for the implementation. The fundamental factor of the research study is to curb the enormous challenges of manual, slow and operational cost processes and the need to improve the payment system using blockchain technology. The methodology of this research study is a triangulation approach of both quantitative and qualitative methods.

To link to the online survey questionnaires, the target population was contacted by email, WhatsApp messages, phone calls, and social media, if necessary. The cloud-based online software selected are the survey forms, which were used to collate the data. Jamovi and Qualitative Data Analysis (QDA) are statistical software used to analyse the data accordingly. Since data collection would be managed online, an informed consent form would not be signed and collected from the respondents. However, a consent option would be included in the online survey questionnaires to tick mandatorily.

3.1.1 zation of Chapter

This chapter aimed to deliberate on the research method, analyse the rate of data collected from the respondents, and specify how the researcher handled missing data. A brief discussion was conducted on the demographic data, including gender, age, business role/status/level, and years of the organisation. The researcher also analysed the blockchain information vis-à-vis the demographic data to produce the effects of implementing the technology.

This chapter focused on the research methodology to adopt and the appropriate design to achieve the aims and objectives of the research study. It also stipulated the target sample population of the banking and payment management staff of the Central Bank of Nigeria and a focus group consisting of the blockchain/cryptocurrency investors and operators in the Nigerian financial industry. The survey forms were the material/research tool adopted in designing the online survey questionnaire.

Finally, this chapter embraced the research approach and design, population and sample of the research study, materials/instrumentation of research tools, operational definition of variables, study procedures and ethical assurances, and data collection and analysis. This chapter was divided into seven sections made up of the introduction, research and design, which have been covered in this aspect, population and sample of the research study, materials/instrumentation of the research tools, operational definition of variables, study procedure and ethical assurances as well as data collection. This segment considered the perception of blockchain technology implementation in the country, and the takeaway from the data analysis outcome will be briefly highlighted. The emphasis was on the alignment of the research questions with the results of the data analysis.

3.2 Research Approach and Design

As stated in the previous chapter, the methodology of this research study was concentrated on a triangulation approach, a mix of quantitative and qualitative methods. The technique was adopted to enhance the possibility of deepening the intuitions of this study as the intricacies of human endeavour dictate more complex actions to capture the aphorisms. The mixed method was reflected in the various stages of the design process with the purpose of the research study manifested in the outcome (Aung et al., 2022). In this circumstance, the quantitative method, a case study approach, would be the primary technique in a proposed online questionnaire survey. The main reason for opting for the online questionnaire survey was to reach a large population, over 700 targeted individuals. Other causes include capturing appropriate data, low cost and time-savings for the researcher, and the possibility of presenting the survey in a friendly and easy-to-use template in a timely way (Deepa et al., 2022; Zheng et al., 2018).

Questionnaire Vs Interview

The decision to use the questionnaire as the only data collection method was the simplicity of designing the survey questionnaires and extending it to the respondents. The interview method was considered to be resource-rigorous and time-consuming as most participants complained that they may not have the chance and time for it. The quality of data to be retrieved from the respondents is often contingent on the expertise of the researcher, which may be lacking. Furthermore, the interview process may be influenced by several factors that can impede the precision and attribute of the data particularly in the areas of the interview's social allure predisposition vis-à-vis the respondent's honesty, rapport, language and cultural obstacles. The tendency for the interviewer to influence the respondents cannot be ruled out especially when the participants are deficient in the requisite understanding or knowledge of the issue at stake. There was also the possibility that there might be too many unguided answer choices to the open questions, which might create integrity issues in the data collection. The enthusiasm of the respondents to share their perspectives may be impacted by the communication style of the interviewer, the unethical conduct of the participants and the colossal cost of the process.

Besides the above challenges associated with interviews, getting artefact documentation examined was nearly impossible because data gathering on blockchain technology was more or less a recent development and would not be available. Other reasons why the questionnaire is preferred that the interview include the telecom network connection issue, delayed response time, distractions such as background noise, expressions inundated with non-verbal indications, ignorance of questions by the respondents, reluctance towards complex areas, diverse interpretations, survey fatigue, lack of accessibility, superficial responses and challenges to verifying the fact.

This online questionnaire survey was extended to the target respondents in a single-stage random selection process who are colleagues and contemporaries in the Central Bank of Nigeria and the financial industry. At the same time, the qualitative online focus group was also used to reach out to other target participants, mainly financial and payment experts, blockchain operators, and investors, with a sample population size of approximately 700. This design approach was chosen over the others (correlational, quasi-experimental and experimental) to derive concrete responses from the sample population vis-à-vis the impact of blockchain technology in the Nigerian financial industry. This approach was to enable the researcher to address the research questions aligned with the survey questionnaires and publish them to selected participants, as stated above.

The online-focused group was a consortium of cryptocurrency groups of investors and participants, of which I am a member. This approach was chosen over the other qualitative research designs, such as ground theory, phenomenology, ethnography, and narrative. A focus group is an approach that encourages reaching out to many individuals at a time in a concentrated area of attention and examination, as opined by (Nyumba et al., 2018). They emphasised that a focus group is economical and stimulates the creation of various survey questions (Vangelis, 2017). This approach would enable the researcher to obtain and perceive the opinions and even attitudes in some instances of the participants (de Boer et al., 2018). It also allows for faster data collection, an increased number of more participants than anticipated, ease of gathering social data and more responses in a conducive environment and stimulating interaction and safety among participants than an individual interview (Stewart & Shamdasani, 2016).

The ground theory design was not considered because this research was not a new theoretical study. The ethnographic design was inappropriate for this research study since it is used for the cultural observation of participants and does not have a conclusive outcome. The phenomenology design was unsuitable for the study as its concept is based on the philosophical investigation of various ideas of realism (Padilla-Díaz, 2015).

The case study design approach was selected to achieve the purpose of the research study. In contrast, the other designs, such as the comparative and narrative, were inappropriate for accomplishing the aim of the study. The narrative option was unacceptable as it would not enable the researcher to achieve the study's goals. The narrative research design leans toward philosophical pressures akin to the phenomenological method and, therefore, is unsuitable for a study of this magnitude (Bruce et al., 2016).

3.2.1 hodology

The online survey forms applications that were used to design cross-sectional survey questionnaires were explorative and expressive and forwarded to the target participants through an email link to their email accounts. Using an email questionnaire survey to take advantage of the ease of assessment, prompt transmission and feedback, low conduction and data (Saunders et al., 2019). A window period of six weeks would enable participants to respond with frequent reminders if necessary. The survey forms would also capture all the respondents' data, and Jomovi statistical software would analyse them accordingly.

The typical characteristic of choosing this design was first to understand the spectacle of the design and use it to change the current situation regarding blockchain technology. Padilla-Díaz (2015) posited that understanding the design would enable the desired outcome to be accomplished. The design approach would expose the researcher to the nitty-gritty of the methodology adopted to harmonise the data collected from the online survey questionnaire and the focus group.

3.2.2 Data Collection Tool

This study identified the research gaps and the future direction of blockchain technology research. It was not surprising to hint that the future we are discussing is now. The importance of future research was to underscore the unexplored areas in academic and professional research study and underpin the impact of blockchain technology in the global financial landscape.

The deployment of blockchain technology among the world's central banks was steadily rising vis-à-vis the need to improve the existing system and digitise the global financial system (Lam, 2018). The prediction from this theoretical framework of what will likely happen in the future of the Central Bank of Nigeria is to use blockchain technology to enhance the payment system through digital currency.

Implementing a practical central bank digital currency depends on the general usage for transaction purposes as postulated by Eleanya (2022). He expressed that more people would key into the initiative when the digital currency is viewed as the same as the cash transaction. The ease of transaction in adopting would continue to spread among the populace, thereby encouraging more users to adopt it. Bindseil (2020) posited that the central banks need to arouse the financial industry through digital currency utilization.

3.3 Population and Sample of the Research Study

3.3.1 ample Population:

The proposed population is in Nigeria and comprises mainly the Central Bank of Nigeria staff in Banking Services, Other Financial Institution Supervision, Statistics, Branch Operations, Consumer Protection, Payment Systems Management, Information Technology, and Banking Supervision departments. These are staff whose processes are somehow related to blockchain technology, particularly those in charge of supervising Financial Institutions. The Banking Services Department has the International Payment Division, comprised of Foreign Payment, International Funds and Documentary Credit Offices. The estimated size of this population was approximately three thousand (3,000); however, about seven hundred and fifty (750) are expected to complete the survey questionnaire.

The researcher targeted the entire population of the relevant departmental and branch staff of the Central Bank of Nigeria. This approach scrapped the idea of determining a sample from the whole population. Besides, some financial institutions have some payment staff, which would also receive the survey questionnaire to respond appropriately as most of them are my contemporaries in the financial industry. It was expected that at least twenty (20) of them would respond to the survey questionnaire since they are also engaged in payment system operations. The essence of the sample population was to align with answering the research questions.

Since the population was relatively small, the researcher included the entire population, eliminating the need to determine a sample.

3.3.2 Focus Group: The WhatsApp platform was adopted in the focus group as a medium for data collection through the circulation of the survey link in the forum which participants were expected to click on, and the questionnaires would be displayed in the survey form window. When the participants respond to the questionnaire and submit it, the data will be stored in the Google database. In essence, the WhatsApp platform cannot be used for data collection but served as the platform where respondents were allowed to participate as a focus group in the survey. The content of the email introducing the survey to the participants was the same as the content in the WhatsApp group.

There were three groups designated for blockchain operations and investments in the WhatsApp platform focus group. These proposed respondents collaborate at various forums on blockchain operations in the WhatsApp platform. Each group has approximately twenty (20) members, thus approximating sixty (60) proposed participants, with at least twenty (20) of these expected to respond to the focus group questionnaire. The focus group questionnaire was open-ended, with more detailed responses expected from the respondents. This population was selected to respond to the survey questionnaire because their process was connected to blockchain or cryptocurrency operations.

The researcher perceived that most focus group members might not participate in the survey exercise. However, the payment operations, supervisory, and policy developers form the basis of this sample population, which would match the study problem and the purpose of the research (Vangelis, 2017; Risius & Spohrer, 2017). It was believed that the targeted sample population was quite conversant with the blockchain technology scenario in the country and would be in a better position to draw the line with the revelation of the effects of its implementation. In this research, cause-effect was a critical issue in identifying the purpose of the study (Archibald, 2016), especially when drawing inspiration from past and present research postulations. The same approach applied to the staff of the Central Bank of Nigeria population was also used in the focus group to get an appropriate response to the research questions and target the core operators of blockchain technology.

3.3.3 Research Questions and Sample Population: The research questions are the motivating factors in selecting the sample population.

Research Question-1: **What are the current blockchain applications developed on cybersecurity to mitigate cyberattacks?**

Cybersecurity is a critical factor in mitigating cyberattacks, and relevant information was needed from the respondents to answer the research question since there was a hypothetical relationship between blockchain applications and cybersecurity.

Research Question-2: **How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?**

The focus was on using blockchain technology to simplify payment. Most sample population respondents were involved in the payment system, targeting the payment professional. Hypothetically, there was a relationship between conventional payment and blockchain applications.

Research Question-3: **How can the Central Bank of Nigeria regulate blockchain technology?**

Central banks' importance in regulating blockchain technology transactions cannot be overemphasised in this research question. Without supervision and compliance, what would be experienced is system anarchy. Most respondents were knowledgeable in managing all financial institutions, and some were in charge of supervising them as it was their process to do so. Therefore, professional respondents provided appropriate feedback to answer this research question. There was indeed a hypothetical relationship between centralised and non-centralised regulations. However, there were null hypotheses when there was no connection with the blockchain network by an unlicensed financial institution.

3.3.4 Linking Research Questions to Data Collected

Research Question-1: Blockchain Applications in Cybersecurity

Research Question 1: What are the current blockchain applications developed on cybersecurity to mitigate cyber-attacks?

Data Collected: This question sought to explore the existing blockchain applications specifically designed for cyber-security. The data collected included information about the types of blockchain applications, their functions, their effectiveness, and the hypothetical relationship between blockchain applications and cyber-security.

Data Collection Method: Cross-sectional survey questionnaires were employed to gather quantitative data. Questions like "Are you aware of Blockchain/Cryptocurrency/Bitcoin?"

helped gauge the respondents' awareness and familiarity with the subject. Additionally, a focus group consisting of experts in blockchain and cybersecurity provided qualitative insights, fostering in-depth understanding and exploration of emerging technologies and applications.

Research Question-2: Blockchain Technology in the Nigerian Financial Industry

Research Question 2: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?

Data Collected: This question targeted the feasibility, benefits, challenges, and hypothetical relationships between conventional payment and blockchain application payment in the Nigerian financial system. The data included respondents' perspectives on implementing blockchain technology for payment, investments in cryptocurrencies, and potential areas of disruption in the financial industry.

Data Collection Method: Surveys with questions like "Have you made any investment in blockchain/cryptocurrency/Bitcoin?" captured both awareness and engagement with blockchain technology. Focus group with professionals in the Nigerian financial industry to provide nuanced insights into the practicalities and complexities of implementing blockchain technology.

Research Question-3: Regulation of Blockchain Technology by the Central Bank of Nigeria

Research Question 3: How can the Central Bank of Nigeria regulate blockchain technology?

Data Collected: This question delved into the regulatory dynamics of blockchain technology. The data encompassed information on regulation strategies, compliance issues, centralized and non-centralized regulations, and the hypothetical relationship between these regulations and unlicensed financial institutions.

Data Collection Method: Through survey questions like "In what area does your organization plan to implement Blockchain technology?", insights into the regulatory landscape were gleaned. Focus group with experts from regulatory bodies, including the Central Bank of Nigeria, fostered a rich understanding of the regulation and supervision of blockchain technology.

Conclusively, the well-crafted research questions were intricately linked to the data collected and the methods employed. By utilizing a combination of survey questionnaires and a focus group, the research design ensures a comprehensive exploration of the subject matter. The alignment between the research questions and the data collection strategy reflected a thoughtful approach to understanding the multifaceted aspects of blockchain technology, from applications in cybersecurity to its implications in the Nigerian financial landscape. In sum, this research leveraged a robust methodology to explore the complexities of blockchain technology. It not only sought to understand the current state but also aimed to predict future trends, providing valuable insights that can guide both academic and professional research in the global financial landscape.

Power Analysis: In their journal, using power analysis to estimate the appropriate sample size, Tomczak et al. (2014) posited that related research on the study should be analysed and proven to identify the correlation differences for their fundamental and scientific justification. (UCLA (2021) advised that estimates of outcome size should be computed using the standard deviation unit and the correlation constant to establish the differences between variability measurement and mean values as expressed. However, Brownlee (2020) and Huberman et al., (2019) opined that the null hypothesis vis-à-vis the reflection of the alternative idea selects the statistical test to adopt desired test power and the level of importance. In determining the sample size and the appropriate power analysis, Birken et al. (2017) postulated that available information could be used to compute the sample size and establish the performance of the power analysis to justify the effects of blockchain technology implementation.

Participants Recruitment: Participants, having been identified, were recruited through a group email list forwarded to them. The email contained brief content of the informed consent and a link to the survey questionnaire where they were expected to respond to the questions. In the case of the focus group, the message was conveyed to them through the WhatsApp platform where they operate.

Sampling Procedure: Sampling is a subset of a whole reality in a single swoop to present the systematic approach of evaluating and aligning the sampling to the actual life situation of a larger population, as opined by Kirk et al. (2016). The sampling procedure adopted was computer-based (Nilsen, 2015), targeted at selected and judgemental professionals in the organisation and focus group because of their level of education and experience coupled with influence in the cryptocurrency/digital landscape. This survey research was used to identify various constructs on the effects of blockchain technology implementation. The survey questions' answer presentation depends on the suitably measured construct adopted (Skolarus et al., 2017), tailored to the perception and effects of implementing blockchain technology. Birken et al. (2017) postulated that a single answer format does not fit all research problems, but various measured constructs were suitable for several answer setups. The coding schemes adopted were the basic ones to ensure appropriate data analysis. However, Atkins et al. (2017)

opined that uncoded procedures could accomplish limited values in a situation where there were no parameter variations, which may be universally accepted. Most data collected were reliable and valid based on the structure of the survey questionnaires vis-à-vis expected feedback from respondents.

Pilot Phase: While developing the survey questionnaires, pilot implementations were carried out to ensure that the process was consummated from end to end. Sample emails were forwarded to five participants, including the researcher to complete the survey while the questionnaires were run over and over to isolate areas of concern and infractions. Questions were removed, added, modified and moved where necessary to reflect the participants' perceptions. The database was amended several times to ensure that the variables were well captured and reflected and eventually deleted to prepare for the final rollout to the participants. Some participants who took part in the pilot phase participated and provided some relevant amendments to some pertinent questions and the addition of options for a wider scope and provided the opportunity to the participants to select several options of their choice.

3.4 Materials/Instrumentation of Research Tools

The instrumentation or material tool was strictly a survey questionnaire to retrieve data from over 700 respondents. The survey enabled the researcher to reach out for relevant information to a large sample population, especially when the survey is online (Pandey & Pandey, 2015). This study adopted the online survey instrument whereby questionnaires were designed and developed using survey forms mentioned in previous sections. These were survey software that enabled the researcher to create the survey questionnaire according to the research questions and the topic of the study. Deepa et al. (2022) stated that the survey process was made up of several events, including setting goals for information gathering, designing the research study, preparing a dependable and effective survey instrument, which in this case is the online questionnaire, managing the survey, handling and analysing data collected from the survey and reporting the outcomes or results. The survey forms can also be used to analyse the data collected, depending on the extent of data analysis involved. I installed the Microsoft Office package that included the forms for the development of the survey. I operated an email account with Google, enabling users to use the forms to design surveys freely.

The survey forms were an open and accessible internet-based application for gathering information via online surveys and forms. At the same time, feedback was received and stored on a cloud-based Google Drive in spreadsheet format for easy analysis (Rhodes, 2019). The survey forms performed similar functions in all ramifications. They were free and easy web-based applications that could place data on an Excel spreadsheet and collect data for analysis (Peters, 2018). Any instrument has no basis for self-development as it is freely available online. These instruments were built with a high capacity to develop various forms, including surveys.

3.5 Operational Definition of Variables

The identification of variables was hinged on their relevance to the research topic and questions. Appropriate operational variables include biodata or demographic variables, including gender, age, employment status, business level, business role, organisation's years of operations and years in the organisation. Gender was the only dependent variable as it indicated the number of males and females participating in the survey and predicted future participation in blockchain technology.

Under the blockchain status section, blockchain awareness, source of blockchain awareness, level of blockchain awareness, blockchain level of participation, blockchain investment possibility, Central Bank of Nigeria (CBN) digital currency participation, blockchain training awareness and proposal for blockchain investment were the operational variables, and most variables were independent except the dependent blockchain awareness. The blockchain cybersecurity section related to the research questions and hypotheses; therefore, all the variables were dependent. These included; cryptography security, blockchain cybersecurity, blockchain risk mitigation, and blockchain protection.

The blockchain payment system was another critical section related to the research question and hypotheses, as all the variables are operational and dependent. Variables in this section included the blockchain payment system, Central Bank Digital Currency (CBDC) payment system, CBDC improvement of payment and benefits of payment in blockchain technology.

Another significant blockchain section was the regulatory aspects of the research question and hypotheses. Operational and dependent variables included blockchain regulation feasibility, blockchain remote regulation, blockchain regulation strategy, blockchain regulatory challenges and future research on blockchain technology.

3.6 Study Procedures and Ethical Assurances

This research study underwent the rigorous process of getting the Unicaf Research Ethics Committee (UREC) approved for data collection. Doctoral Studies REAF Form and informed consent form, research tools (survey questionnaires), and gatekeeper letter were submitted and approved before data collection. Human subjects were utilised through an email forwarded to participants, including a link directing them to the forms containing the surveys. The emails were confidentially sent to various mailing groups using blind copies of their email accounts. The survey was strictly anonymous, as names, phone numbers, and email addresses were not requested.

3.6.1 Ethical Assurances

It was imperative to state that the source of ethical conduct spins around the norms of rules, procedures, codes of conduct, and appropriate legal concerns.

The ethical measures adopted were aimed at protecting the safety of the research participants. These beliefs were not different from the research ethics and principles already established by various ethical committees, which in most cases are tailored towards the ethical principles, and they include the following:

Honesty: The researcher was plain and explanatory, with the research participants devoid of dishonesty in the survey questionnaires. There was no deception in any form, as this relates to respect for the participants. This perception could be why Benatar and Singer (2000) stated that every international ethical declaration should be well interpreted to avoid ambiguity in understanding the context of the research study.

Objectivity and Debriefing: The researcher avoided bias in the analysis of data collected or interpretation. It is honourable to be as objective as possible in the data collection process. Apart from providing adequate information for the research participants, efforts were made to appreciate their input, evaluate the whole process, and possibly get their views on the study's outcome to maximise the potential benefits expected from the research study (Hickey, 2018).

Deception: There was no deceit in place, as the research participants were aware of the purpose of the research study. Hickey (2018) opined that deception sets in when research participants are kept in the dark about the research objectives or misled about a different purpose of the study.

Integrity: As portrayed in the survey questionnaires, the researcher kept his word. Integrity was regarded as one of the ethical principles that promote veracity, accuracy, truthfulness, and consistency (American Psychological Association, 2017).

Openness and Carefulness: Cautiousness was the watchword of the researcher, where proper records of the research activities and correspondence with research participants and peers were kept. Relevant data and results were shared where necessary. At the same time, the researcher was open to constructive criticism and suggestions from research participants when they called to suggest amendments to the survey questionnaires. This carefulness extended to all and sundry in the research study to ensure justice for all (Dawson et al., 2019).

Anonymity: All respondents were anonymous to protect their privacy except when the law or the individual prevails otherwise. By this, Saunders et al. (2019) implied that the researcher should preserve the participant's identity as they perceived that this clause could be circumvented if related criminal cases need to be reported. However, there was no need for such instances in this research study.

Payment and Gifts: Opinions differed when the services of underage participants in research studies were paid or given gifts as a way of motivation or incentive to participate (Hickey, 2018). While some view it as tips or compensation, others see it as another inducement or corruption and could be related to benefits for the research participants, which was not applicable in this case.

Respect: Respect as an ethical principle was not restricted to persons but was accorded to copyrights and any form of intellectual property. Appropriate permission was sought before using any published data, like in the case of the **e₦aira** launched by the Central Bank of Nigeria. That means there was no room for unpublished information and plagiarism, which was also extended to every participant and contemporary in the research study. Hickey (2018) emphasized that respect should transcend the participant's personality to include their social and cultural circumstances.

Innocuous: Every research participant was free of any potential harm related to the principle of non-maleficence. Ike and Onyia (2018) affirmed that no research study should be conducted if there was the slightest inclination that any harm would happen to any research participants. Glad to state that there was no noticeable or potential harm to any of the participants during data collection.

Fidelity and Responsibility: The researcher placed trust in the relationship with his participants and other professionals as they were expected to take ownership of their social responsibilities (American Psychological Association, 2017).

Non-Discrimination: In the realm of unbiased research, (Hickey, 2018) maintained that there should be no room for prejudice, ethnicity, religious bigotry, partiality, and other factors unrelated to the research study, which is linked to justice and non-maleficence. However, this perception was taken cognisance of during the data collection by the researcher.

Competence: The researcher exhibited professionalism to the highest order and competence during research participation. American Psychological Association (2017) stipulated that competency must be displayed by the researcher and participants who are professionals in their discipline. Every participant should demonstrate competency, including tasks delegated to persons with appropriate training, qualifications, and experience. Personal challenges and conflicts of interest should not impede the competencies expected of professionals, as displayed by the enormous participation of respondents in the survey.

Fairness: Fairness is being just to all participants, as this attitude entails the rule of law, which is justice, one of the ethical principles. All relevant laws should be obeyed, and there must be justice and fairness to all related to the research study. Hickey (2018) opined that manipulation and the absence of satisfactory justice in tackling the exposure of risk and maltreatment to communities and individuals were thoroughly considered. However, this was not evidenced in the research process.

Protection and Confidentiality: Protection from any harm, minimisation of risks, respect for privacy, dignity and animosity was encouraged by the researcher. Participants' confidential information, personal records, and welfare were guaranteed and not made manifest under any guise. Hickey (2018) emphasised that adequate attention should be provided to protect the research matters and take a holistic view of every process connected to the research program.

Informed Consent: Informed consent from the research participants was solicited before the research process. At the same time, this aspect was detailed in the survey questionnaires adopted as it was linked to the ethical principle of respect for persons. Saunders et al. (2019) pointed out that informed consent comprised the information to be provided, which must be sufficient for the research participants to comprehend the purpose of the study and the willingness to participate. However, Hickey (2018) believed that informed consent was the keystone of research ethics. He, therefore, suggested that when there are challenges in getting informed consent, efforts should be made to gather more resources to enlighten the participants about the research study. As confirmed by Ike and Onyia (2018), every research participant in an informed consent must be seen as a volunteer, which means the participants should not be goaded to remain even when they desire not to continue participating in the research study. No string was attached to any participant in the event of any withdrawal, which was reflected in the survey questionnaires.

There were significant reasons for adhering to ethical norms in this study, and these included promoting the objectives of the research, entrenching the values that were fundamental to the collaborative task, for the research to be held accountable and building public support, and promoting social values and strong morals (Resnik, 2020).

3.7 Data Collection and Analysis

3.7.1 Data Collection Process

The exact steps the researcher took to collect data were very straightforward, using web-enabled survey forms to design and circulate the survey questionnaires within a maximum of six (6) weeks. Data collection was done online through the developed forms forwarded to their email accounts from the researcher to the participants.

3.7.2 Steps Adopted for Data Collection

The data was derived from the online survey questionnaire developed from the research questions and hypotheses using the survey forms and forwarded to professional colleagues in the Central Bank of Nigeria and the focus group of blockchain technology operators and investors. The online survey was in two parts; one segment comprised thirty (30) questionnaires developed for Central Bank of Nigeria staff with roles related to the payment system and blockchain technology. In contrast, the other part comprises fifty-two (52) open-ended questionnaires developed for blockchain/cryptocurrency operators and investors. After setting up these online survey questionnaires, they were forwarded to prospective respondents through links to their email addresses and a focus group forum on WhatsApp. The survey forms were used to code the questionnaire for Central Bank of Nigeria staff and the focus group.

Introductory comments were made in the email, composed with a compelling message to assure the respondent that the link was not a phishing email and that the survey was entirely anonymous and would not be identified with any of the respondents in any way. The duration to complete the survey was stated in the email as a heads-up of what to expect when filling out the survey. A section in the survey was used to appreciate the respondent after completing the questionnaire, while appreciation was expressed in the email in anticipation of participating. **There was a section for 'consent'; participants were expected to accept by mandatorily clicking on the sole option provided. All 765 respondents consented**.

3.7.3 Statistical Software

Jamovi was the statistical software used to analyse the quantitative data collected. This software was an open-source application akin to SPSS. It was freely available on the internet with ease of usage for data analysis because of the user-friendly statistical design that simplifies data for visualised and refined critical output delivery. **Jamovi was built on the dominant statistical programming language, R, and easily integrates with SPSS and other statistical packages**.

This study used the Qualitative Data Analysis (QDA) miner software to analyse textual data, including open-ended feedback and still images.

The data collected were based on the survey questionnaires developed from the research questions/hypotheses. The information derived from the data collected was in tandem with answering the research questions.

3.7.4 Types of Data Collected

The data types collected were quantitative and qualitative and had the characteristics of nominal, ordinal continuous and discrete. Jamovi was the statistical software used to analyse the data to produce an outcome directly tilted toward the title of the project and relevant responses to the research questions. The quantitative data collected were specific and direct from the respondents, while the qualitative data were open-ended as they were continuous. Data were collected using the survey forms as they were used to design the survey questionnaires.

3.7.5 Missing Data

Respondents were allowed to skip any question as they were not mandatory except for the consent option, which was required. As a result, some questions were ignored in all the variables, including the dependent variables. However, only three respondents skipped one question out of three, including the gender question out of 765 participants, which is insignificant. The researcher left all skipped questions blank, though they were reckoned with in the data analysis as missing data. Missing data were conspicuously noticed in most of the other responses, with four respondents missing out on six different questions; two respondents missing out on two questions; five respondents skipping one question; seven respondents missing out on one question; eight respondents skipping two questions, and nine respondents also kipped one question.

3.7.6 Data Analysis

Data Analysis Method: Data analysis involves the scrutiny of data collected while observing the differences and similarities to isolate the various categories and identify elements from the data in line with the objectives. The stored data in the survey forms were converted to an Excel spreadsheet and migrated to the data analysis tools such as Jimovi and QDA platforms. Data were analysed in tabular form and other empirical charts and graphs in percentages and actual figures in tandem with the appropriate variables. Cross-tabulation analysis, correlation, question interrogation, comparativeness, expansion of responses to open-ended questions, visualization of results and interpretation of actionable intuitions were some of the attributes used in analysing the data.

As stated above, the Jamovi was used to process and analyse the quantitative data collected statistically to align with the research questions. This statistical software can identify the variables of the data collected and analyse data in various forms, from exploration to regression and frequency. On the qualitative data, the QDA Miner was strictly for qualitative and mixed-methods data analysis and was used to analyse the data collected. QDA Miner has the features of integrating statistical and imagining data, including heatmaps, clustering, sequence and corresponding analysis, Pearson correlation, Chi-Square and other statistical assessments.

3.7.6.1 Quantitative Data Analysis

As shown in Table 3.1, 72.4% of the study respondents were males, and 27.7% were females. A higher proportion of the respondents (40.5%) were aged 30 – 39, followed by 31.2% within 40-49 years. More than half (52.8%) of the respondents were at the Senior/Executive Management level, while 26.7% and 20.5% were in middle and junior management, respectively. Over sixty per cent (63.8%) of the respondents had 0 -10 years of working experience, followed by 20.0% who had 11 – 20 years and 16.2% over 20 years of working experience.

The wide disparity between the males and females was mainly due to both genders' levels of interest and awareness. It was observed that males are more interested in blockchain technology than females. Besides, the actual population showed more males than females in those locations where the survey was forwarded. In the organization of the respondents, there were more males than females as the staff composition is tilted more toward the males than the females.

In other studies, such as the one researched by Klein (2007), the participation of females was more than that of males, as is typical in other environments. There was also a mix in the variables adopted for the gender even when the females were more in number than the males. There were instances where the high gender result was dependent on the male and female ratio population, which was tilted to the result of the respondents. Kwiek and Roszka (2021) affirmed in their study that gender disparities arise from the nature of the research with inequality manifesting in the variables of the survey questionnaire, cross-disciplinary gender variation and age-related disparity in global research collaboration. The structural, material, and symbolic bearings of most organizations contribute to gender inequalities (Zippel, 2019).

Table 3.1

Socio-Demographic Characteristics of Respondents

Variable	Parameter	Frequency	Per cent
Gender	Male	554	72.4
	Female	211	27.6
Age category	20 - 29	72	9.4
	30 - 39	310	40.5
	40 - 49	239	31.2
	50 - 59	144	18.8
Employment level	Senior/Executive Management	404	52.8
	Middle Management	204	26.7
	Junior Management	157	20.5
Years working in the current organization	0-10 years	488	63.8
	11-20 years	153	20.0
	>20 years	124	16.2
Total		**765**	**100.0**

Surprisingly, the other age category of 20-29 years (9.4%) did not indicate any significant push for blockchain technology by them. It was perceived that this classification should show more enthusiasm on specifically the cryptocurrency process when compared to the other groups; alas, it wasn’t reflected as expected. This variation could be because many respondents in this set did not participate in the survey exercise. However, the 50-59 years set had double the previous group, as 18.8% participated in the survey. As expected, this was because this group are workers still in the system and therefore were open to participation in the survey exercise. Despite the age difference, the overwhelming response was simply because of the activeness of the participants, mainly since most of them are still in service.

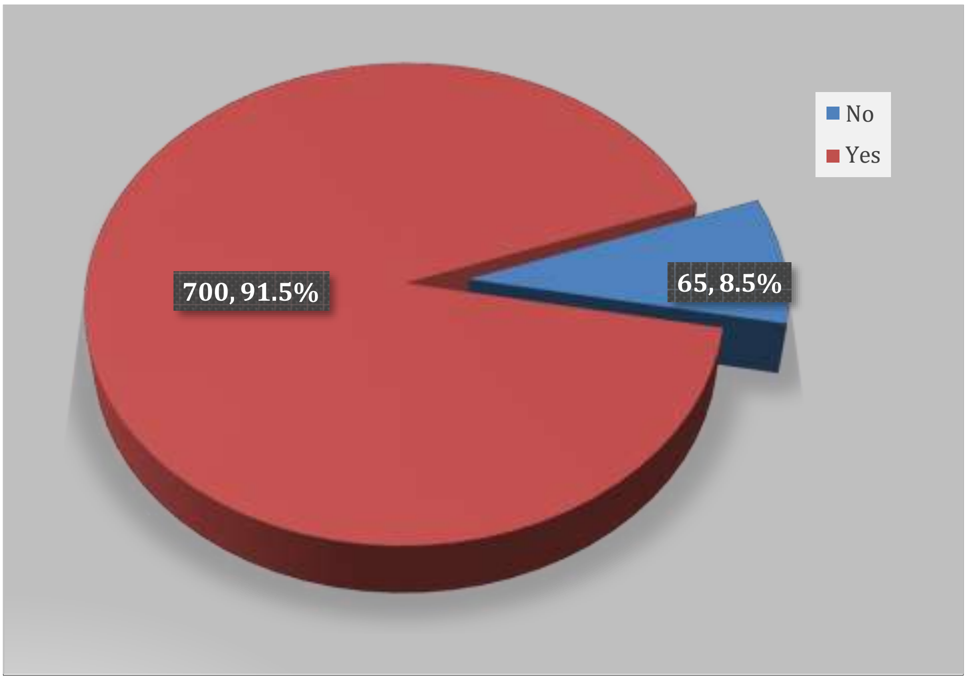
Blockchain technology is a web-based application network that cannot be divorced from cyberattacks, emphasising the cybersecurity landscape where blockchain is berthed.

As shown in Figure 3.1, a significant proportion of respondents (92%) were aware of blockchain technology, against just 8.2% who did not know about it.

In respondents' feedback, if they are aware of blockchain, cryptocurrency, or Bitcoin, 699 of 765 92% responded 'Yes' while 61 or 8.0% responded negatively. This development confirmed that most populate are conscious of blockchain technology due to cybersecurity feedback.

Figure 3.1

Awareness of Blockchain Technology

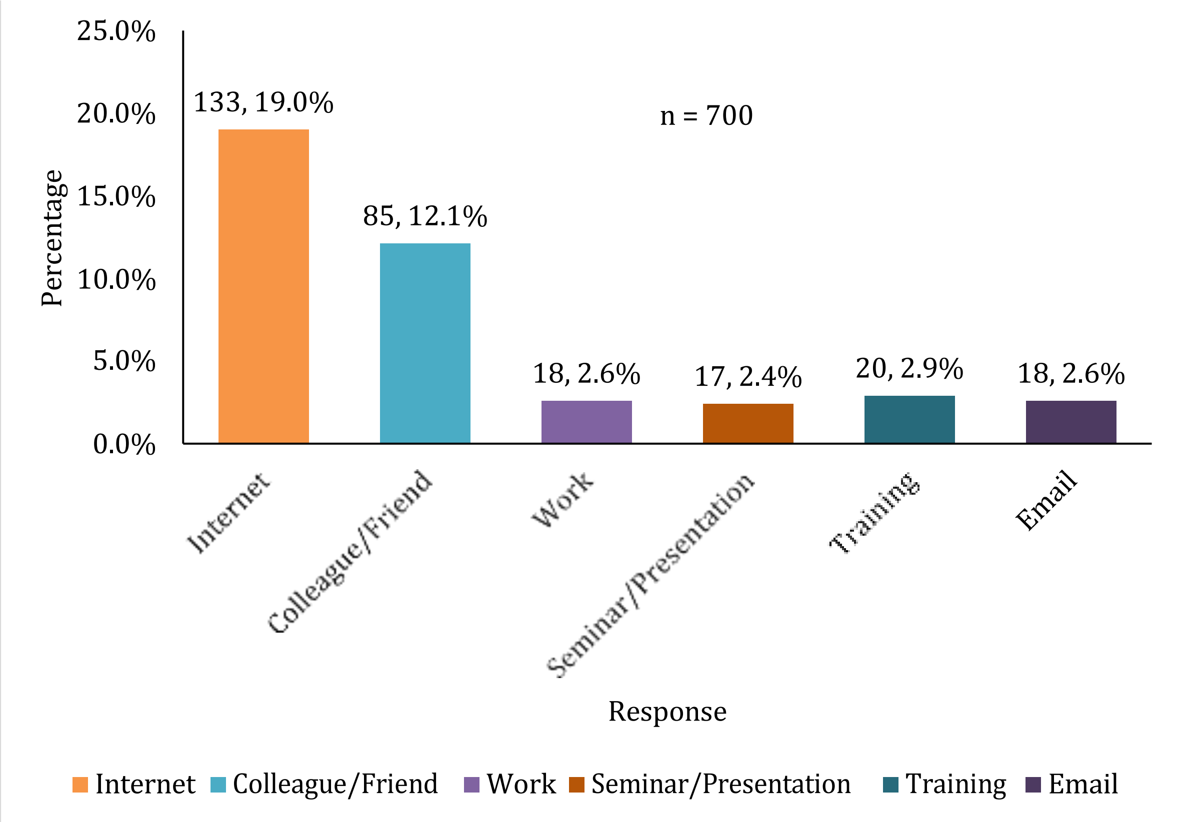


Of the 700 respondents aware of blockchain technology, 19.0% heard about it through the internet, 12.1% from colleagues/friends, 2.9% 2.6%, and 2.4% knew about it through training, email and work, and seminal/ presentation, respectively.

In Figure 3.2, it was not surprising that 19.0% got to know about blockchain technology through the internet, and 2.6% recorded the email respondents, which showed that 21.6% knew about it from cyberspace since blockchain technology is web-based. This feedback from the respondents implied that the possibility of being exposed to the *Internet of Things* (IoT) within the Internet is relatively high compared to activities outside the Internet (Atlam et al., 2018). The activities that trend on the internet have risen astronomically over the years compared to the high rate of data usage as postulated by Nadhom and Loskot (2018) in their survey of public data sources.

Figure 3.2

Sources of Information on Blockchain Technology



As shown in Table 3.2, of the total 700 respondents who knew about blockchain technology, a significant proportion, 95.5%, 92.2%, and 80.3% of senior/executive, middle, and junior executives, knew about blockchain technology, respectively ($p<0.05$).

Table 3.2

Demographic Distribution of Respondent's Knowledge of Blockchain

Variable	Parameter	Yes	No	X^2 (P-value)
Gender	Male	502 (90.6)	52 (9.4)	2.044 0.153
	Female	198 (93.8)	13 (6.2)	
Age category	20 – 29	63 (87.5)	9 (12.5)	6.232 0.101
	30 - 39	288 (92.9)	22 (7.1)	
	40 - 49	223 (93.3)	16 (6.7)	
	50 - 59	126 (87.5)	18 (12.5)	
Employment level	Senior/Executive Management	386 (95.5)	18 (4.5)	34.149 0.000*
	Middle Management	188 (92.2)	16 (7.8)	
	Junior Management	126 (80.3)	31 (19.7)	
Years working in the organization	0-10 years	452 (92.6)	36 (7.4)	3.884[a] 0.143
	11-20 years	140 (91.5)	13 (8.5)	
	>20 years	108 (87.1)	16 (12.9)	
Total		700 (91.5)	65 (8.5)	

It showed that the general perspective about blockchain technology is well known to the respondents, manifested in their responses as ratified by Sanka et al. (2021) in their survey of development in blockchain technology. However, respondents' gender, age category, and years of working experience were not statistically associated with knowledge of blockchain technology (p> 0.05).

Differences Between Table 3.1 and Table 3.2: While Table 3.1 deals with the characteristics of the respondents such as variable, parameter, frequency and percentage, Table 3.2 focuses on the demographic distribution of respondents' knowledge of blockchain, which includes the same variable and parameter with table 3.1 but included "Yes" (affirmation of the knowledge of blockchain), "No" (lacking in the blockchain knowledge) and X^2 (P-value).

As shown in Table 3.3, more than half (51.2%) of male respondents and 44.9% of female participants rated their knowledge of blockchain technology as average. Although a low proportion of the respondents said they had high knowledge of blockchain technology, males were significantly more knowledgeable (13.1%) than females (7.1%), $p<0.05$. Most respondents (52.6%) and 49.9% within the senior/executive and middle management level had an average knowledge of blockchain technology. More than half (52.5%) of respondents within the junior management level had a low knowledge of blockchain technology ($p<0.05$). The age category and years of working experience of respondents were not statistically associated with their level of knowledge of blockchain technology ($p> 0.05$).

However, it should be noted that the junior management's low exposure level contributed to the insufficient knowledge of blockchain technology and the inadequate responses. Their level of response indicated that lack of awareness is still prevalent among all the participants, particularly the junior management. Another reason could be the available information at their disposal since the infrastructure does not exist. The desire to get the necessary information to guide their decisions may also not be in them, even if the intention was good. This analogy also applied to a few of the other categories despite their level of exposure.

Some level of intelligence was needed when responding to questionnaires in the survey as many of the participants may not be conversant with the purpose of the study even when the researcher elaborates on it. A study should be encompassing to give room to all and sundry participating in the survey. The aim was to get every participant's view irrespective of background and culture (Scheuren, 2004). As a result, different views were expected from the participants regarding their status and level in society. Of most importance was their ability to respond to the questionnaires appropriately.

Table 3.3

Level of Knowledge of Blockchain Technology

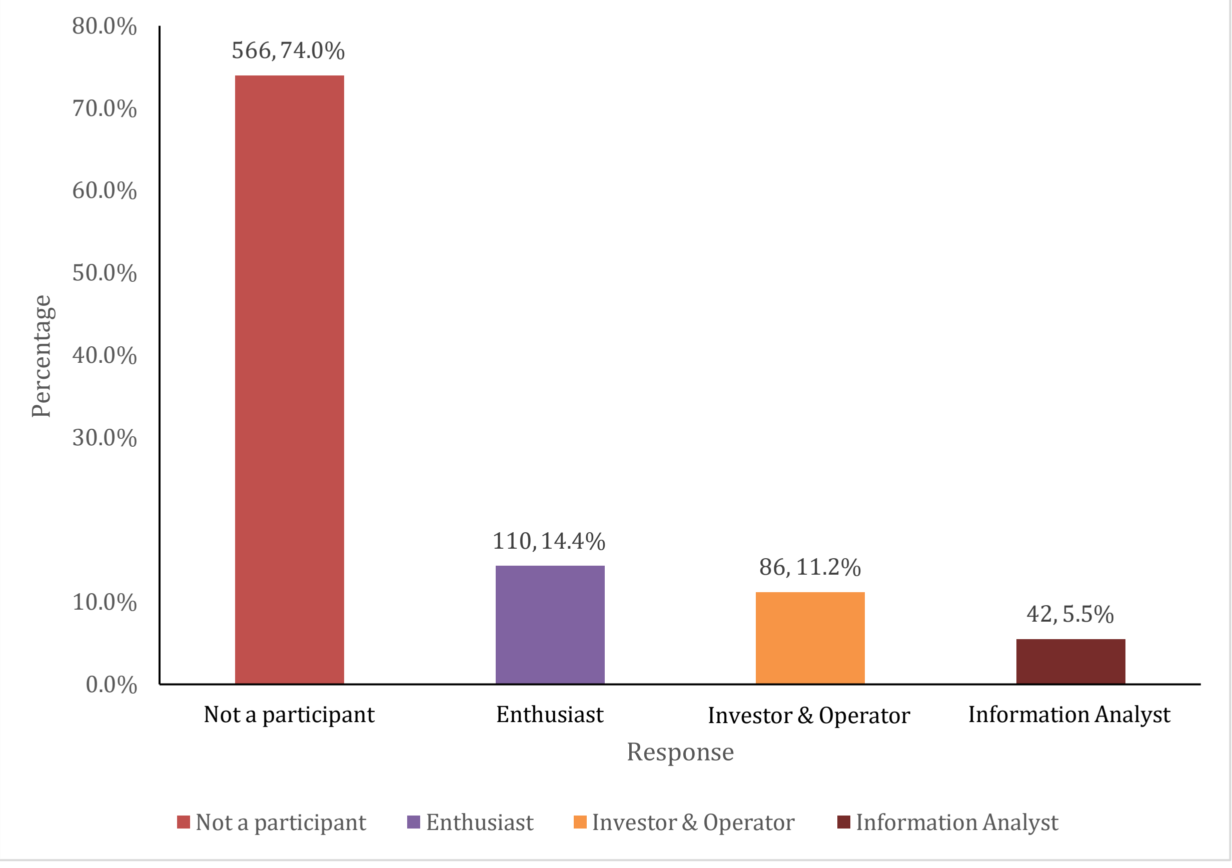
Variable	Parameter	High	Average	Low	P-value
Gender	Male	66 (13.1)	257 (51.2)	179 (35.7)	11.217 0.004*
	Female	14 (7.1)	89 (44.9)	95 (48.0)	
Age category	20 - 29	8 (12.7)	32 (50.8)	23 (36.5)	5.522[a] 0.479
	30 - 39	39 (13.5)	138 (47.9)	111 (38.5)	
	40 - 49	25 (11.2)	114 (51.1)	84 (37.7)	
	50 - 59	8 (6.3)	62 (49.2)	56 (44.4)	
Employment level	Senior/Executive Management	51 (13.2)	203 (52.6)	132 (34.2)	14.042[a] 0.007
	Middle Management	19 (10.1)	93 (49.5)	76 (40.4)	
	Junior Management	10 (7.9)	50 (39.7)	66 (52.4)	
Years working in the organization	0-10 years	57 (12.6)	216 (47.8)	179 (39.6)	7.795[a] 0.099
	11-20 years	16 (11.4)	79 (56.4)	45 (32.1)	
	>20 years	7 (6.5)	51 (47.2)	50 (46.3)	
Total		80 (11.4)	346 (49.4)	274 (39.1)	

Figure 3.3 showed the level of respondents' participation in blockchain technology. Almost four-fifths (74%) of respondents were not participants, 14.4% were enthusiasts, 11.2% were investors & operators, and 5.5% were information analysts. The feedback on this question was quite glaring and showed that awareness of blockchain technology, including cryptocurrency (Bitcoin), was still lacking. The other side of the coin could also be the lack of interest in participating in cryptocurrency investment, even if they are aware and well-informed about it.

Some participants may view cryptocurrency as gambling, others may see it as an investment opportunity, and some may view it as educative and an opportunity to be in the financial landscape.

Figure 3.3

Respondents' Level of Participation in Blockchain/Cryptocurrency/Bitcoin

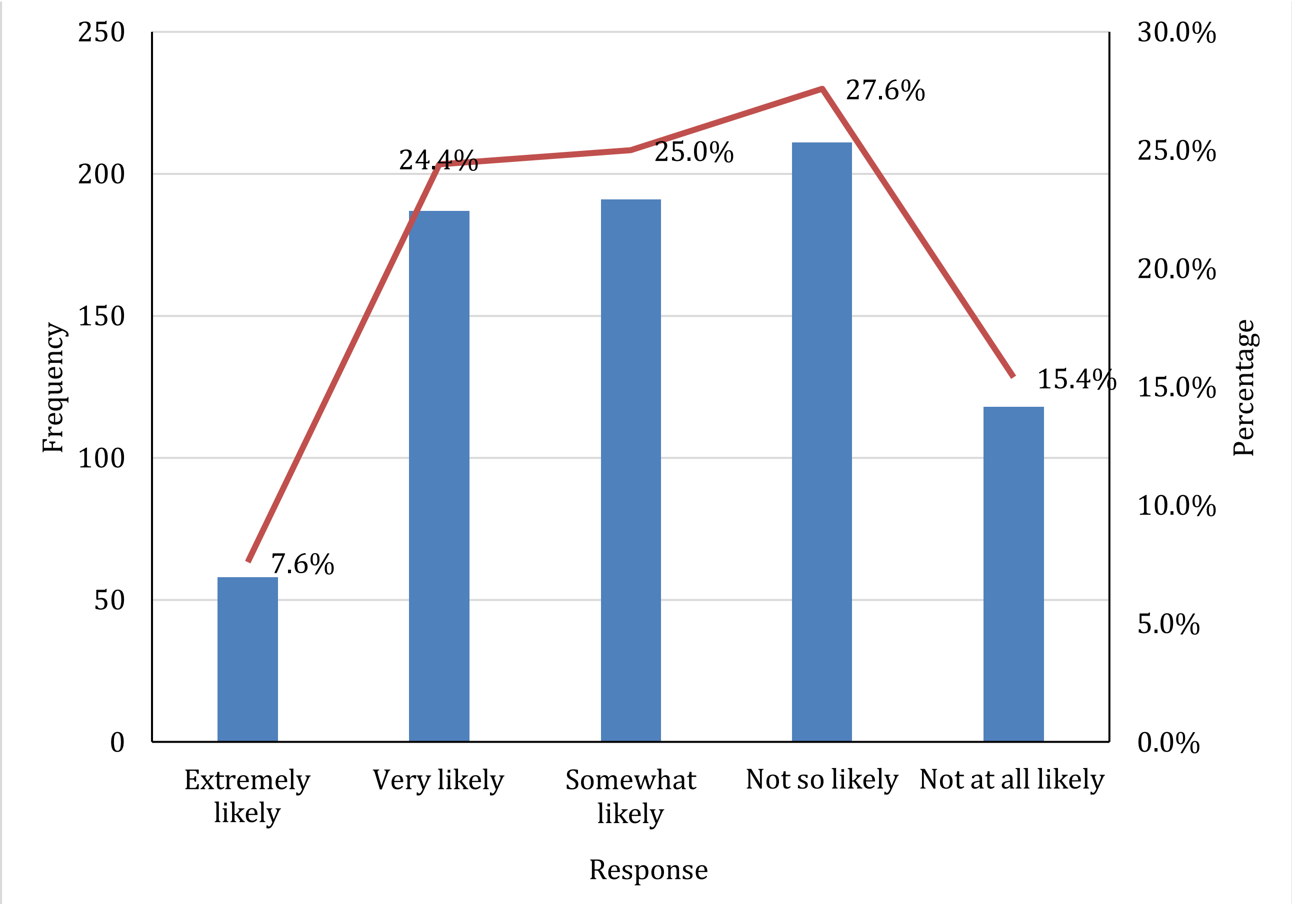


As stated above, though respondents' age category and years of working experience were not statistically associated with their knowledge of blockchain technology ($p > 0.05$), the researcher observed that their working experience contributed to their knowledge of blockchain technology. However, many respondents were yet to participate in blockchain technology investments, including cryptocurrency. This perception was not uncommon due to the low level of participants' interest in blockchain investments (Grigaitis, 2019).

As shown in Figure 3.4, 27.6% of the respondents said they were not so likely to invest in blockchain technology if given the opportunity, 25.0% were somewhat likely, but 24% were very likely to invest in it. Also, 15.5% of the respondents were not at all likely, while 7.6% were highly likely to invest if given the opportunity.

Figure 3.4

Respondents' Likelihood of Investing in Blockchain Technology



As shown in Table 3.4, a high proportion of the respondents (70.1%) believed that the gait of cryptocurrency adoption by CBN would raise public participation. Also, a significant percentage (91.1%) thought that further technical advances, awareness and training on Blockchain/Cryptocurrency are needed. However, only 10.8% had invested in blockchain before the CBN prohibited banks from cryptocurrency transactions to facilitate payment for cryptocurrency accounts domiciled with them. Also, more than a quarter (29.9%) said there was the possibility that they would invest in Cryptocurrency after the ban is lifted.

Table 3.4

Respondent's Perception of Blockchain Technology

Perception	**Frequency**	**Per cent**
The gait of Cryptocurrency adoption by CBN will, in turn, raise the public's participation.	536	70.1%
There is a need for further technical advances, awareness and training on Blockchain/Cryptocurrency, generally	697	91.1%
Have you made any investment in blockchain/cryptocurrency/Bitcoin or other virtual coins before the prohibition to Banks of cryptocurrency transactions and facilitation of payment for cryptocurrency exchanges by the CBN	83	10.8%
Is there the possibility that you will invest in Cryptocurrency after the ban is lifted?	229	29.9%

The possibility of participants investing in blockchain technology, including cryptocurrency, would always be there if the opportunities for participation remain. The level of that possibility may vary from various surveys, but it was given that once there is a window of prospects for participants to invest. In the next session, the researcher would analyse the research questions vis-a-vis the feedback based on blockchain cyber security, payment systems and regulation.

Research Question-1: What are the current blockchain applications developed on cyber security to mitigate cyber-attacks?

Blockchain Cybersecurity (5 questions of yes = 2, Maybe = 1, No = 0)

Five questions (17-21) were used to determine respondents' perceptions of blockchain cyber security. A maximum of 2 marks is allocated to responses "Yes", "Maybe" = 1, and "No" = 0. The total score was 10; a score above 5 was considered positive perception, and a score of 5 or below was considered poor perception.

As shown in Table 3.5, less than a quarter (23.1%) of respondents believed that blockchain can secure the network against cyberattacks. In comparison, only 12.5% were aware of any blockchain application that can mitigate cyberattacks. Also, more than half (58.2%) of respondents believe that the risks associated with Blockchain applications can be mitigated. Similarly, 57.5% perceived that blockchain applications could be protected against cyber threats, while only 23.0% were confident that blockchain was well protected against cyberattacks. All respondents had a poor perception of blockchain cybersecurity 3.71 ± 2.89. This poor perception was attributable to the general opinion of the respondents on blockchain technology, which in most cases, is relatively low. Some responses could be vague due to a lack of appropriate blockchain technology knowledge on the technicalities of cyber security. There were several applications for cyber security developed to protect blockchain technology. However, cryptography was the default technique that secures a transaction between only the sender and recipient in the blockchain technology platform (Menezes et al., 2019).

Table 3.5

Perception of Blockchain Cyber Security

Perception of Blockchain cyber-security	**Yes**	**Maybe**	**No**
Blockchain/Cryptocurrency/Bitcoin uses cryptography to secure and verify transactions. Do you believe this is strong enough to secure the network against cyberattacks?	177 (23.1)	-	588 (76.9)
Are you aware of any Blockchain/Cryptocurrency application developed on cybersecurity to mitigate cyberattacks?	96 (12.5)	-	669 (87.5)
Do you believe that the risks associated with Blockchain/Cryptocurrency/Bitcoin applications can be mitigated?	445 (58.2)	56 (7.3)	264 (34.5)
Do you perceive that the Blockchain/Cryptocurrency/Bitcoin applications can be protected against cyber threats?	440 (57.5)	57 (7.5)	268 (35.0)
Are you confident that Blockchain/Cryptocurrency/Bitcoin transactions are well protected against cyberattacks?	176 (23.0)	56 (7.3)	533 (69.7)
Overall perception	**3.71 ± 2.89**	**Poor perception**	

This assertion was corroborated by (Menezes et al., 2018) in their study in the “Handbook of Applied Cryptography”.

As shown in Table 3.6, the respondent's perceptions about blockchain cyber-security among all strata of management level were not statistically different ($p > 0.05$). All respondents had a poor perception of blockchain cyber-security 3.71 ± 2.888.

Table 3.6

Perception of Blockchain Cyber Security at the Management Level

Perception about blockchain cyber-security	N	Mean ± SD	95% Confidence Interval for Mean		P-value	Remarks
			Lower Bound	Upper Bound		
Senior/Executive Management	404	3.69 ± 2.850	3.41	3.97	0.773	Poor
Middle Management	204	3.63 ± 2.701	3.26	4.01		Poor
Junior Management	157	3.85 ± 3.217	3.34	4.35		Poor
Total	**765**	**3.71 ± 2.888**	**3.50**	**3.91**		Poor

The poor perception of blockchain cyber-security was not surprising as the primary information level may be lacking among the participants. Besides, many participants were not interested in issues they did not desire. Many participants viewed blockchain technology as technical, let alone cyber-security, as being technically inclined to higher knowledge as the desire to understand the workings was useless to them. The interest would not be there if the participants were not curious about the technical aspect of any issue.

Research Question-2: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?

Blockchain Payment Application

Adopting blockchain technology to facilitate payment in the network landscape was one of the objectives of the inventors. Digital payment can only be transacted in a digital platform, which is electronically based. The adoption of blockchain technology was to simplify payment that would reduce operational costs and ensure that the beneficiaries receive their appropriate funds.

Four questions (22-25) were used to determine respondents' perceptions of the Blockchain Payment Application. A maximum of 2 marks was allocated to the responses "Agree/Yes", "Neutral/Maybe" = 1, and "Disagree/No" = 0. The total score was 8; a score above 4 was considered positive perception, and a score of 4 or below was considered negative perception.

Table 3.7 below showed the respondents' perception of the blockchain payment application. Most respondents (63.0%) agreed that blockchain technology (digital currency) could facilitate efficient payment in the Nigerian financial industry. Also, more than half of respondents (66.8%) were confident that CBN's preposition to introduce digital currency by October 1, 2021, would stimulate the payment system in the Nigerian financial industry. Most participants (60.4%) also perceived that implementing blockchain technology (digital currency) in the payment system would improve the current challenges plaguing the payment landscape.

Table 3.7

Respondent's Perception of Blockchain Payment Application

Perception of Blockchain Payment Application	**Agree**	**Neutral**	**Disagree**
It is perceived that Blockchain Technology (digital currency) can be used to facilitate an efficient payment system in the Nigerian financial industry. Do you agree with this perception?	482 (63.0)	56 (7.3)	227 (29.7)
	Yes	**Maybe**	**No**
CBN recently proposed introducing digital currency by October 1, 2021. Are you confident this would stimulate the Nigerian financial industry's payment system (cross-border trade, remittance improvement and revenue tax collection)?	526 (66.8)	51 (6.7)	188 (24.6)
Do you perceive that implementing blockchain technology (digital currency) in the payment system would improve the current challenges plaguing the payment landscape?	462 (60.4)	59 (7.7)	244 (31.9)
Would the benefits of implementing blockchain technology, such as financial inclusion, monetary policy effectiveness, targeted social intervention and macro management improvement, outweigh the challenges?	441 (57.6)	61 (8.0)	263 (34.4)
Overall perception	**5.29 ± 2.87**	**Positive perception**	

Also, 57.6% were optimistic that the benefits of implementing blockchain technology, such as financial inclusion, monetary policy effectiveness, targeted social intervention and macro management improvement, would outweigh the challenges. These perceptions were corroborated by Nikiforova et al. (2019) and Holotiuk, et al. (2019) when they posited that the impact of blockchain technology or digital currency had gained ground in many countries.

Holotiuk et al. (2018) illustrated that unveiling the critical challenges of the payment system would propel a significant improvement in the revolution of applying blockchain technology in the payment industry. However, the impact of blockchain technology hinges on the payment system, as preferred by Mehrländer (2018).

All respondents had a positive perception of blockchain payment application 5.29 ± 2.87.

As shown in Table 3.8, participants' perception of blockchain payment applications among all management levels was not statistically different ($p>0.05$). All respondents had a positive perception of blockchain payment application 5.29 ± 2.872.

Table 3.8

Perception of the Blockchain Payment Application

Perception of the blockchain payment application	N	Mean ± SD	95% Confidence Interval for Mean		P-value	Remarks
			Lower Bound	Upper Bound		
Senior/Executive Management	404	5.42 ± 2.833	5.15	5.70	0.424	Positive
Middle Management	204	5.14 ± 2.980	4.73	5.55		Positive
Junior Management	157	5.15 ± 2.829	4.71	5.60		Positive
Total	**765**	**5.29 ± 2.872**	**5.09**	**5.50**		Positive

The feedback portrayed the payment system as the anchor of the blockchain technology hence the pertinent need to provide adequate cyber security and regulatory applications as perceived by Cooper (2019) when he enumerated the strides on how blockchain can improve the payment system.

Table 3.9

The Prospect of the Blockchain Payment Application

The prospect of the blockchain payment application	**N**	**Mean ± SD**	**95% Confidence Interval for Mean**		**P-value**	**Remarks**
			Lower Bound	**Upper Bound**		
Senior/Executive Management	404	5.35 ± 2.313	5.12	5.58	0.210	Positive
Middle Management	204	5.00 ± 2.281	4.69	5.31		Positive
Junior Management	157	5.29 ± 2.442	4.91	5.68		Positive
Total	765	5.24 ± 2.333	5.08	5.41		Positive

Table 3.9 showed respondents' prospect of blockchain payment applications among all management levels was not statistically different ($p > 0.05$). All respondents positively perceived the prospect of blockchain payment application 5.24 ± 2.333. The researcher believed that the respondents' perception of using blockchain technology to enhance the payment system is not different from the prospect of achieving the purpose. The difference was insignificant, as all the respondents positively perceived both initiatives. Payment transactions across the border were inevitable especially when blockchain technology was adopted to stimulate the process. This initiative will attract society when the ease of making payments is smooth and seamless (Deng, 2020).

Figure 3.5

Respondents' Perception regarding the Prospects for Blockchain

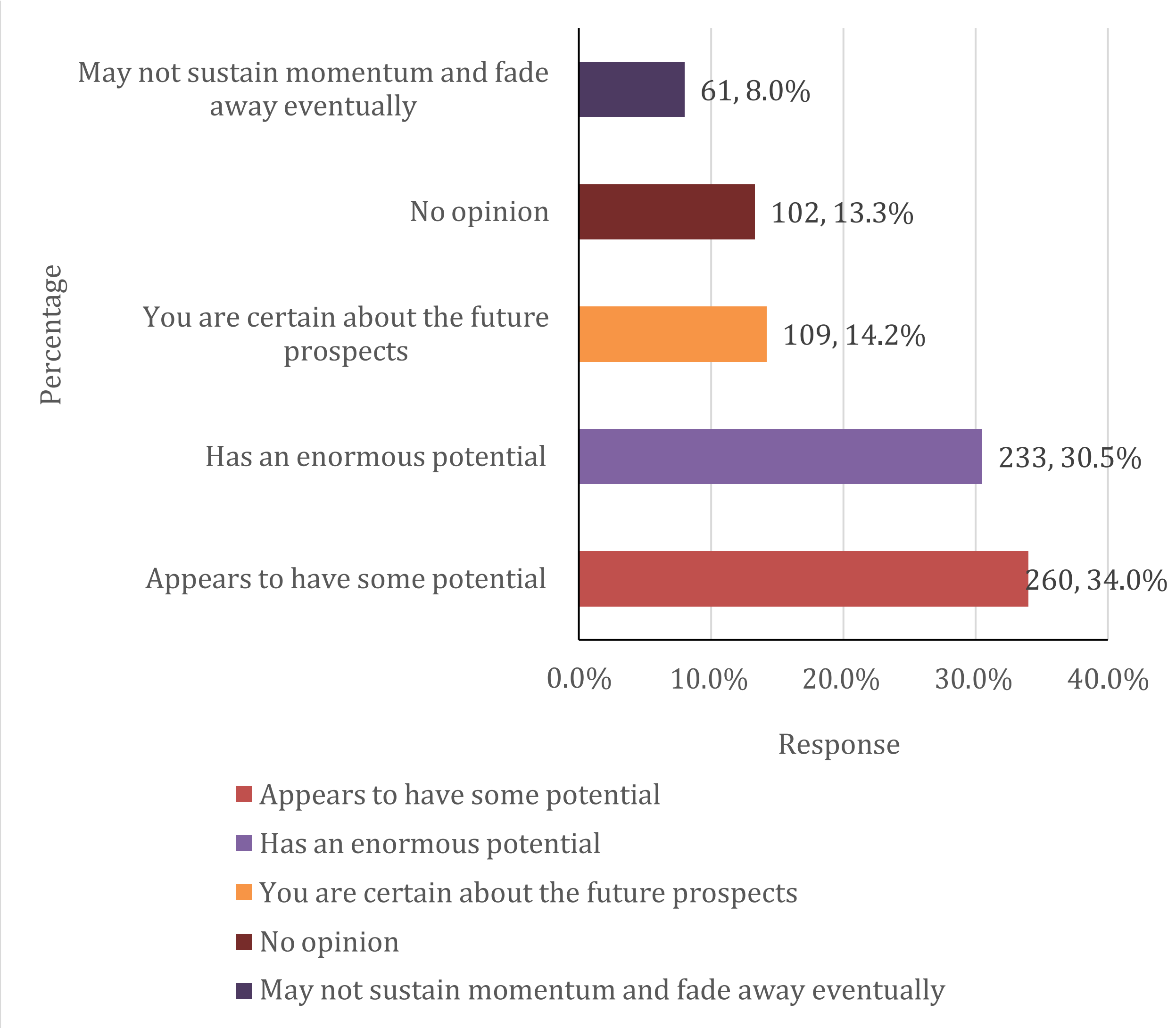


Figure 3.5 showed respondents' perceptions regarding the prospects for blockchain. The majority of the respondents (34.0%) believed that it has some potential, 30.5% believed it has enormous potential, and 14.2% were sure about its prospect. However, 13.3% had no opinion, while 8.0% believed it might not sustain momentum and eventually fade.

The perception that blockchain technology has an enormous prospect was magnified by the improvement observed by the respondents in the payment system. Much as there were other views to the contrary, the fact that over 60% believed that the prospect has enormous potential appeared to overcome the other perceptions.

The potential of blockchain technology revolutionising the payment system was intensified by Murray (2019) in his study on “Central Banks and the Future of Money” when he postulated that digital currencies would form the primary means of exchange in place of cash, and this was corroborated by Sanel et al. (2019) in their study.

Their study was based on the future of blockchain technology's impact on the payment industry. They posited that with the digital rate currency being stimulated in the payment landscape, it would not take long before the impact would manifest. They firmly believed that blockchain technology would influence digital currency as a transaction. Having elaborated on the blockchain payment application, the next is blockchain regulation.

Research Question-3: How can the Central Bank of Nigeria regulate blockchain technology?

Blockchain Regulation

Regulation of blockchain technology by central banks of the world has always been an issue considering that participants are not directly under the supervision of the central banks. The research question of how the Central Bank of Nigeria can regulate blockchain technology was split into four (4) questions. Artemov et al. (2017) postulated that modalities must be implemented to regulate the blockchain network; otherwise, it would promote instability in the global financial system.

The four questions (26 - 29) were used to determine respondents' perceptions of blockchain regulation. A maximum of 2 marks is allocated to responses "Yes", "Maybe" = 1, and "No" =

0. The total score was 8; a score above 4 was considered positive perception, and a score of 4 or below was considered poor perception.

As shown in Table 3.9, more than sixty per cent of the respondents (69.5%) were hopeful that the blockchain/cryptocurrency network could be regulated. More than half (51.2%) were convinced that CBN could regulate the process of the blockchain network, even remotely. Also, most participants (66.5%) were hopeful that the CBN would overturn the recent ban on Cryptocurrency and adopt its implementation to put a structure in place to regulate the process. In addition, more than half (52.3%) perceived that the inability of the CBN to regulate blockchain technology effectively would be a showstopper to its implementation.

All respondents had a positive perception of blockchain regulation 5.24 ± 2.33.

The participants' curiosity in their feedback showed significant blockchain awareness. The above-average participants who were hopeful that the CBN could regulate the blockchain network indicated that at least they have a basic knowledge of the workings of the technology. The conviction of more than half of the participants also indicated that the regulation by the CBN was possible. After all, the people were the ones to work on the system. The participants that responded hopefully about the possibility of the CBN overturning the ban placed on the banks using their accounts for cryptocurrency was a clue that the interest is growing.

Perception on any issue was very vital. Any person's perception portrays the human being of what they hold on to in life. The preacher says, "***For as he thinketh in his heart, so is he:***"

The perception was what a human being is, especially when it concerned his judgement, culture, well-being, sentiment, or family. So, perception was vital in the participant's response.

Table 3.10

Respondent's Perception of Blockchain Regulation

Perception of blockchain regulation	Yes	Maybe	No
Generally, are you hopeful that the Blockchain/Cryptocurrency network can be regulated?	532 (69.5)	43 (5.6)	190 (24.8)
Regulation of the Blockchain/Cryptocurrency network has been a thorny issue for global central banks. Are you convinced that CBN can regulate the process, even remotely?	392 (51.2)	37 (4.8)	336 (43.9)
Are you hopeful that the CBN will overturn the recent ban on Cryptocurrency and adopt its implementation to put a structure in place to regulate the process?	509 (66.5)	45 (5.9)	211 (27.6)
Do you perceive that the inability of the CBN to regulate blockchain technology effectively would be a showstopper to its implementation?	400 (52.3)	221 (28.9)	144 (18.8)
Overall perception	**5.24 ± 2.33**	**Positive perception**	

The feedback from the participants was not surprising that the general perception of regulating the blockchain platform was positive because of the supervisory role of central banks worldwide. The Act establishing most central banks included regulating the financial industry to ensure global best practices are implemented, especially regarding cross-border payment.

The feedback on regulating blockchain technology was amplified by Afzal and Asif (2019) when they posited that the importance of regulating the platform could not be over-emphasised as it would be like a car without a driver to control it. The researcher agreed that the platform is automated; however, the essence of human intervention cannot be ruled out. After all, automation was built by men. Therefore, blockchain technology must be regulated to ensure all stakeholders comply with the appropriate policies (Yeoh, 2017).

3.7.5.2 Qualitative Data Analysis

The survey questionnaires were circulated through a link among the focus group on the WhatsApp platform, and twenty respondents provided feedback. As stated in previous sections, the Google survey form was used to design the questionnaires to enable participants to access the survey questionnaire from the WhatsApp platform. Fifty-two (52) open-ended questions were asked, which took about 10 minutes to respond depending on the speed of the respondents.

Demographic Information

Table 3.10 provided **demographic information** about the focus group discussion participants. The **gender representation** showed 17 male and 3 female participants, meaning that 85% were male and 15% were female. The **age of the participants** ranged from 0 to 29 years old (45% of the participants), 30 to 39 years old (25%), 40 to 49 years old (25%), and 50 to 59 years old (15%). **The employment status** of the participants included being fully employed (35%), fully engaged in business (25%), retired or a pensioner (5%), seeking opportunities (15%), and being a student (5%). The **business/employment level** of the participants included being in senior/executive management (26.7%), corporate business (20%), middle management (40%), and SME business (13.3%), with one participant being a student (6.7%). Finally, the **roles of the participants** included banking administration (11.1%), financial management (27.8%), engineering personnel (5.6%), office management (5.6%), research and statistics management (11.1%), business development (5.6%), IT management

(16.7%), health management (5.6%), partnership management or liaison (5.6%), services (5.6%), and medical (5.6%).

Table 3.11

Demographic characteristics of focus group discussion participants

Variable	Parameter	Frequency	Percentage
Gender	Male	17	85%
	Female	3	15%
Age	0 - 29	9	45%
	30 - 39	5	25%
	40 - 49	5	25%
	50 - 59	3	15%
Employment status	Fully Employed	7	35%
	Full Business Engagement	5	25%
	Retired/Pensioner	1	5%
	Seeking Opportunities	3	15%
	Student	1	5%
Business/Employment level	Senior/Executive Management Corporate Business	4 3	26.70% 20%
	Middle Management	6	40%
	SME Business	2	13.30%
	Student	1	6.70%
Roles	Banking Administration	2	11.10%
	Financial Management	5	27.80%
	Engineering personnel	1	5.60%
	Office Management	1	5.60%

	Research & Statistics Management	2	11.10%
	Business Development	1	5.60%
	IT Management	3	16.70%
	Health Management	1	5.60%
	Partnership Management/Liaison	1	5.60%
	Services	1	5.60%
	Medical	1	5.60%

All have heard about Blockchain/Cryptocurrency/Bitcoin.

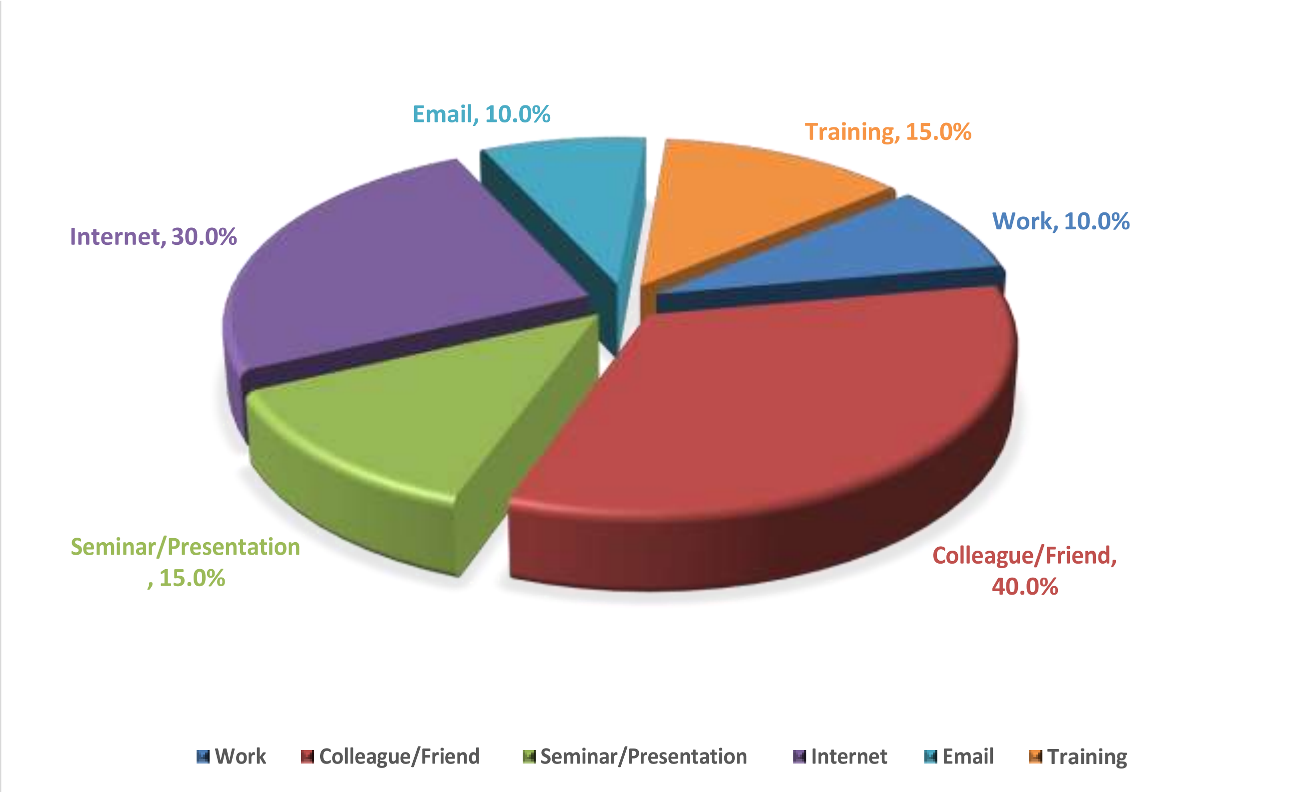
Respondents' source of information about Blockchain/Cryptocurrency/Bitcoin

Most focus group data participants heard about Blockchain/Cryptocurrency/Bitcoin from their friends (40.0%) and through the internet (30.0%). In comparison, the most minor expected sources of information include work (10.0%) and email (10.0%), as shown in Figure 3.6. More than half of the respondents rated their knowledge of Blockchain/Cryptocurrency /Bitcoin average; 20% had very high knowledge, while the rest had insufficient or deficient knowledge of it (Figure 3.7).

Information dissemination was very rapid in social media through collaboration between networks of relationships in organizations and any gathering be it in places of worship and political gatherings. Once a meeting was established, it would involve the exchange of pleasantries and introduction, which would in most cases extend to discussions on business tips including the likes of digital technologies and any opportunities that would yield proceeds.

Figure 3.6

Source of information about Blockchain/Cryptocurrency/Bitcoin

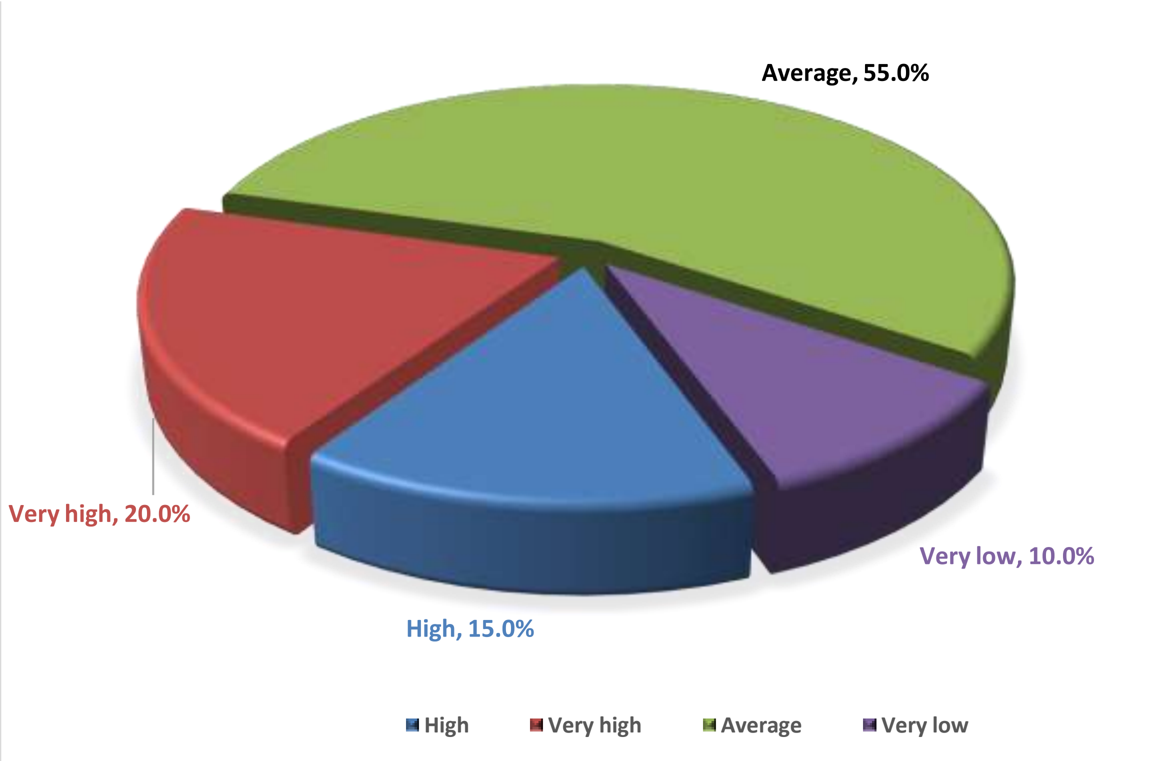


Compared with the survey questionnaire, the source of information showed that close to half of the participants learned about blockchain from their friends and colleagues. At the same time, the internet ranked the highest, followed by email as the source of information in the quantitative survey.

More than half of the respondents that rated their knowledge of blockchain technology average indicated the widespread among the participants. A signal that 90% of them already have appreciable knowledge of blockchain technology. The economic challenges in the third world or developing countries have triggered a significant shift in the quest for various means of making money. Nigeria was not exempted from this development, as many of the citizens have opted to try other means especially cryptocurrency businesses to elk a living.

Figure 3.7

Respondent's knowledge of Blockchain/Cryptocurrency/Bitcoin



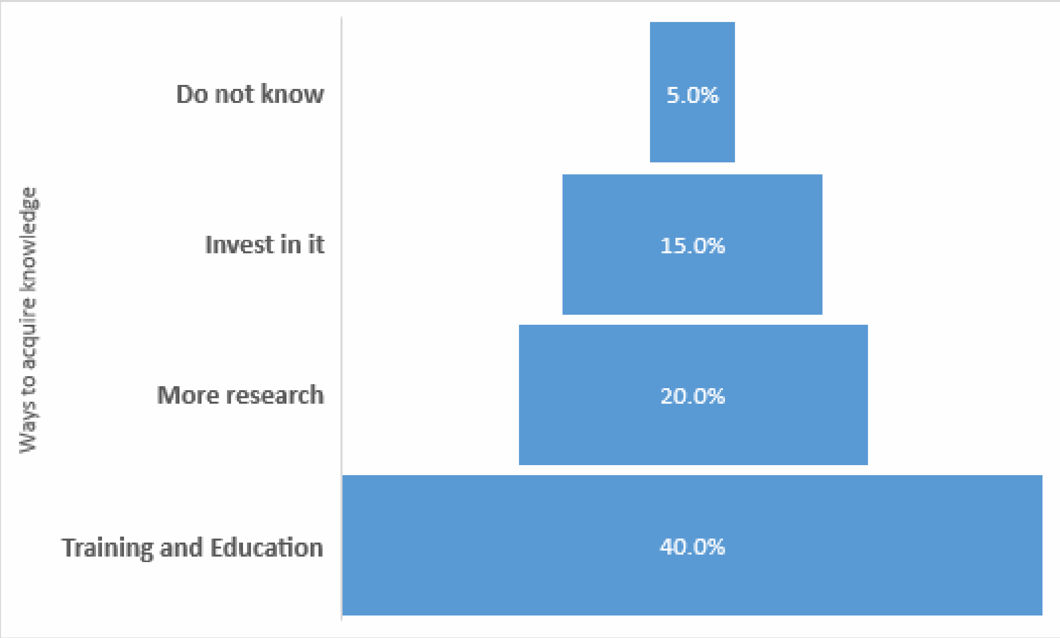
How respondents intend to improve their knowledge of Blockchain / Cryptocurrency / Bitcoin

Figure 3.8 showed that 8 out of the 20 respondents (40%) indicated that they intend to improve their knowledge of blockchain/cryptocurrency/Bitcoin by obtaining training and education. Four respondents (20.0%) planned to do more research on it, with 15% wanting to learn more by investing in it (15.0%). Only 5% of the participants did not know how they intended to improve their knowledge.

The quest to gain knowledge has become unprecedented like never before in light of the technological boom in recent years. If the saying "***my people perish for lack of knowledge***" is anything to go by, then it was not surprising that a lot of people as exemplified in the survey seek knowledge by any means even among those who were unsure of it.

Figure 3.8

How respondents intend to improve their knowledge of Blockchain



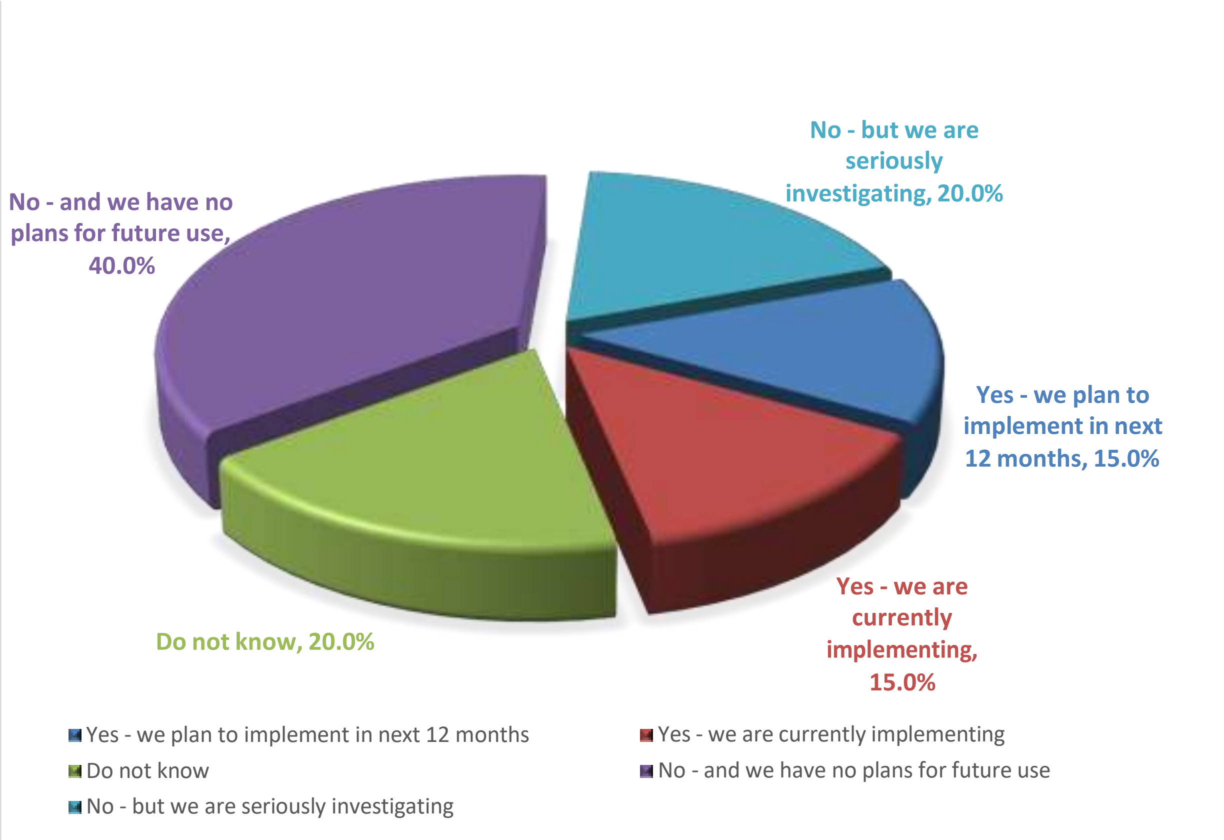
Organizations currently implementing or plan to implement Blockchain technology

Respondents were asked if their organizations are implementing or planning to implement blockchain technology. Respondents from three companies said they are currently implementing blockchain technology, 3 companies plan to implement it within the next 12 months, 4 companies were seriously investigating the possibility of implementing it, and 8 companies have no plans in the foreseeable future. It was worth noting that there were also 4 responses of “do not know,” which indicated a lack of information or understanding about the use of blockchain technology within these organizations (Figure 3.9).

Implementing blockchain technology in many organizations was still in its infancy, considering the low level of exposure to the blockchain. Other companies may have strong reservations about the blockchain policies emanating from the regulatory bodies (Kshetri, 2018). However, he posited that most central banks were exercising great caution in the implementation of blockchain technology.

Figure 3.9

Organizations currently implementing or planning to implement Blockchain



As defined in Chapter Two, blockchain technology is a decentralized and distributed digital ledger that records transactions on multiple computers, making it difficult for one party to alter the records. It has recently gained popularity due to its potential to increase transparency, security, and efficiency in various industries such as finance, supply chain management, and healthcare (Garg et al., 2021).

The companies currently implementing or planning to implement blockchain technology within the next 12 months may be doing so to take advantage of these benefits and stay competitive in their respective industries. On the other hand, companies with no plans in the foreseeable future for using blockchain technology may have determined that it is not a necessary or appropriate technology for their business operations (Wust & Gervais, 2018).

It is also worth considering the challenges and risks of implementing blockchain technology, such as the need for specialized skills and resources, regulatory uncertainty, and potential security breaches. These may have influenced the decision of some companies not to pursue the use of blockchain technology.

Generally, the data suggested diverse attitudes and approaches towards adopting blockchain technology among these companies. It will be interesting to see how this technology will evolve (Campbell-Verduyn & Goguen, 2018).

The extent to which organizations currently using Blockchain technology

Out of the 15 responses, 13.3% were companies that expect blockchain applications in production within the next 12–24 months, 6.7% are companies that are currently experimenting with blockchain technology, and 13.3% now have blockchain applications in production. However, 66.7% (10 out of 15) of participants lack information or understanding about blockchain technology within these organizations. The total row indicates that there are a total of 15 responses.

The companies that expect blockchain applications in production within the next 12-24 months or are currently experimenting with it may be doing so to assess the potential benefits and challenges of implementing this technology. The companies that now have blockchain applications in production were likely already realizing the benefits of using them in their business operations; otherwise, no company would want to operate at a loss. The essence of companies implementing or considering the implementation of blockchain technology was primarily based on the potential benefits and the policies in the operating environment (Ølnes et al., 2017).

Table 3.12

The extent to which organizations currently using Blockchain Technology

Response	Number of Companies	Percentage
We expect to have Blockchain applications in production within the next 12-24 months	2	13.3%
We are currently experimenting with Blockchain	1	6.7%
Do not know	10	66.7%
We now have Blockchain applications in production	2	13.3%
Total	**15**	**100%**

Respondents' perception of the benefits specific to their organization/industry hope to obtain from using Blockchain Technology

According to Table 3.11, the respondents' perceptions of the benefits specific to their organization/industry hope to obtain from using blockchain technology are focused on improving business efficiency, transaction efficiency, and reducing risk.

Improved business efficiency was expected to be achieved by identifying new ways of automating business processes among partners, saving time, enabling new business models, and strengthening working relationships with partners through better collaboration. Improved transaction efficiency was expected through better transaction integrity and visibility, increased transaction speed, and lower transaction costs (Michael et al., 2018).

Risk reduction was expected to be achieved by reducing risks such as conspiracy, tampering, and unintentional leakage of information, as well as better data protection provided by blockchain's ability to eliminate points of failure in business networks (Lu et al., 2019).

Overall, the respondents hoped to obtain a wide range of benefits from using blockchain technology, including increased efficiency, improved transaction integrity and visibility, and reduced risk (Pal et al., 2021).

Table 3.13

Respondent's perception of the benefits specific to their organization

Theme	Sub-theme
Improved business efficiency	Identifying new ways of automating business processes among partners
	Time savings (e.g., reducing the time required for settling disputes, finding information, and verifying a transaction)
	Enabling new business models (e.g., contract management, financial transaction management, identity management)
	Stronger working relationship with partners (via better collaboration)
Improved transaction efficiency	Better transaction integrity and visibility
	Increased transaction speed
	Lower transaction cost
Risk reduction	Reduction of risks (e.g., by eliminating the risk of collusion, tampering, and unintentional leakage of information)
	Better data protection provided by blockchain's ability to eliminate points of failure in business networks

Areas of possible dramatic disruption in Blockchain Technology

When respondents were asked to list the areas of possible dramatic disruption in blockchain technology, the central theme of their responses was the potential for disruption in various industries due to the adoption of specific technology or practices. People saw the disruption of business by blockchain technology from different perspectives. While some viewed it as a means of improving the process and enhancing efficiency, others thought that the emergence of blockchain technology has brought significant benefits to the business world including all forms of payment transactions and software development.

Figure 3.10 depicts the areas of disruption identified within this central theme, which include:

Payment: The respondents mentioned the potential for payment disruption, explicitly citing the possibility of a new, more accessible option for payment that does not require a third party (such as a bank) and may leave traditional financial institutions at a loss. They believed that the absence of an intermediary would fast-track the payment process without any gridlock or delay challenges.

New businesses: The feedback from the respondents indicated that new businesses might emerge due to this disruption. This is a positive development as it would open up the business landscape and provide opportunities for other small, and medium, enterprises (SMEs) to thrive. This is a norm when an initiative is introduced in the business environment.

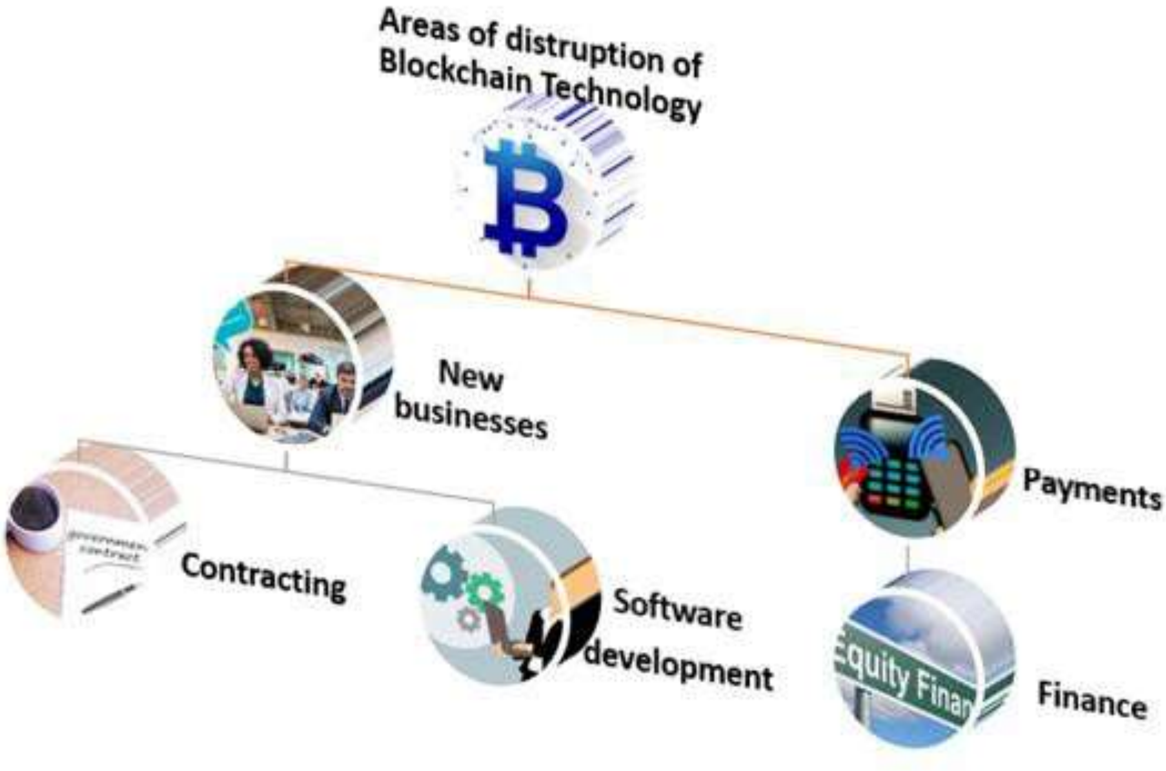
Payment and contracting: The respondents mentioned the potential for disruption in payment and contracting and suggested that this disruption may represent a paradigm shift for software developers and users. Smart contracts fall into this category, especially in the application of blockchain for higher education registries as is being done in Brazil (Palma et al., 2019).

Software development: The study participants also said that adopting particular technology or practices may significantly affect how software is coded. The application of artificial intelligence has contributed to this development.

Finance and supply chain: The participants mentioned potential disruption in the finance and supply chain industries under blockchain technology implementation (Wang et al., 2019).

Figure 3.10

Areas of possible dramatic disruption in Blockchain Technology



Industries and domains in which Blockchain Technology will have the most significant impact

Respondents' views of the industries and domains in which blockchain technology was expected to have the most significant impact are finance and accounting, banking, and information technology. These three areas represented a combined 75% of respondents' responses.

A respondent said, "***The finance and accounting industry is likely to be impacted by blockchain technology due to the potential for increased efficiency and security in financial transactions***." Another respondent said, "***Blockchain could enable real-time tracking and validation of financial transactions, reducing the potential for fraud and errors***."

The banking industry was also expected to be significantly impacted by blockchain technology. According to the study participants, "***Blockchain could enable faster and more secure financial transactions, as well as reducing the need for intermediaries such as banks in some cases***.*"*

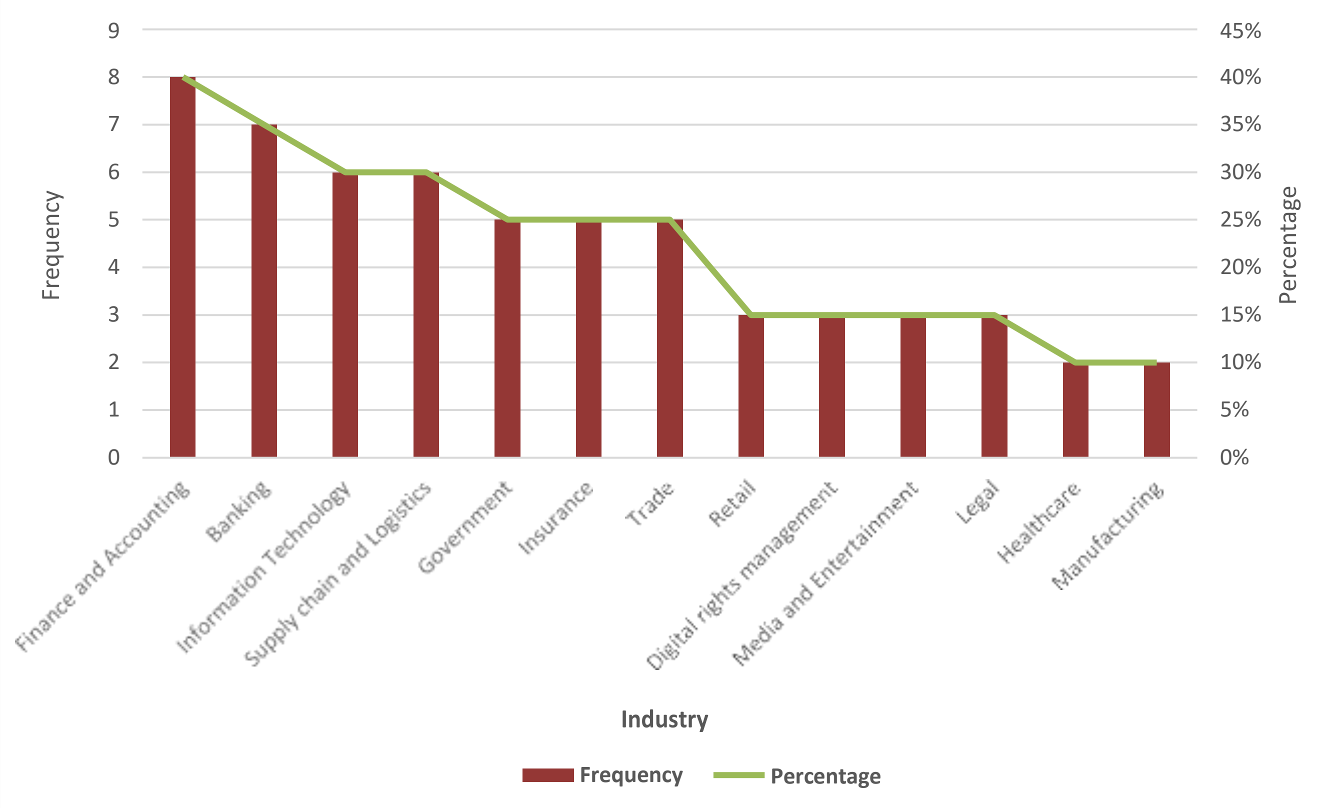
The *Internet of Things* (IoT) is a network of interconnected devices that can communicate with each other and exchange data (Atlam et al., 2018). Using blockchain technology in the IoT could increase security and trust in these interconnected devices and enable new business models and use cases (Banerjee et al., 2018).

Blockchain technology was expected to significantly impact other industries, including supply chain and logistics, government, insurance, trade, retail, digital rights management, media and entertainment, legal, healthcare, and manufacturing, as postulated by Miller (2018). These industries represent a combined 25% of respondents' responses. Each of these industries has the potential to benefit from the increased efficiency, security, and transparency that blockchain technology can provide, as shown in Figure 3.11.

Also shown was the implication that the benefits of blockchain technology together with IoT would span our ways of doing things, as indicated in their responses since our involvement in our businesses and places of work aligns with our everyday activities. Chanson et al. (2019) pointed out that our privacy has been infringed by the internet, which by extension has also "*influenced*" our psychological ways of doing things. The listed areas in the industrial sector transcend the feedback received as other segments were not covered in the survey questionnaires. However, the emphasis was on the most substantial effect as received from the respondents.

Figure 3.11

Industries/domains in which Blockchain have the most significant impact



The biggest adoption challenges to organization's efforts to utilize Blockchain Technology

Blockchain technology has the potential to transform various industries and organizations. However, its adoption can be challenging for some organizations. Having studied the potentials of blockchain technology to understand the challenges that organizations face in adopting the technology, eleven significant challenges were deduced from the responses of the focus group data participants. The biggest adoption challenges identified by the respondents were:

Lack of understanding of what blockchain can do/is good for (35%): The respondents noted that a lack of understanding about the potential uses and benefits of blockchain technology could be a challenge in adopting it.

Blockchain is still an emerging technology (30%): This was the most common challenge cited by the respondents. The respondents noted that blockchain is still an emerging technology, so it can be challenging to understand and implement effectively.

Lack of experts skilled in blockchain technology (25%): The respondents noted that the availability of experts with knowledge and experience in blockchain technology could be limited, which can be a challenge in adopting it.

Regulatory constraints (25%): The respondents cited regulatory constraints as challenging to adopt blockchain technology.

Lack of industry standards (10%): The respondents noted that the lack of industry standards and protocols could challenge adopting blockchain technology.

Retail (10%): Two respondents said adopting blockchain technology can be challenging in the retail industry.

Some respondents mentioned that identifying specific use cases for their organization that were relevant and cost-effective can be a challenge in adopting blockchain technology.

Privacy and security considerations (5%): Some respondents mentioned that privacy and security considerations could be challenging in adopting blockchain technology.

Supply chain and logistics (5%): One respondent mentioned that adopting blockchain technology can be challenging in the supply chain and logistics industry.

Limited market for available blockchain solutions (5%): One respondent mentioned that the limited market for available blockchain solutions could be a challenge in adopting the technology.

*"**My organization is a humanitarian organization, the focus is not on making a profit (5%)**":* One respondent mentioned that their organization, which is a humanitarian

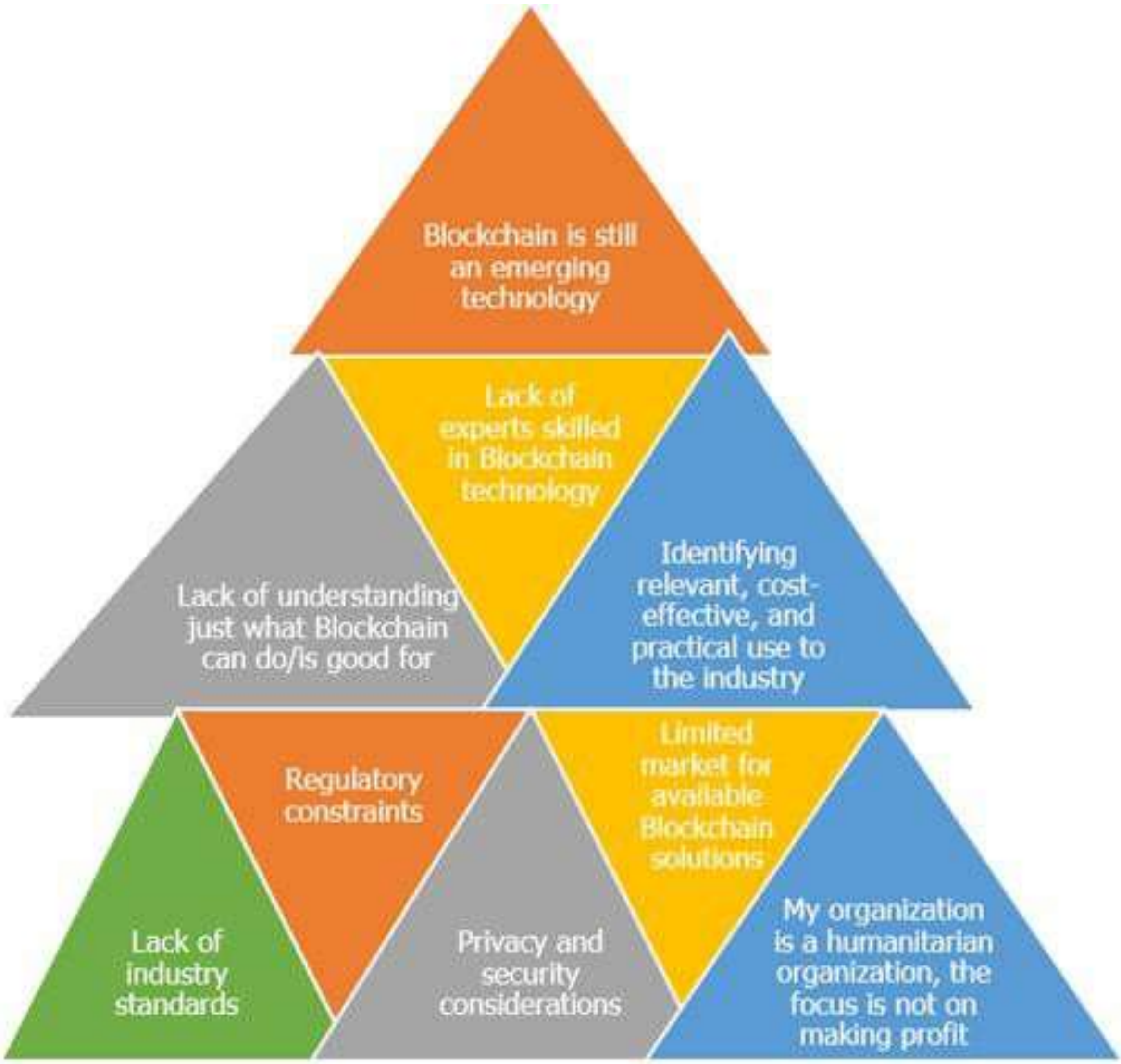
organization, does not have a focus on making a profit and therefore may not see the benefits of adopting blockchain technology, as shown in Figure 3.12.

The results of the focus group data indicated that the most prominent adoption challenges for organizations in utilizing blockchain technology were that it was still an emerging technology, there was a lack of understanding about its potential uses and benefits and a lack of experts skilled in the technology. Other challenges include regulatory constraints, privacy and security considerations, and the lack of industry standards. Adopting blockchain technology may also be more challenging in specific industries, such as retail, supply chain, and logistics. To effectively adopt blockchain technology, organizations may need to invest in training and education, as well as address regulatory and privacy concerns.

From the respondents' feedback, it was evident that challenges abound in implementing blockchain technology. However, the respondent implied that blockchain technology implementation might not be necessary since the outfit is a non-profit organization entirely out of reality. The respondent should know that blockchain technology was not for specific organizations as all entities could benefit depending on the scope of work in that organization. That an organization was not profit-making does not mean it will not need blockchain technology to stimulate efficiency, transparency and accountability in its operations. Blockchain technology transcends only profit-making organizations as the benefits include services that promote organized operations and decent processes to the benefit of not only the organisations but their stakeholders as well (Koumbarakis & Dobrauz-Saldapenna, 2019). They opined that stimulating efficiency would trigger productivity, which would eventually result in profitability of any organization particularly when the operations include service deliverables.

Figure 3.12

The most significant adoption challenges to Blockchain implementation



Level of importance respondents attach to the development of industry standards and practices for supporting Blockchain platforms, applications, and commercial products

The overwhelming responses of the participants indicated that the establishment of standard policies to facilitate the processing of blockchain operation is paramount as these policies serve as a guide for smooth implementation. Deployment of systems including Blockchain technology was leveraged on the application of standard policies to harmonise the operations.

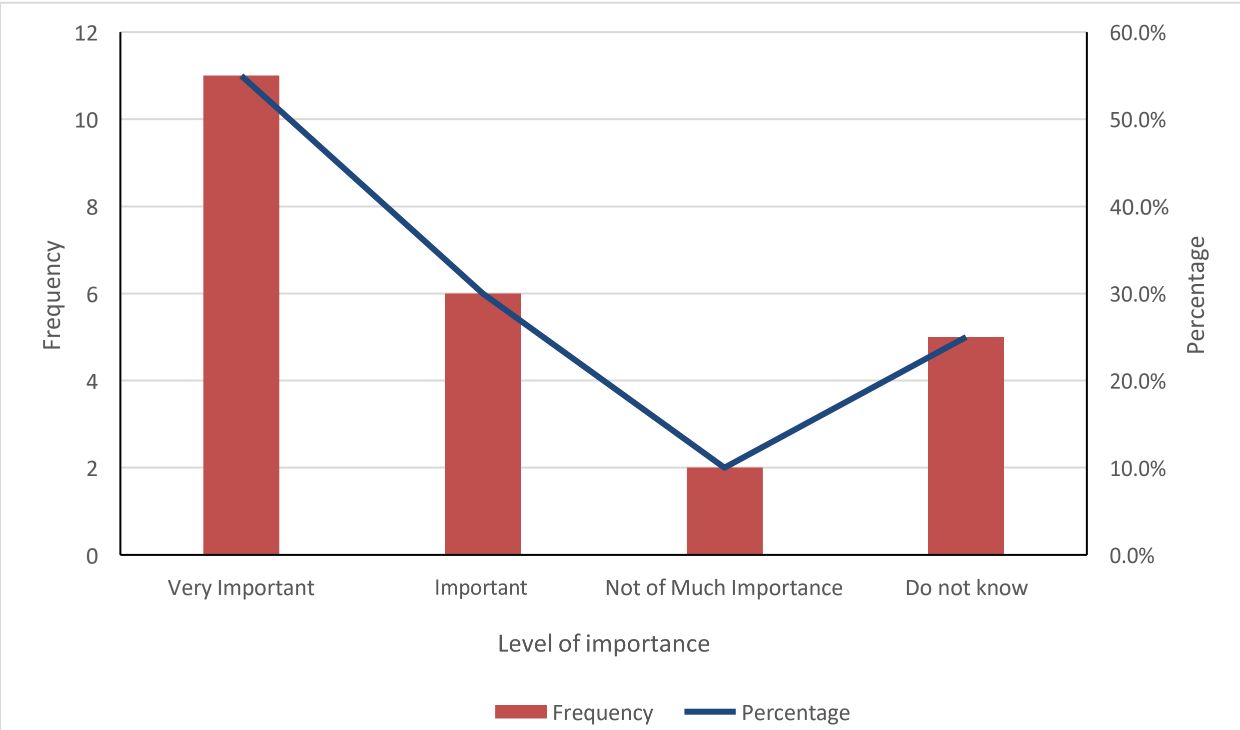
Respondents classified the levels of importance as ‘very important’, ‘important’, and ‘not of much importance.’

Very important: Many respondents considered industry standards and practices very important for end-user organisations and commercial enterprises' successful adoption of blockchain technology.

Important: Some respondents considered standard frameworks and practices essential but not necessarily crucial for successfully adopting blockchain technology.

Figure 3.13

Level of importance to the development of industry standards



Not of much importance: A small number of respondents believed that blockchain technology is unstoppable and its adoption by end-user organizations and commercial enterprises will be widespread regardless of the development of industry standards and practices (Figure 3.13).

Respondents' aspiration to participate in Blockchain/Cryptocurrency/Bitcoin in the next five years

As part of a study on the aspirations of participants in blockchain, cryptocurrency, and Bitcoin, a survey was conducted to gather insights into their goals and objectives in the next five years. The following is a summary of the findings:

Some participants hoped to **become experts in the field**, with a deep understanding of the technology and its various applications. They aimed to stay up-to-date with the latest developments and contribute to the industry's growth.

Others hoped to own some currencies or **become investors in the field**. They saw the growth potential and wanted to be a part of it by owning a stake in various projects.

Some participants hoped to make a **significant investment and profit from it**. They envisioned the potential for high returns in the field and wanted to take advantage of it.

Others are **not sure about their aspirations in this field**. They may still be exploring the possibilities and unsure of what direction to take.

Some want to **introduce the following line of young multi-millionaires built on cryptocurrency**. They perceived the potential for technology to change the world and wanted to help others benefit from it. This perception was peculiar to experienced cryptocurrency operators as most were entirely into it and were willing to extend the business to others. However, with the ups and downs in the cryptocurrency market, it would be challenging to convince potential investors when it is low.

Some **hoped to be full-time investors,** while others hoped to be **investors, operators, or enthusiasts**. They realized the potential for various roles in the field and wanted to contribute in different ways.

Some participants hoped to **provide enlightenment on the best ways to use the blockchain**. They reckoned with the for education to help others understand the technology and its potential.

Respondents' likelihood to invest in cryptocurrency

Based on the responses, most respondents (61%) indicated that they are highly likely to invest in cryptocurrency this prevailing year. However, there was a projection from the data analysis tool used that this would extend to 70% of "highly likely" investors in the cryptocurrency business.

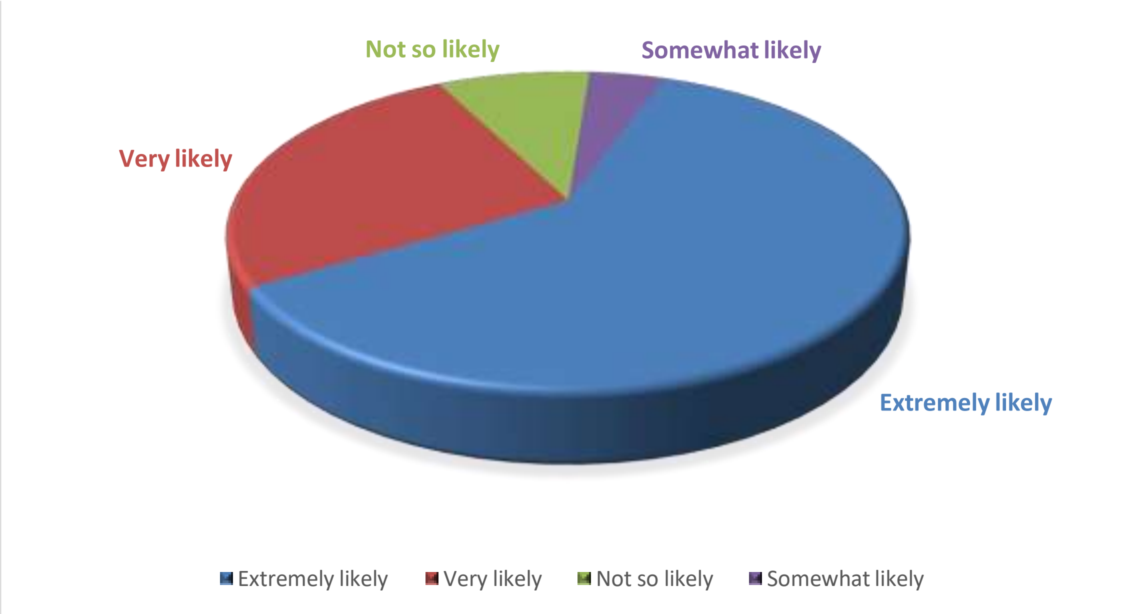
Another 26% of respondents were "very likely" to invest in the cryptocurrency business with a forecast that this would increase to 30% within a given period.

An additional 5% of potential investors indicated that they would be "somewhat likely" to invest in the cryptocurrency business.

In contrary feedback, 9% showed that they are "not so likely" to invest in cryptocurrency transactions, which would likely stretch to 10% from the prediction as displayed below (Figure 3.14).

Figure 3.14

Respondents' likelihood to invest in Cryptocurrency



Reasons why respondents would invest or not invest if given the opportunity

Here is a summary of the reasons given by respondents for why they would invest in cryptocurrency if given the opportunity:

Already invested in it and seen success

Believed it is a genuine and profitable business

Interested in learning about and staying current with emerging technologies

Believed it is a secured investment and can lead to financial benefit

Believed it is the future of monetary value and a more efficient way to save and invest

Interested in attaining financial freedom

Here is a summary of the reasons given by respondents for why they would not invest in cryptocurrency if given the opportunity:

Not sure about it

Respondent's perception of the need for further technical advances, awareness and training on Blockchain/Cryptocurrency

According to the focus group data responses, most respondents (85%) believed there is a need for further technical advances, awareness, and training on blockchain/cryptocurrency. Lack of general awareness was the critical factor of this feedback.

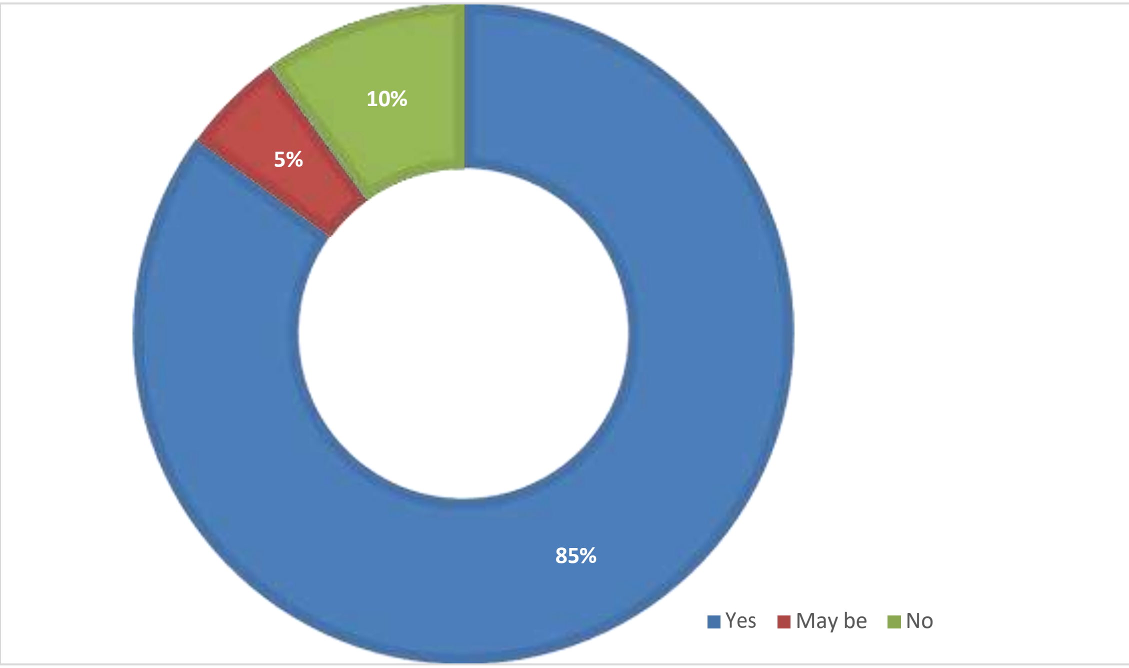
Five per cent (5%) of the respondents indicated that they might think there was a need to further propose general awareness involving pieces of training, seminars, workshops, and conferences. However, ten per cent (10%) of the respondents perceived that they did not think it was necessary to embark on this venture as displayed in (Figure 3.14).

The data analysis suggested that most respondents believed that further technical advances, awareness, and training on blockchain/cryptocurrency are necessary. This finding may be due to a belief that these technologies were essential for the future and that a lack of understanding or knowledge about them could hinder their adoption and development.

The respondents' overwhelming perception of this issue revealed the importance of sensitizing the public. The current level of those who subscribed to the CBN digital currency is abysmally low in all ramifications. This perception has uncovered a high rate of cash transactions despite the redesign of the Naira currency notes due primarily to the shortage in circulation in the public domain. The expectation was that many people would gradually switch to electronic means of transaction and reduce the use of cash.

Figure 3.15

Respondent's perception of the need for further awareness of Blockchain



The respondents who said there was a need for further technical advances, awareness, and training on blockchain/cryptocurrency provided various suggestions on how this could be achieved. Some of the suggestions included:

Sensitization and awareness campaigns to increase understanding of blockchain/cryptocurrency among the general public: These campaigns could be targeted at different demographics and conducted through various mediums such as social media, traditional media, and in-person events.

Involving professionals in the field to provide training to the general public: This could consist of hosting seminars, workshops, and online training sessions to educate people about the basics of blockchain/cryptocurrency and more advanced concepts.

Research and development to drive technological advancements could imply investing in and supporting research efforts to explore new applications and possibilities for blockchain/cryptocurrency technology.

Awareness campaigns in tertiary institutions and financial institutions: This could comprise incorporating blockchain/cryptocurrency education into the curricula of universities and financial institutions or hosting events and workshops specifically for these audiences.

Advertising and training through seminars, workshops, and online training sessions could entail using various mediums such as social media, traditional media, and in-person events to promote blockchain/cryptocurrency education and training opportunities.

Setting up an institution dedicated explicitly to blockchain/cryptocurrency education: This could be a standalone organization or a department within an existing institution and could focus on providing education and training on blockchain/cryptocurrency to the public.

Incorporating blockchain/cryptocurrency education into school curricula: This could involve adding blockchain/cryptocurrency topics to elementary, middle, and high school curricula to increase awareness and understanding among young people.

Increasing public awareness through media campaigns and advertisements could embrace using various mediums such as social media, traditional media, and in-person events to promote blockchain/cryptocurrency and raise awareness about its potential uses and benefits.

Promoting the acceptance of digital currencies could imply educating people about the benefits of using digital currencies and overcoming any fears or misconceptions preventing wider adoption. This sensitization is paramount to get the public's buy-in, especially in light of the new central bank digital currency, the **e₦aira**.

Educating young children about blockchain/cryptocurrency: This could involve incorporating blockchain/cryptocurrency education into the curricula of elementary schools or hosting events specifically for young children to learn about these technologies.

These suggestions highlighted the importance of increasing awareness and understanding of blockchain/cryptocurrency through various means, including education, training, and media campaigns.

Respondents' investment status in cryptocurrency

Overall, most respondents (80%) did not invest in cryptocurrency before the CBN's prohibition on banks not allowing their accounts to be used for such operations. On the other hand, 15% of respondents had invested in cryptocurrency before the prohibition, with no indication of whether they would continue to invest after the ban was lifted. However, 50% indicated that they might consider investing in cryptocurrency after the ban is lifted, while 40% were uncertain, and 10% indicated that they would not consider investing.

Table 3.14

Respondents' investment status in Cryptocurrency

Response	Frequency	Percentage
Have you invested in blockchain/cryptocurrency/Bitcoin or other virtual coins before the prohibition by the CBN?		
Yes	3	15%
May be	1	5%
No	16	80%
Is there any possibility that you will invest in cryptocurrency after the ban is lifted?		
Yes	10	50%
May be	8	40%
No	2	10%

Table 3.14 presents the responses of individuals regarding their reasons for investing in cryptocurrency in the past and the future. The Table was divided into two sections of the reasons for investing in cryptocurrency in the past and future.

The most common reason for investing in cryptocurrencies in the past was that they brought people out of poverty. Other common reasons included emerging new ideas, the potential for cryptocurrency as an investment, and the ability to earn from trading cryptocurrency. Some respondents also mentioned that cryptocurrency has made business more accessible.

The most conventional reason for not investing in cryptocurrency in the past was uncertainty due to government regulations. People who did not invest also said they did not know enough about cryptocurrency or were still learning about it.

The second part of the Table lists the reasons for possible future investment in cryptocurrency. The reasons for possible future investment were that cryptocurrency was the wealth of the future, the possibility of new ideas to emerge, a form of investment like any other, there are earnings from the cryptocurrency trading. Some responses implied that cryptocurrency has improved the ease of doing business while others were just enthusiastic about it for the past three years, possible investment in future, and the possibility that new technology will emerge. Other common reasons were the chance to improve investments already made, the assurance that the investment outlook looks good, cryptocurrency investment is a form of paradigm shift to the latest technology, the pertinent need to understand the cryptocurrency dynamic before investment, investment would commence once there was possibility of making profit, time would dictate how everything would go, the ability to monitor the cryptocurrency market would be the basis for investment, profitability would be the basis for investment, the love to trade and earn would be factor to invest in cryptocurrency, and the need to keep up with the shift toward digital forms of currency.

On the other hand, uncertainty was the most common reason for not investing in cryptocurrency in the past, the inability of the government to regulate was the basis for the unwillingness to invest. Other reasons included the need to understand more about cryptocurrency and the lack of a specific reason for investing. Some respondents mentioned that they would invest once they understood the dynamics of cryptocurrencies, while others cited profitability as a potential reason. Others included the inability to be assured of the crypto investment in the past, the limited knowledge was a bane for not investing thus far, the fact that one is just getting to know about the cryptocurrency market and the absence of a government’s guarantee was a setback for investment in the past.

Table 3.15:

Respondents' reasons for investing in Cryptocurrency in the past and future

Reasons for Investing in Cryptocurrency in the Past	**Reasons for not Investing in Cryptocurrency in the Past**
Cryptocurrency has brought people out of poverty	Not sure of it due to government regulations
New ideas will still emerge	Limited knowledge
As a form of investment	Just getting to know about it
Earns from trading cryptocurrency	Not sure of it due to government regulations
Cryptocurrency has made business easier	
Been an enthusiast for 3 years	
Reason for possible future Investment in cryptocurrency	Reason for not investing in cryptocurrency in the future
Cryptocurrency is the wealth of the future	Not sure
New technology will emerge	No reason
Enhancement of investment	Yes
Assurance	
Need to align with the paradigm shift	
Still need to understand more	
Once able to understand dynamics, will invest	
Profitable	
Time reveals everything	
For profit-making	
Most digital forms of investment can be monitored everywhere	
Earns from trading cryptocurrency	
Cryptocurrency is the future	
Love cryptocurrency	

Research Question-1: What are the current blockchain applications developed on cyber security to mitigate cyber-attacks?

Blockchain Cybersecurity

Blockchain/Cryptocurrency/Bitcoin used cryptography to secure and verify transactions (Menezes et al., 2019); respondents were asked if they believed this was strong enough to secure the network against cyberattacks. Based on their responses, 40% believed that blockchain and cryptocurrency networks were secured against cyber-attacks due to their use of cryptography, 35% did not know if cryptography's security was enough to protect against cyberattacks, and 25% think it might be enough but were unsure (Figure 3.16).

The reasons given by respondents for their choices vary. Some believed that the decentralized nature of blockchain networks, combined with the immutability of data on the blockchain, make them resistant to tampering and cyber-attacks. Others argued that cryptography was a powerful means of securing transactions but that the network's overall security may depend on other factors, such as the investment in infrastructure protection and the level of knowledge and expertise within the network. Some were unsure of the strength of cryptography to protect against cyber-attacks due to a lack of knowledge about the subject or the complexity of the technology. Some people also said that, just like with any other banking system, the security of each transaction might depend on the use of personal codes and pins (Figure 3.17).

On the other hand, some gave contrary views including the issue of too many uncertainties in the crypto network, the need for an in-depth knowledge of how the cryptography works and the need to invest in the cryptography infrastructure to protect transaction data on the platform.

Figure 3.16

Respondent's perception of the strength of Blockchain that uses cryptography

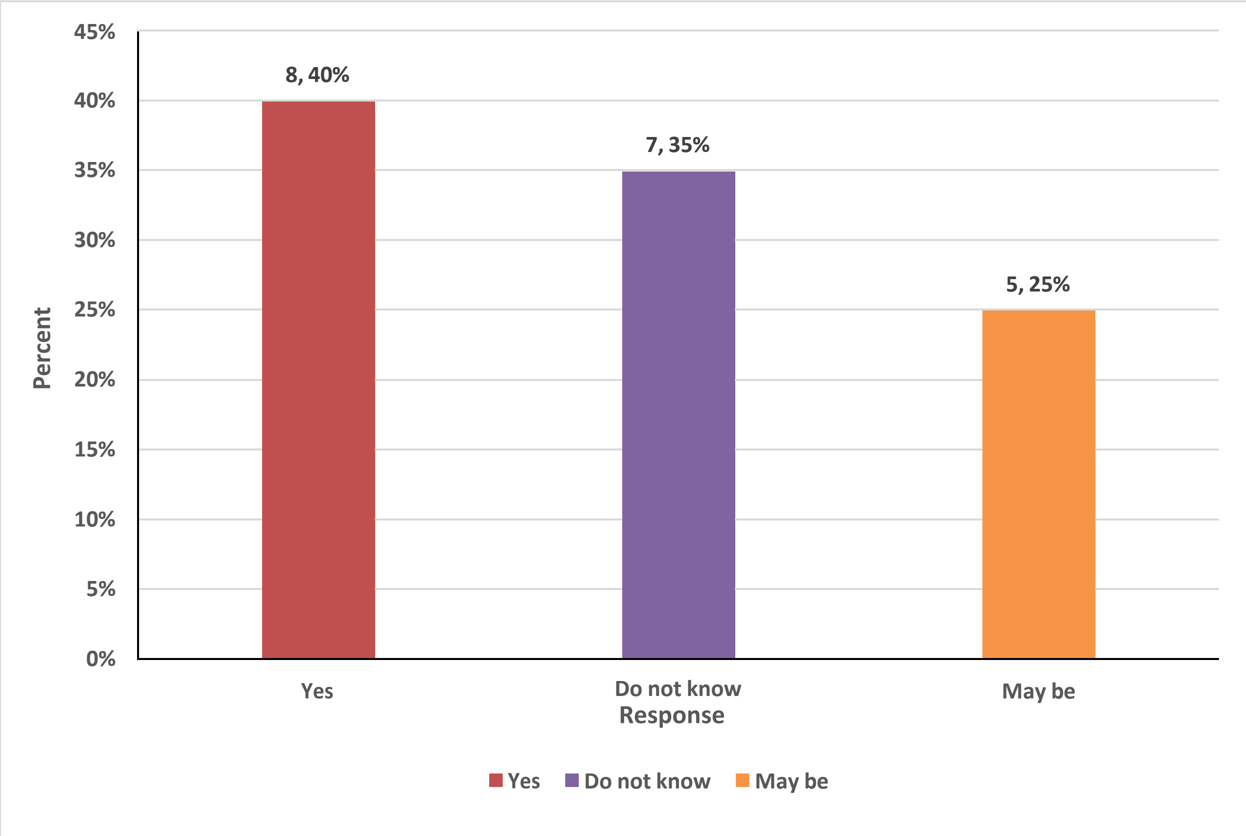
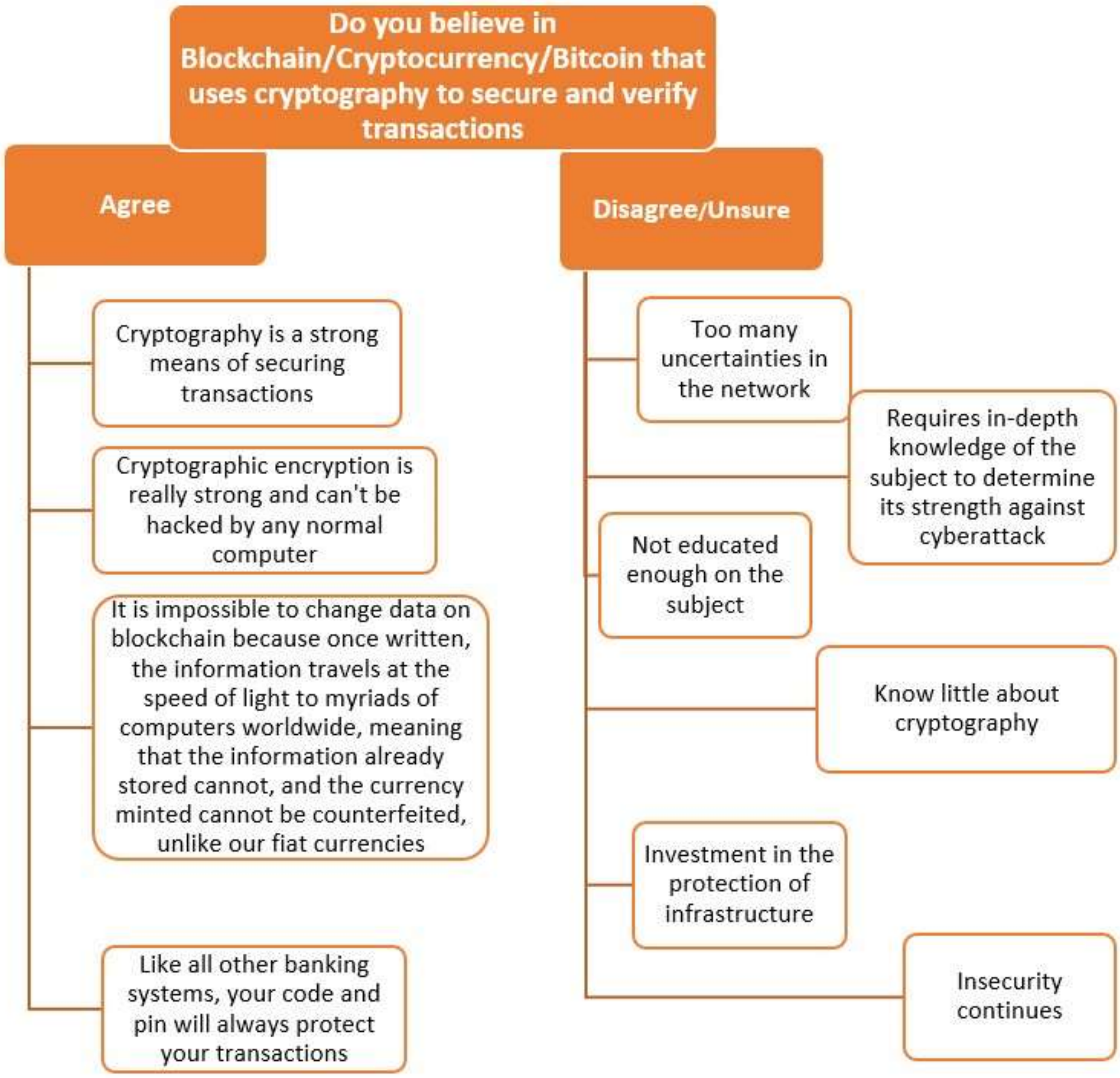


Figure 3.16 stipulated the ‘agree’ and ‘disagree/unsure’ reasons for the respondents deciding whether using cryptography was strong enough to secure transactions in the blockchain network. Most reasons aligned with their decisions except where they were sceptical about the efficacy of the cryptography functionalities. For the respondents who agreed with the secure capacity of cryptography, the reasons they proffered were convincing enough, especially in line with current realities. Among the respondents who disagreed or were unsure, while some were unsure due to a lack of cryptograph knowledge, others were uncertain about the stability of the network and suggested the investment in securing the infrastructure to earn investors' confidence.

Figure 3.17

Reasons for respondents' perception of the strength of Cryptography



Respondent's knowledge of cryptocurrency

When asked if they were aware of any Blockchain/Cryptocurrency application developed for cybersecurity to mitigate cyberattacks, most respondents (70%) were unaware of it. Another 25% of respondents revealed that they do not know about such applications. Only 5% of respondents indicated they knew at least one such application.

Among those aware of a blockchain/cryptocurrency application for cybersecurity, two specific applications were mentioned: **cryptography and a power crypto application**.

Table 3.16

Knowledge of any Blockchain Cyber-Security Application

Response	Frequency	Percentage
Aware of any Blockchain/Cryptocurrency application developed on cybersecurity to mitigate cyberattacks		
Yes	1	5%
No	14	70%
Do not know	5	25%
Specify any cybersecurity application on Blockchain/Cryptocurrency that you are aware of		
Cryptography	1	5%
Power crypto application	1	5%
Not aware of any	14	70%

Respondents' perception on possible mitigation of risks associated with Blockchain/Cryptocurrency/Bitcoin applications

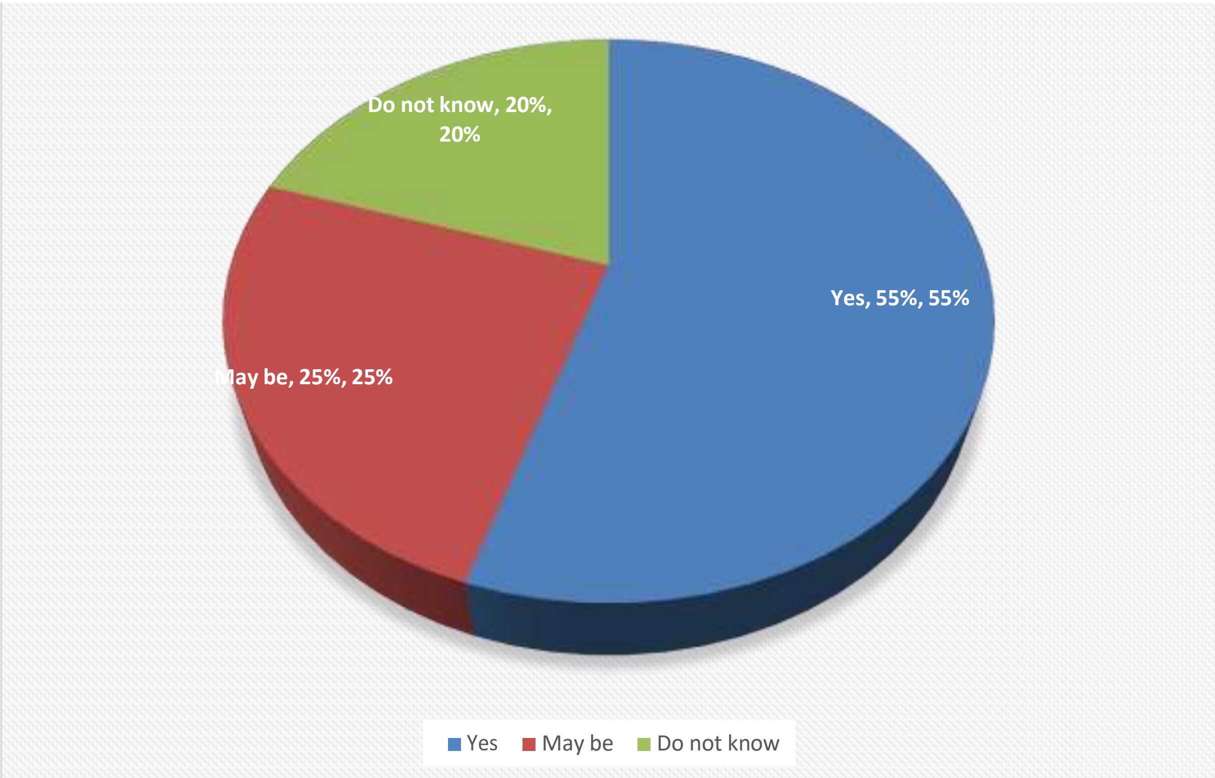
Based on the responses, most (55%) respondents believed the risks associated with blockchain/cryptocurrency/Bitcoin applications could be mitigated. An additional 25% of respondents believe the risks may be mitigated, while 20% indicated that they do not know if they can be mitigated (Figure 3.17).

Respondents provided various reasons for believing the risks associated with blockchain/cryptocurrency/Bitcoin applications can be mitigated. Some of the reasons mentioned include using cryptography, training the masses on identifying cryptocurrencies with meaningful projects, increasing technology, standards and policies built around it, adequate monitoring, and proper management and monitoring. Other respondents mentioned that the risks could be mitigated to some extent through using private and single private IP keys and traditional measures such as code and pin protection.

The reasons adduced by the respondents were all compelling and related to their decisions to respond the way they did. However, their responses were enough to raise investors' confidence that their investments were safe through the blockchain network. When investors knew their investments were secured, they wanted to invest more in the business.

Figure 3.18

Respondent's perception of possible risk mitigation of Blockchain



Respondent's confidence that their transactions/investments in Blockchain are well protected against cyber-attacks

Most of the respondents (35%) indicated that they were confident that their transactions/investments in blockchain/cryptocurrency/Bitcoin may be well protected against cyberattacks to some extent. In comparison, 30% of respondents indicated they were confident that their transactions/investments were well protected. About 20% of respondents indicated that they did not know if their transactions/investments were well protected, and 15% indicated that they were not confident that their transactions/investments were well protected (Table 3.16).

Respondents provided a variety of reasons for their responses. Some of the reasons mentioned include using cryptography, the fact that the information on the blockchain cannot be changed, adequate security of vital infrastructure, traditional measures such as code and pin protection, and using secure wallets.

However, other respondents mentioned that blockchain technology was still evolving and that there was a risk of attacks in which attackers could manipulate and modify the blockchain information. Some respondents also mentioned that they had lost coins/tokens to hacking or had heard of cases in which hackers had stolen funds.

Respondents showed a mix of confidence and uncertainty regarding protecting transactions/investments in blockchain/cryptocurrency/Bitcoin against cyber-attacks, which cannot be ruled out. With the high rate of cyber-attacks in ransomware, phishing, and malware, the researcher could understand the scepticism manifested by the respondents in their responses. As stated above, only 30% of the respondents were sure of the confidence the blockchain network is well protected against cyber-attacks.

Table 3.17

Respondents' confidence that transactions in Blockchain are well-protected

Response	Frequency	Percentage
May be	7	35%
Yes	6	30%
Do not know	4	20%
No	3	15%

Research Question-2: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?

Respondents' Perception Of Blockchain Technology Facilitating An Efficient Payment System In The Nigerian Financial Industry

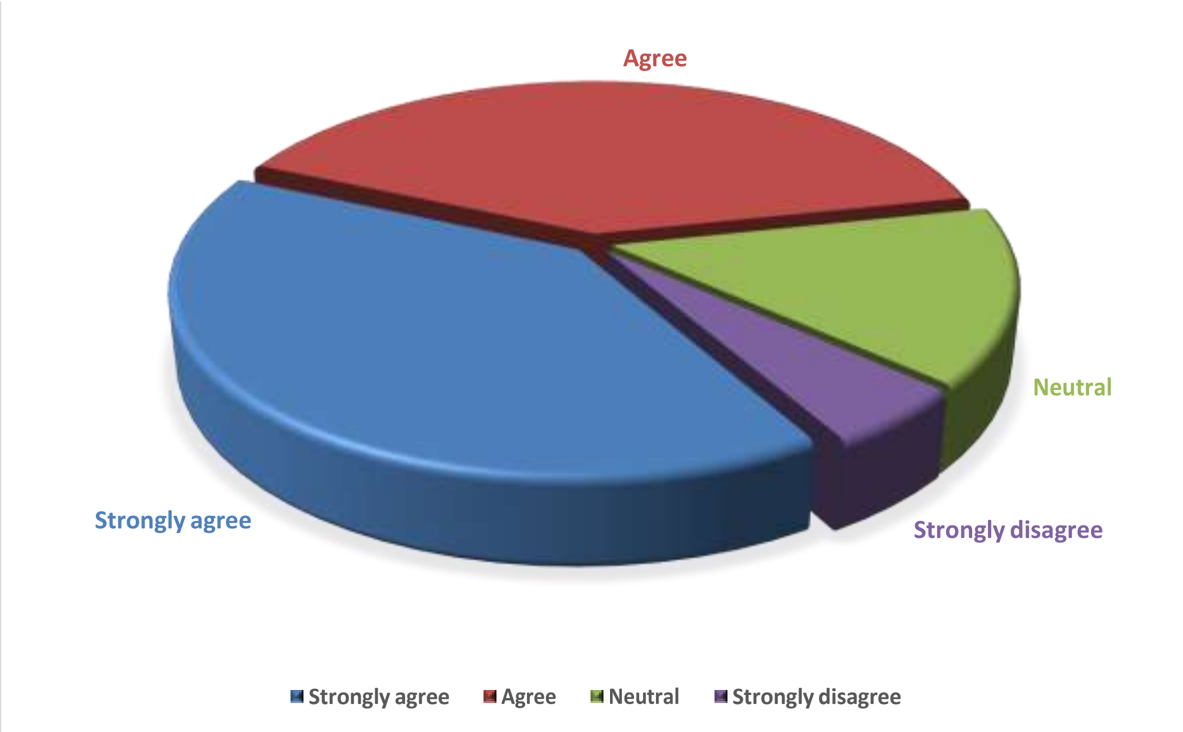
Based on their responses, most respondents shared the (80%) equally with 40% "strongly agree" and 40% "agree" with the perception that blockchain technology can facilitate an efficient payment system in the Nigerian financial industry. However, 15% of respondents were neutral, while only 5% strongly disagreed with this perception (Figure 3.18). The forecast of each variable will remain the same based on the projection.

Respondents provided a variety of reasons for their responses. Some reasons mentioned for agreeing with the perception included that blockchain technology was a trust-less protocol with efficient proof of work, efficiency and low cost for bookkeeping, reduced cash transactions and aids the cashless policy, and was time efficient and secure. Other respondents mentioned that they knew little or were unsure about the matter.

The reasons presented by the respondents on the viability of blockchain technology promoting efficiency in the payment system were not out of place as they were thought-provoking, with convincing explanations to support their decisions. The payment system has been an avenue to showcase the efficiency of digital payment (Soutter et al., 2019). Of all sectors where blockchain technology has been applied, the payment system was the most vibrant and complex simply because of the importance of market trading and the need to exchange goods and services.

Figure 3.19

Respondents' Perception of Efficient Blockchain-based Payment System



Respondent's perception of CBN's statement that they propose introducing digital currency by the end of 2021

Analysis of the focus group data showed that 45% of respondents believed that the introduction of digital currency by the Central Bank of Nigeria (CBN) would stimulate the payment system in the financial industry. On the other hand, 35% of respondents thought it might have this effect, while 20% did not know as displayed in (Figure 3.20).

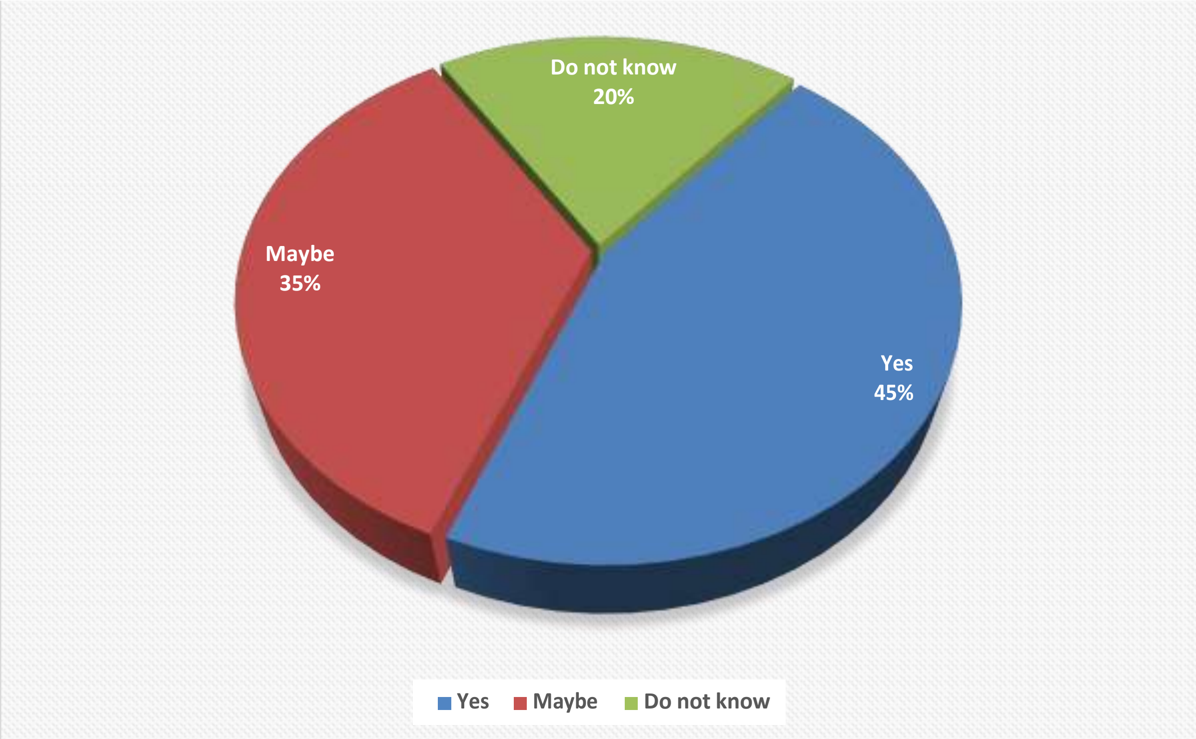
The main reasons for believing that digital currency would stimulate the payment system included the fact that it was coming from the regulator, the possibility of reduced challenges in carrying cash and faster transactions, increased security would match the possibilities of any attack and the possibility of a better payment option than currently exists. It was also mentioned that digital currency could be applicable in multiple industries and allow people to try something new.

One reason was that ***if it is properly implemented then the challenges of carrying cash will drastically reduce, payment for goods and services will be made with ease, and transactions will be delivered at a faster pace***.

On the other hand, some respondents mentioned that they were waiting for the digital currency to be introduced before making a judgment, an opportunity to try something new and different, another way of stimulating the system through the provision of incentives in the form of "helping" the society, while others expressed uncertainty about its potential effects. The quantitative data responses almost aligned with the qualitative data feedback, which implied a significant push for digital currency to be launched.

Figure 3.20

Respondent's perception of CBN's introduction of digital currency



Respondent's belief that the benefits of implementing blockchain technology outweigh the challenges.

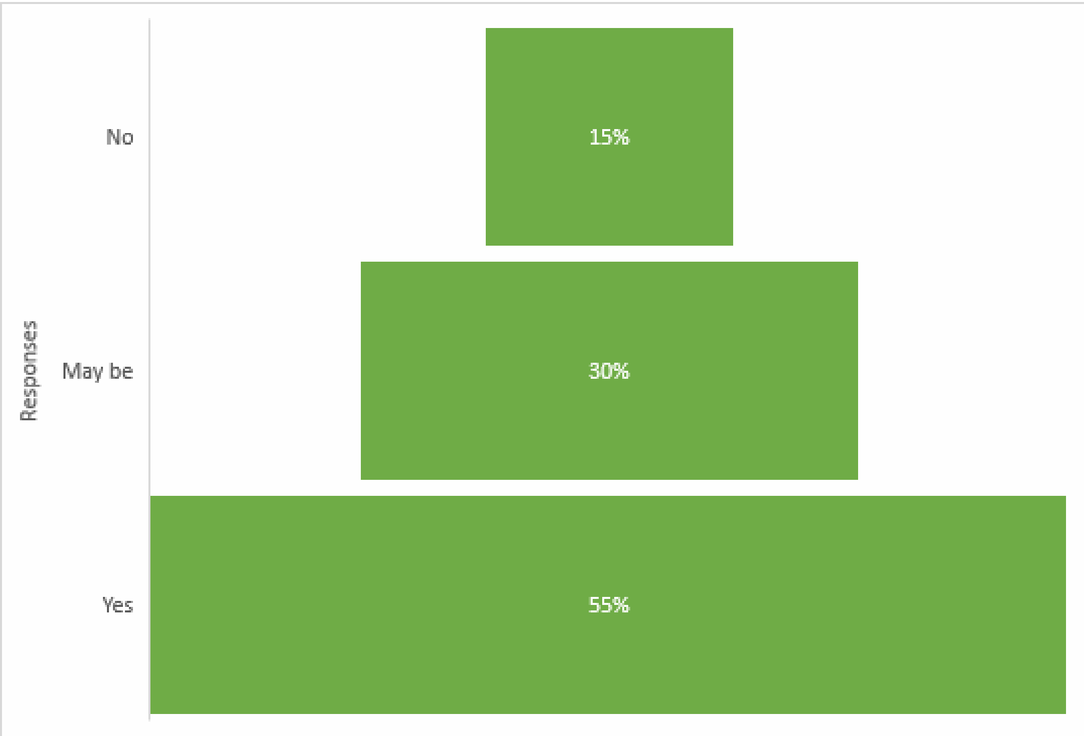
The analysis of the focus group data showed that 55% of the respondents believed that the benefits of implementing blockchain technology would outweigh the challenges. In comparison, 30% of the respondents thought that the possibility that the benefits would outweigh the compelling challenges is probable, while 15% of the respondents claimed not to be aware of whether the benefits of implementing blockchain technology would overshadow the challenges as displayed in (Figure 3.21).

The main reasons for believing that the benefits of blockchain technology would outweigh the challenges included the probability of it leading to greater transparency in transaction activities and the possibility of it presenting a better option than currently exists. It was also mentioned that blockchain could boost the economy and lead to a better tomorrow. Some indicated that the implementation would advance the financial landscape by limiting the circulation of cash if properly deployed in line with the global standard.

On the other hand, some respondents mentioned that they have no idea about the potential effects of blockchain technology. In contrast, others suggested that if the banking institution can be well managed, the challenges of implementing blockchain can also be managed. Over half of the respondents acknowledged that the benefits of using blockchain technology appear significant compared to the challenges inherent in the implementation. As stated above, 30% were neither here nor there and were pessimistic about the possibility of achieving the benefits, while the remaining 15% claimed ignorance of the benefits.

Figure 3.21

Respondent's belief that blockchain's Benefits outweigh the challenges



Research Question-3: How can the Central Bank of Nigeria regulate blockchain technology?

Respondent's perception of regulating the Blockchain/Cryptocurrency network

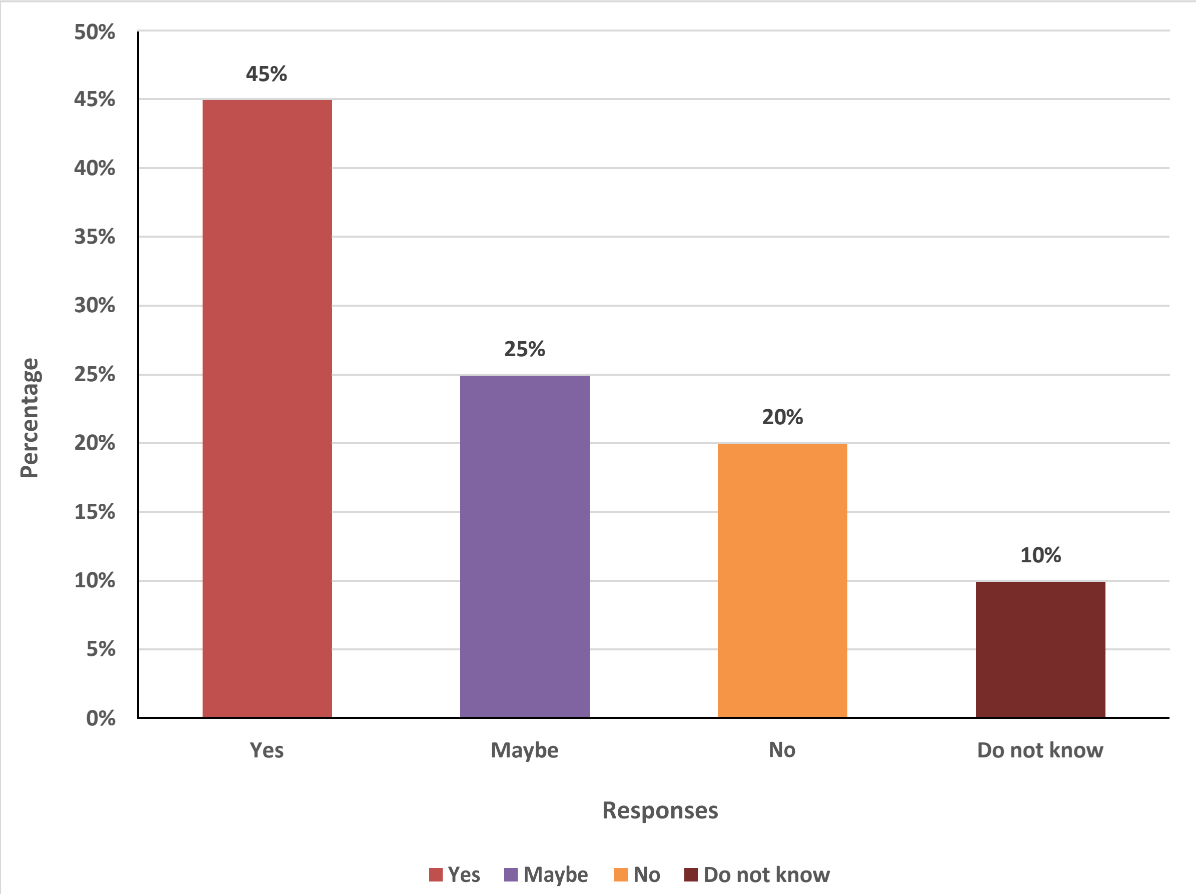
Almost half (45%) of the respondents believed that the blockchain and cryptocurrency platforms could be regulated. However, while 25% reasoned that it might be possible to regulate the blockchain network, 20% of the respondents did not believe it could be regulated. On the probable side, 10% of respondents assumed that they did not know how feasible it would be to regulate the platform considering the privacy of the transactions (Figure 3.22).

The main reasons for believing that the blockchain and cryptocurrency network can be regulated were the possibility of remote regulation and the introduction of new standards. Some respondents also suggested that new legislation should be created to regulate virtual currency in Nigeria. Every financial institution can be regulated if the responsible agency works diligently. Some of the respondents were of the view that since the platform was not solely owned by any government, the level of regulation by the authority would amount to a smaller percentage. One respondent envisaged that one can only be hopeful that regulation would be feasible considering the setup of the network.

On the other hand, some respondents mentioned that decentralizing the blockchain and cryptocurrency network makes regulation difficult. In contrast, others pointed out that it was currently not set up in a way that required regulation. However, there was this school of thought that regulation under a decentralized system was almost impossible compared to the centralized platform, where every registered member of the group was under the supervision of the central authority, and the issue of confidentiality was trivial (Subramanian et al., 2020).

Figure 3.22

Respondent's perception of regulating the Blockchain Platform



Respondent's opinion on the thorny issue of the regulation of the Blockchain / Cryptocurrency for global central banks

The regulation of the Blockchain/Cryptocurrency network has been a complex issue for central banks worldwide. According to the responses from the focus group data, there were a variety of opinions on how this issue could be addressed.

One common suggestion was the idea of remote regulation, where governments would allow citizens to operate cryptocurrency in banks and open crypto accounts, enabling transactions to be monitored through individual wallets. Other respondents emphasized the importance of new knowledge and constant engagement with stakeholders in achieving regulatory goals.

Some respondents believed self-regulation was the best approach, arguing that a central regulatory body was unnecessary. Others suggested involving key personnel from various industries in the regulatory process.

Table 3.18

Respondent's opinion on the thorny issue of Blockchain regulation

• Remote regulation
• Governments should allow their citizens to operate cryptocurrency in banks, open a crypto account and operate deposits and withdrawals seamlessly through their wallets so each transaction can be monitored
• New knowledge
• Constant engagement with stakeholders
• I believe it should be self-regulated. No need for a central regulatory body
• Involve key personnel in every industry
• No thoughts yet
• Legislation and specialized monitoring
• Setting up standards and limits
• I think that when the right people do the work, things will go well
• Regulation would be onerous because the blockchain is built on a system of decentralization
• The concept of cryptocurrency is decentralization, so regulations are, to an extent
• Regulators need to sit down with stakeholders to be able to draw up regulations for the industry

There were also suggestions for legislation, specialized monitoring to regulate the Blockchain/Cryptocurrency network, and the need to set standards and limits. Some respondents noted that the decentralization of the blockchain network made regulation difficult, while others emphasized the need for regulators to work with stakeholders to develop a comprehensive regulatory framework. Regulation by proxy involved contracting a consortium team that would include the banks to provide intermittent documentation about their customers to the Central Bank of Nigeria.

Table 3.18 shows the several reasons cited by the respondents on the issue of regulation by the central authority, which were pertinent considering the importance of regulation in the operations of the blockchain technology network to protect all stakeholders concerned.

Blockchain Technology Prospects

Respondents' opinion on Blockchain/Cryptocurrency/Bitcoin prospects should CBN approve the implementation.

Based on the responses provided, most respondents believed blockchain/cryptocurrency/ Bitcoin has enormous potential for the future. Specifically, 9 out of the 13 respondents expressed this opinion. This perception suggested that there was a strong belief among these respondents that blockchain/cryptocurrency/Bitcoin has the potential to impact various industries and sectors significantly. Additionally, three respondents believed blockchain/cryptocurrency/Bitcoin appeared to have some potential for the future. This assessment indicated that these respondents are somewhat less sure about the potential of blockchain/cryptocurrency/Bitcoin but still believed that it could have some impact in the future.

Finally, one respondent disagreed with blockchain/cryptocurrency/Bitcoin prospects. This feedback suggested that this respondent was unsure or neutral about the potential of these technologies.

Respondents gave various reasons for believing that blockchain/cryptocurrency/Bitcoin has enormous potential for the future. Some of the main themes that emerged from the responses include the potential for proper regulation to help these technologies thrive, the disruptive nature of blockchain technology, and the belief that more excellent knowledge about these technologies will lead to their success.

Several respondents also emphasized the potential for blockchain/ cryptocurrency/ Bitcoin to contribute to the digital process and increase transparency in transaction activities. Some respondents also mentioned the potential for these technologies to improve the economy and create wealth and employment.

Other respondents cited that blockchain/cryptocurrency/Bitcoin would likely become more popular regardless of regulatory decisions and that the Internet was improving things. Finally, one respondent noted the potential danger of blockchain/cryptocurrency/Bitcoin if they were not adequately controlled.

Some of the respondents' statements are quoted as follows:

"Blockchain is a disruptive Technology and should be allowed to thrive in our country to aid the development of both man and infrastructure" was given as a reason for choosing the option of blockchain/cryptocurrency/Bitcoin having an enormous potential for the future.

"Cryptocurrency is going to happen irrespective of the central regulatory agencies like CBN. It will evolve into a form that people feel secure, and once all the features like power, etc., are available, and there can be a way to do without central agencies like the CBN, then it will catch on to a much greater degree."

"It will lead to greater transparency in transaction activities."

"No harm with trying".

"Improve the economy and create wealth and employment."

"It looks promising."

"With the internet, things are getting better."

"If not controlled, it can be deadly in the hands of Nigerians."

Summary of Chapter Three

The expected outcome of the data collection and analysis of the research study was to ascertain the effects and propose implementing blockchain technology as a payment medium in the Nigerian financial industry. The possible potential was to recommend appropriate measures, among which was the proposal of using CBN *e-Naira* to make payment transactions between financial institutions and the Central Bank of Nigeria, regulating the participants and transactions of blockchain technology platform by a consortium of regulators through the Financial Services Regulatory Coordinating Committee (FSRCC). The FSRCC is an inter-regulatory agency constituted to support public interest matters and concerns to the various regulators and supervisors in the Nigerian financial services industry (FSRCC, 2021). The body comprised banking, pension, insurance, corporate affairs, securities and exchange commission regulators.

The data collection tools varied from the method adopted in the research study, as qualitative and quantitative methods have been implemented (Mkandawire, 2019). The online survey questionnaire was designed for quantitative and qualitative-focus group using the survey forms to collect the data (Vogl et al., 2016). Jamovi statistical software was adopted to analyse the quantitative data, while the Qualitative Data Analysis (QDA) software was used for the focus group data. At the same time, the sample population was targeted at blockchain professionals working in the Central Bank of Nigeria and a focus group of blockchain operators and investors in the private sector.

Survey questionnaires were drawn from the research questions, while the data collected were linked to the topic of the research study and answers to the research questions. Power analysis was used to estimate the sample size of the population in the Central Bank of Nigeria and the focus group operators in the WhatsApp platform. Participants were recruited randomly through a link forwarded to their email accounts with a convincing ethical assurance that the mail was not a phishing email and that all respondents would be anonymous. A sampling procedure was followed in the design of the survey questionnaires to ensure data reliability and validity.

Chapter 3 involved various sections of research approach and design, including the research method, research problem, research purpose statement and methodology of the research technique. The other area was research methods and data collection, which focused on the tools used.

Submitting the doctoral studies REAF form, informed consent, research tools (survey questionnaires), and gatekeeper to the Unicaf Research Ethics Committee (UREC) for final approval followed intermittently as corrections and requests for more document details in the REAF form were accomplished. This chapter also involved the population and sample of the research study, which comprises the sample population, power analysis, participants' recruitment, and sampling procedure.

The data collection summary was about completing the template involving the type of survey used, distribution method, the date the survey was issued and completed, number of respondents that participated, kind of respondents and location.

The material/instrumentation of research tools section was about the operational definition of variables, study procedure and ethical assurances, principles of an ethical approach to the research project and ethical assurances. The data collection and analysis section included the steps adopted, statistical software, types of data collected, data analysis method and research questions.

The data analysis findings can be traced through the research questions up to the topic of the research study. From the respondents' feedback, there was a general perception that cryptography was strong enough to secure transactions against cyber-attacks, including other cybersecurity applications developed to protect transactions from threats in the blockchain network. The confidence exhibited by the respondents on this issue was encouraging since most of them hypothetically perceive a relationship between blockchain cybersecurity applications and cyberattacks.

The outcome of using blockchain technology to facilitate payment was overwhelming as most respondents were confident and hopeful of an efficient payment system when implemented. Launching the CBN digital currency attested to this possibility since there was a clear correlation between conventional and digital payment. Other related payments included financial inclusion, remittances, tax revenue generation and cross-border trading.

Another pertinent analysis was the blockchain technology regulations, in which most respondents affirmed that it was possible even to proffer some modalities to achieve this. Of importance is the suggestion that regulation could be made effectively through proxies and financial institutions. Most admitted that challenges there were regulating decentralised platforms, but remote regulation through proxies could be very effective.

CHAPTER 4: RESEARCH FINDINGS

4.1 Trustworthiness of Data

Data trustworthiness was a key factor from the conception of this research study, along with the data collection process, data analysis, and outcome, as it aligned with the study's objectives. **The trustworthiness** of data was fortified through the identity of the sample population and the method of collecting data. The integrity of the data source was not in doubt, as professional bankers were the bulk of the sample population, along with blockchain investors and operators. Participants from the Central Bank of Nigeria were mandated to log in to their work-tool devices to participate in the online survey questionnaire.

4.2 Reliability and Validity of Data

The licensed Microsoft forms were used to design the survey questionnaire and grant access to participants after login in with the username and password. Pouryazdan et al. (2017) maintained that **credibility** can only be guaranteed if consistency and legitimacy are utilised. They postulated that trustworthy content analysis means the outcomes are "***worth paying attention to***" (He et al., 2015). Most research study participants were identified as *bonafide* staff of the Central Bank of Nigeria.

The data provided through the survey questionnaire were dependable and could stand the test of time under varying circumstances. The data collected were firm and solid and remained consistent when analysed repeatedly in different conditions. They were undoubtedly recognised so that when studied in various states, the elucidations would be similar in the outcomes (Sheehan et al., 2020). They implied the result would be comparable and related when analysed across multiple developers.

Reliability Testing

Reliability refers to the consistency or stability of a measure. A reliable measure produced similar results under consistent conditions. There were several types of reliability, and each has its corresponding formulas:

Test-Retest Reliability: Assessed the consistency of a measure over time and it is calculated using the correlation between scores at Time 1 and Time 2.

Parallel Forms Reliability: Assessed the consistency of different versions of a test and it is calculated using the correlation between scores on two different forms of the test.

Internal Consistency Reliability: Assessed the consistency of results across items within a test.

Cronbach's Alpha was a common measure:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k}\sigma_{Y_i}^2}{\sigma_X^2}\right)$$

where k is the number of items, $\sigma_{Y_i}^2$ is the variance of item i, and σ_X^2 is the variance of the observed total scores.

Validity Testing

Validity refers to the accuracy or truthfulness of a measure. A valid measure measured what it was supposed to measure. There were several types of validity, and methods to assess validity often relied on logical or empirical evaluation rather than specific formulas:

1. **Content Validity:** Ensured the measure covered the full range of the construct's meaning. Evaluated through expert judgment and logical analysis.
2. **Criterion Validity:** Correlated the measure with an external criterion. Calculated using the correlation between the measure and an external variable.

3. **Construct Validity:** Verified the underlying structure of the construct. Assessed through factor analysis or other statistical modelling techniques.
4. **Convergent and Discriminant Validity:** Assessed the degree to which measures of constructs that theoretically should be related are related. Evaluated through correlation and factor analysis.

Based on the research questions and hypotheses:

Current Blockchain Applications: Facilitating payment and providing cybersecurity (RQ-1, H-1).

Blockchain Technology for Regulations: Adoption within the Central Bank of Nigeria (RQ-2, H-2).

Research Question and Hypothesis H-1:

Blockchain Payment Applications: Variable identified "Blockchain payment application."

Cybersecurity: Variable - "Perception about blockchain cybersecurity"

Research Question and Hypothesis H-2:

Centralized Regulations: Variable - "blockchain_regulation" and "cbn_regulate_process."

Based on the correlation matrix, these groups were tested:

Group 1: Related to organizational experience

"age" (may need clarification on the meaning)

"Years in the organization"

Group 2: Related to perceptions about blockchain

"Perception about blockchain cybersecurity"

"Blockchain payment application"

"Blockchain regulation perception"

The Cronbach's Alpha for Group 1 (related to organizational experience) was approximately 0.0093, indicating very low internal consistency. This suggested that the variables in this group may not form a coherent scale. However, they can be ignored since they were not correlated and less relevant to the study objectives.

The Cronbach's Alpha for Group 2 (related to perceptions about blockchain) was approximately 0.089, also indicating low internal consistency. This suggested that the variables in this group may not form a coherent scale either.

On **confirmability** of data, they posited that research outcomes go through the *audit trail*, *internal audit*, *external audit* and the concluding research statement, which was corroborated by (Saunders et al., 2019). The audit trail is a complete compilation of data collection and analysis tasks, including the intermittent alterations and the basis for the modification. Pouryazdan et al. (2017) expressed that internal audit is the codification and assessment of relational and differential data provided by the respondents. An external audit is a situation where a researcher who was not connected to the study reviews the process bearing in mind some pertinent questions relating to the objectives of the research study (Ng et al., 2018). This audit was accomplished in the course of scrutinising the data collected. As proffered by He et al. (2015), the last process was the compilation of the final research report, which is composed in such a manner as to snowball the confirmability of the study.

This report underlined the **limitations** and proffered a close connection between the study's outcome and the participants' real experiences by stipulating their perceptions in their own words. Hughes et al. (2019) and Tandon et al. (2020) surmised that a typical research report must reflect the limitations and envisage the distinctive experience of the contributors, which was done in the study's data analysis. The major constraint was the inability of the researcher to get enough feedback from respondents in the blockchain investment and operational landscape. Despite the series of reminders forwarded to them in the focus group platform and considering the limited time, only about 20 could respond. However, their responses were so detailed since the survey questionnaires circulated to them were more open-ended questions. Another shortcoming was the narrow scope of the participants from the Central Bank of Nigeria, even though they were spread across various departments related to the external stakeholders in the blockchain technology arena.

Transferability is also related to dependability regarding what the study aims to achieve. The data analysis was done so that people could generally conduct a comparative assessment of their actual situation vis-à-vis that of the study (Vaismoradi et al., 2017). Comparing data allows participants to review the data provided and their natural "live" situations. The researcher explored the data collected repeatedly to ensure consistency and perception of the participant's responses.

Dependability connoted data constancy over time and under various situations, as posited by Bellini et al. (2019) while focusing on the explicit objectives to accomplish (Hai et al., 2020). They implied that the duration of time affects data stability, primarily when thorough observation was not used to collate the data. So the implication was that there was bound to be instability when changes are observed over a certain period. However, Guest et al. (2018) stated that data dependability would be questioned when not adequately secured. The researcher ensured that the data collected were without any alteration whatsoever.

Dependability was synonymously aligned with reliability because reliable data can be dependable, according to Ferguson et al. (2018). The data collected are trustworthy because of the reliability attribute associated with the data. Bellini et al. (2019) inferred that if data from the *Internet of Things* (IoT) platform can be relied upon, then the data that would ride on blockchain technology should also be dependable.

Variable constructs defined domains and structures with various changeable values, including demographic, social, behavioural or physical (Ellen, 2016). The demographic variables used in this study were familiar and straightforward, such as gender and age. There were others closely related to the objectives and title of the study on blockchain technology implementation effects in the Central Bank of Nigeria and, most notably, the research questions. Variables are treatise issues for numbers and objects (Albayati et al., 2020). The essence of variables was to support the hypothesis in statistical assessments to identify prospective flaws and clarifications of data collected and analysed.

4.3 Results

The research outcomes from the online surveys conducted for Central Bank of Nigeria staff and blockchain operators through a focus group were clearly stated in this paragraph. The research results were tailored around the research questions and hypothesis following a similar structure of the introduction, methodology and data analysis. This section was centred on the deductions from the data analysis drawn from the survey questionnaires and tied to the research questions and hypothesis described in the previous chapter along with the research objectives and literature review where necessary. The results and evaluation of findings were picked from the demographic information, blockchain status, blockchain cybersecurity applications, blockchain payment, blockchain regulation tips and prospects of the blockchain technology.

The results gathered aligned with the objectives of the study, which introduced the modalities for the implementation of blockchain technology in the CBN. This proposal was to provide a guide and stipulate the viability of deploying blockchain technology in the financial industry.

It was based on this backdrop that online survey questionnaires were developed through the literature review which focused on the definition, historical, prevailing, and future perception of blockchain technology. As stated in the previous chapter, the data collected were analysed using the appropriate statistical software tools that were configured and utilised to analyse the data collected. The presentation of the results as stipulated below was structured in strategic order in tandem with the research questions and hypothesis.

4.3.1 esults

Quantitative Demographic Information

The demographic data received from the respondents include gender, age, current employment/business level, business role, number of years in the organisation and number of years of the organisation. The information feedback aligned to implement the blockchain technology by users that are males and females with ages ranging above 20 and less than years. All the respondents are gainfully employed and categorised in the junior, middle, senior and executive cadres. The number of years participants have worked in the organization varied from a few months to 35 years, which is the required maximum number of years a civil servant is expected to work. The number of years the organization has been in existence since 1959.

Table 4.1

Quantitative Demographic Information of Respondents

Variable	Parameter	Frequency	Percent-%
Gender	Male	554	72.4
	Female	211	27.6
Age category	20 - 29	72	9.4
	30 - 39	310	40.5
	40 - 49	239	31.2
	50 - 59	144	18.8
Employment level	Senior/Executive Management	404	52.8
	Middle Management	204	26.7
	Junior Management	157	20.5
Years working in the current organization	0-10 years	488	63.8
	11-20 years	153	20.0
	>20 years	124	16.2
Total		**765**	**100.0**

The above table showed the gender representation of those who participated in the survey, with 72.4% males and 27.6% females. The total number of respondents that participated in the online survey was 764, with 553 males and 211 females. The number of males was more than double that of females. As stated previously, the level of interest and awareness is dominant among the males than the females. Besides, the number of males that got the survey questionnaire reflected the gender composition in the organization.

As stated in the previous chapter, the extensive gap between females and males was largely due to perception and the degree of interest by both genders. It was noted that the females exhibit less interest in blockchain technology than the males. Besides, the actual population showed fewer females than males in those locations where the survey was

forwarded to the participants. Likewise, it is pertinent to note that there are fewer females than males in the organization of the respondents as the staff composition is tilted more to the males than the females.

On the age result of the participants, the minimum age of the respondents was 22, while the maximum was 59. Recall that it was indicated that the minimum age would be 18 in the Final Research Ethics Application to the Unicaf Research Ethics Committee (UREC) submitted. However, 24 respondents did not indicate their age, while 741 provided theirs. The frequency of the participant's age is analysed and stipulated in the appendix.

The age result fell within the range stipulated to the UREC, which is 18 and above; no underage person was a participant. So, there was the need to fill out the guardian informed consent form as it was unnecessary under this circumstance. However, it is necessary to highlight that the participants were all adults.

On the employment/business status of the participants, 755 (99%) of the 763 that responded were full employees of the organisation, four (4) of the respondents were into full business engagement, three (3) were partly into employment and business engagement, four (4) were seeking opportunities and two (2) did not respond.

The overall employment/business status revealed the capabilities of the participants to respond appropriately to the survey questionnaires, which was achieved accordingly.

The respondents provided the business/employment level of the participants in six categories, including the others as indicated. The six categories were Junior Management, Middle Management, Senior/Executive Management, Corporate Business, SME Business and Others, as specified by the respondents. The "others" category stated by the respondents includes Clerk, Driver, Junior Cadre, Junior Staff (3), Junior, Senior Staff and Senior

Supervisor (2). It can be deduced from the above table that 399 (52.8%) of the 755 respondents were in senior/executive management, while 193 (25.6%) were in middle management and 147 (19.5%) were in junior management. Three (3) are in the corporate business, while one (1) is in the SME business, and ten (10) did not respond.

Overall, the business/employment level was spread across various cadres of the business, indicating the variety of professional backgrounds of the respondents.

On the business role feedback provided by the respondents, the categories presented in the questionnaires included Financial Management, Banking Administration, Accounting Management, IT Management, Research and Statistics Management and Others. From the descriptive table shown in the appendix, 155 (21.6%) are in the financial management profession, 298 (41.6%) represent the banking sector, accounting management gathered 36 (5.0%) respondents, information technology (IT) professionals raked in 15 (2.1%). In comparison, 59 (8.2%) respondents came from research & statistics management. Other professions, including various occupations ranging from the medical profession and legal to project management, strategy represented 153 which is 21.5%. The complete list of the other professions can be found in the appendix section.

The respondents cut across several business roles as stipulated above, resulting in the fact that most participants who participated in the survey were engaged in diverse roles.

The number of years the participant's organisation has been in operation was part of the feedback provided by the respondents. Six hundred forty-four (644) participants responded with different years, with the least being three years and the maximum being hundred (100) years. The average years of operation were 59 years and four (4) months, while the median was

62 years, and the standard deviation was 11 years. However, 121 did not respond to this question.

The average year of operations of the organizations where the respondents were working showed the experience they have been operating. This revelation indicated that this must have influenced their responses to the survey.

The number of years the participants have spent in the organisation; the minimum was two (2) months as the respondents just resumed work recently, while the maximum was 63 years. It is perceived that this respondent should be in their late eighties or early nineties. A review of this feedback shows the possibility that the respondent confused the question with the number of years the organisation has been in operation. The average years of the participants in the organisation were ten (10) years and seven (7) months, while the median was eight (8) years, and the standard deviation was 9.37 years. The number of respondents who did not answer the question was 26.

The average year of participants in their organizations revealed the years of business experience, which boosted their responses. It was worth noting that while some participants garnered most of their working years' experience from the organization, others had worked in several organizations previously. Mobility of staff especially in the financial sector was germane to elevation in career paths. For example, most staff seldom work in a bank for more than three years or even less before moving to other greener pastures where better offers must have been provided.

The purpose of implementing an initiative was dependent on the quality of staff in that organization and as such the feasibility of a successful deployment of the blockchain technology is prosperous. The age of a new staff above 40 years was an indication that the participants must have worked in other organization(s) before resuming in the CBN.

Qualitative (Focus Group) Demographic Information

Table 4.2

Demographic characteristics of focus group discussion participants

Parameter	Response	Frequency	Percentage
Gender	Male	17	85%
	Female	3	15%
Age	0 - 29	9	45%
	30 - 39	5	25%
	40 - 49	5	25%
	50 - 59	3	15%
Business/Employment Status	Fully Employed	7	35%
	Full Business Engagement	5	25%
	Retired/Pensioner	1	5%
	Seeking Opportunities	3	15%
	Student	1	5%
Business/Employment Level	Senior/Executive Management	4	26.70%
	Corporate Business	3	20%
	Middle Management	6	40%
	SME Business	2	13.30%
	Student	1	6.70%
Business/Employment Roles	Banking Administration	2	11.10%
	Financial Management	5	27.80%
	Engineering personnel	1	5.60%
	Office Management	1	5.60%
	Research & Statistics Management	2	11.10%
	Business Development	1	5.60%
	IT Management	3	16.70%
	Health Management	1	5.60%
	Partnership Management/Liaison	1	5.60%
	Services	1	5.60%
	Medical	1	5.60%

As stated in the previous chapter, the focus group gender information, twenty (20) respondents provided feedback from the various blockchain groups in the WhatsApp platform of investors and operators in the cryptocurrency landscape. Sequel to the response provided, seventeen (17) respondents were males, while three (3) were females. Like the non-focus group's survey feedback, the females gradually show interest in blockchain technology, though at a superficial level, while that of the males is 85% of the females 15%. The involvement of the females is a clear indication that, in the foreseeable future, it would become a context of superiority between both genders.

The demographic gender result reflected the quantitative data findings where more males than females participated in the survey despite the questionnaires being forwarded to an almost parallel mix of males and females. The participation was anchored on the interest of both genders in blockchain technology despite the wide disparity in the focus group.

On the focus group's age result of the 20 participants, the minimum age of the respondents was 18, while the maximum was 57. However, only one (1) respondent did not indicate the age, while 19 provided theirs. The median of the respondents' age is 39, the mean is 37.5, and the standard deviation is 12.9. The frequency of the focus group's participants' age is analysed and stipulated in the appendix.

The focus group age result of the participants also followed the age range as submitted to UREC, which was a minimum of 18 years of adulthood and 57 years, as reflected by respondents. As stated earlier, it was needless to accommodate guardian-informed consent when the participants were all adults.

On the feedback from the focus group on employment/business status, nine (9) of the twenty respondents were fully engaged in employment, six (6) were fully involved in business, four (4) were seeking opportunities, and one (1) is a retired pensioner, as shown in the table above.

The overall result showed a mix of business, employed participants, opportunity seekers and pensioners, indicating that the coverage was well-spread and holistic among the respondents. It was also an indication that the participants were engaged in one business or the other including those seeking opportunities. The retired pensioner was experienced enough to respond to the survey questionnaires and decide on the objective of the study.

The business/employment level of the focus group respondents was almost like the quantitative data survey as the variance was in the middle management, which recorded eight

(8) respondents. Respectively, the corporate business and senior/executive management got four (4) respondents. The small, medium and enterprise (SME) received two (2) respondents, while one (1) respondent was a student, and the other did not specify the business/employment level.

Overall, the business/employment level was distributed across various business cadres, indicative of the kinds of professional backgrounds of the respondents. The career status of the participants was germane to the quality of the data collection in the sense that the background qualification added impetus to the choice of the respondents. It showed the enlightenment and propriety of the participants in achieving the objectives of the study.

On the focus group feedback, participants responded to their role in banking administration (2), financial management (5), IT Management (3), research & statistics management (2), account management (0) and others recorded (1) respondent each in the areas of business development, engineering, health management, medical, office management, partnership management and services.

The overall result on the business/employment role showed a spread across various business units illustrating the categories of the professional background of the respondents. The diverse business roles were an indication that participants were drawn from various disciplines, which must have contributed to their impulse in responding to the survey questionnaires and added value to meeting the aim of the study.

On the years and months, the organisation where the participants have been doing business from the focus group (19) respondents, only the four (4) respondents seeking opportunities did not record any number of years and months; hence the minimum is 0.0 while the full years the organisation has been in business is 72 years. Only one participant did not respond to that question; while the mean is 19 years and one (1) month, the median is eight (8) years, and the standard deviation is 23 years and six (6) months.

As compared to the quantitative data, the average year of operations of the organizations where the respondents were working shows the experience they have been operating in the blockchain market. This feedback was a clue that this must have prompted their responses in the survey and impacted the goals of the study.

The years and months the participants have spent in their various organisations from the focus group (19) respondents, the same four (4) respondents seek opportunities as observed in the previous table. Since they have not commenced any business activities, the number of years and months is zero. In contrast, the maximum number of years the participant has spent in the organisation is 35 years, the total number of years a civil servant can spend in service. However, in business, it could be more than that. In line with the previous table, only one participant did not respond to that question, while the mean is 8.55, the median is five (5) years, and the standard deviation is ten (10) years and two (2) months.

As with the quantitative data, the average year of participants in their organizations revealed the years of experience in the business, which added value to their responses. This was a positive reflection of their background in terms of the period of service in the blockchain technology business.

4.3.2 Results and Research Questions

Research Question-1:

What are the current blockchain applications that are developed on cyber security to mitigate cyber-attacks?

Cyber-attacks cannot be detached from Blockchain technology since the platform is a web-based application network, as devices used to connect to the internet are the medium through which these attacks are lacerated. Gulati et al. (2020) stated that these cyber-attacks are getting more complicated to prevent as the internet becomes very busy with cyber transactions. They posited that cyber security must be a step ahead of cyber attackers to protect the web asset. It was proposed by Liang et al. (2019) that a data protection framework should be developed for every cyber application to thwart the attacking efforts of cyber attackers.

Table 4.3

Blockchain Status - Awareness of Blockchain/Cryptocurrency (Bitcoin)

Levels	Counts	% of Total	Cumulative %
No	61	8.0 %	8.0 %
Yes	699	92.0 %	100.0 %

Quantitative Results: From the respondents' feedback, it was gratifying to deduce that most of them are aware of blockchain technology as this was the starting point to be mindful of what was at stake. 699 of 765 responded with an affirmative "Yes" that they know blockchain, cryptocurrency, or Bitcoin, while 61 or 8.0%, responded unaware of it. The result of this question indicated that the generality of the populates is in the know of blockchain technology. Therefore, the knowledge of playing safe in the blockchain technology network should not be lost on the participants.

Table 4.4

Focus Group – Awareness of Blockchain/Cryptocurrency (Bitcoin)

Levels	Counts	% of Total	Cumulative %
No	1	5.0 %	5.0 %
Yes	19	95.0 %	100.0 %

Qualitative (Focus Group) Results: The same applied to the focus group's feedback on the awareness of blockchain and cryptocurrency (Bitcoin), where 19 of the 20 respondents indicated that they were aware of it. Only one (1) respondent indicated non-awareness of blockchain and cryptocurrency out of the 20 participants.

This blockchain awareness can be attested to in the feedback by the respondents on the level of blockchain knowledge they have developed. It was reassuring to note that the understanding of blockchain technology is still above average, considering the participants' responses as shown below:

Mixed Results: The overall result indicated that on average the general awareness of the participants on blockchain technology including cryptocurrency (Bitcoin) was relatively overwhelming with over 90% of the respondents indicating that they are aware of the network. With this outcome, it became apparent that the responses of the participants in subsequent survey questions were predicated on the fact that they were cognisance of their perception of blockchain technology.

Knowledge of Blockchain Technology and Cryptocurrency (Bitcoin)

Quantitative Results: The result showed that the knowledge of blockchain and cryptocurrency (Bitcoin) from the respondents was comparatively extensive on the statistical premise that their knowledge cuts across over 47% of average, 9.1% of high knowledge of respondents, 2.1% of very high knowledge of participants, 35.6% of very low knowledge of respondents and 6.2% of participants who claimed that they do not know (Figure 4.5):

Table 4.5

Knowledge of Blockchain/Cryptocurrency (Bitcoin)

Levels	Counts	% of Total	Cumulative %
Average	359	47.1 %	47.1 %
Do not know	47	6.2 %	53.3 %
High	69	9.1 %	62.3 %
Very high	16	2.1 %	64.4 %
Very low	271	35.6 %	100.0 %

Qualitative (Focus Group) Results: The knowledge of blockchain and cryptocurrency (Bitcoin) from the focus group respondents was relatively widespread based on the statistics that their knowledge spreads across 11 participants indicating an average understanding of blockchain. Three (3) each specified that they have "high", "very high", and "very low" knowledge of blockchain, respectively, as displayed below:

Table 4.6

Focus Group - Knowledge of Blockchain/ Cryptocurrency (Bitcoin)

Levels	Counts	% of Total	Cumulative %
Average	11	55.0 %	55.0 %
High	3	15.0 %	70.0 %
Very high	3	15.0 %	85.0 %
Very low	3	15.0 %	100.0 %

Mixed Results: The overall result was statistically like the blockchain awareness in the previous section as all the participants knew the blockchain technology though in different categories with the average knowledge category indicating over 45%. This outcome was an indication that all the respondents had the prerequisite information about blockchain technology, cryptocurrency or bitcoin.

Blockchain Cyber Security and Cryptography

Cryptography enabled securing transactions in Internet applications by broadening the visual flow of commerce and providing secure critical infrastructure networks (Kosba et al., 2016). According to Menezes et al. (2018), cryptography was captivating apparently because of the alignment of the theory and practical aspect of the cryptographic application. However, the application of cryptography was a process that involved communication, confidentiality, authentication, digital signature, obscurity, synchronisation and collaboration in strict adherence and purpose against any cyber foe (Syed et al., 2019).

Quantitative Results: The respondents' feedback on whether cryptography is resilient enough to protect transactions against cyber-attacks was quite ambiguous and nebulous, as 43.1% do not know much about the effectiveness of cryptography. In comparison, 23.2% were assertive that it was strong enough to provide safety for transactions on the network. The lack of adequate knowledge of the meaning of cryptography could be the reason for the feedback.

Table 4.7
Blockchain Cyber Security and Cryptography

Levels	Counts	% of Total	Cumulative %
Do not know	329	43.1 %	43.1 %
No	257	33.7 %	76.8 %
Yes	177	23.2 %	100.0 %

Cryptography aims to prevent third-party prying on the conversation between two people in an unsecured environment (Menezes et al., 2019).

Qualitative (Focus Group) Results: In the focus group's feedback on using cryptography to secure transactions in the blockchain network against cyber-attacks, 45% of the respondents were optimistic about the process. In comparison, 35% indicated they knew nothing about it, and 30% were probable. None of the respondents provided feedback that it wasn't possible.

Table 4.8

Focus Group - Blockchain Cyber Security and Cryptography

Levels	Counts	% of Total	Cumulative %
Do not know	7	35.0 %	35.0 %
May be	4	20.0 %	55.0 %
Yes	9	45.0 %	100.0 %

Reasons for their Choices: The explanations tendered for their choices in the focus group's feedback include too many ***uncertainties*** in the network and a lack of ***adequate knowledge*** about cryptography and blockchain cyber-security applications.

Mixed Results: Overall, it appeared that respondents were uncertain about the ability of cryptography to secure blockchain and cryptocurrency networks against cyber-attacks. Some people thought it was enough, but others were not sure or thought that it might be sufficient, other technical issues may affect how safe the network platform is. Relatively, the use of blockchain/cryptocurrency in cybersecurity was not well-known or thought-out among the respondents surveyed.

However, the result from the focus group respondents showed that the level of cryptography as a basis for securing the blockchain network against cyber-attacks was 45%, which is on average.

On a general note, cybersecurity application was a technical term that requires some level of understanding and a lack of it among the participants, will skew their responses. The fact that a participant was unaware of an initiative implies that the response would either be negative or “do not know”. Together, they constitute between 70% and 95%, affirming the lack of adequate knowledge of the cyber security application.

Blockchain Cyber Security Applications

Cyber security risk management was not a straightforward issue as the challenges emanating from the attendant risks are overwhelming even for experienced insurers, according to (J. Dai et al., 2017). They posited that analysing the self-protection level vis-a-vis the risk of a potential loss is challenging to correlate with breaches. Taylor et al. (2020) suggested that risk mitigation of the cyber network should be approached strategically and collaboratively among various organisations. They opined that information through cyber-risk consultation, communication, and assessment was crucial in mitigating cyber risks, just as the intruders also search for information to perpetuate their fraudulent activities, as corroborated by (Taylor et al., 2020).

Quantitative Results: The response to developing a cyber-security application to mitigate cyber-attacks varies from the respondents' perception. 57.8% of the respondents affirmed their belief, 20.6% claimed they did not know, 7.5% specified that it was probable, and 14.1% indicated 'No'. The overall feedback shows that the knowledge of applying cyber security applications to alleviate threats of cyber-attacks is quite feasible and doable, which is quite encouraging.

Table 4.9

Blockchain Application developed on cyber security to mitigate attacks

Levels	Counts	% of Total	Cumulative %
Do not know	157	20.6 %	20.6 %
May be	57	7.5 %	28.1 %
No	107	14.1 %	42.2 %
Yes	440	57.8 %	100.0 %

Qualitative (Focus Group) Result: As the above result is positive, the focus group's feedback negates this positivity. Over half of the respondents stated that they do not believe cyber-security applications were developed to alleviate these attacks' threats. In the focus group's response, participants believed that cyber security applications may not alleviate cyber-attacks as 60% indicated that school of thought, while only one was confident that it would diminish any cyberattack. However, 35% implied that they knew nothing about the possibility.

Table 4.10

Focus Group - Blockchain/Cryptocurrency Cyber Security Applications

Levels	Counts	% of Total	Cumulative %
Do not know	7	35.0 %	35.0 %
No	12	60.0 %	95.0 %
Yes	1	5.0 %	100.0 %

Reasons for their Choices: Most respondents gave their individual choice due to their lack of awareness of any developed blockchain technology cyber security application. However, some indicated that they knew nothing about cyber-security applications.

Mixed Results: On average, there were over 50% of respondents affirmed that blockchain cybersecurity applications are protective enough to secure data transactions.

Mitigation of Risk Using Blockchain Applications

The apprehension of Bouveret (2018) was that cyber risk in the financial sector was becoming a grave and ongoing concern. This trepidation resulted from the lack of adequate data on cyber-attacks from those affected due to systemic and reputational risk. Cyberattack is more severe disruption and actual losses, likening to the COVID-19 pandemic and accompanying fatalities.

Financial cyber risks were information technology assets with severe concerns touching on information security attributes of ***confidentiality, integrity and availability*** of information systems (Choo et al., 2020).

Quantitative Results: On the risks associated with blockchain applications, almost 60% of the respondents held that these could be mitigated, while 9.7% claimed they were unsure of that possibility. However, 7.3% were plausible in their feedback, while 24.6% responded that they do not know about that possibility, as shown below:

Table 4.11

Mitigation of risks associated with Blockchain applications

Levels	Counts	% of Total	Cumulative %
Do not know	188	24.6 %	24.6 %
May be	56	7.3 %	32.0 %
No	74	9.7 %	41.7 %
Yes	445	58.3 %	100.0 %

Data protection in the cloud was synonymous with shielding data in the blockchain network, according to Wang et al. (2019), since data is warehoused in the cloud. He implied that blockchain would engender a relatively low exposure to fraudulent activities by hackers as blockchain identity and access management applications can fortify network vulnerabilities by tracking susceptible breaches in the value chain. Ajayi and Saadawi (2020) posited that one of the ways to protect data is to develop intrusion detection systems to track cyber-attacks on time. However, harmonised attacks may not be spotted early enough, exposing the network to vulnerabilities. They proposed that a coordinated intrusion detection system to segment the potential attacks would go a long way in protecting data though this approach may not be foolproof. (Ramanan et al. (2020) proposed a blockchain-based distributed framework for sensing coordinated rerun attacks through completely isolated data sensors by developing a ***Bayesian Inference Mechanism***.

Qualitative (Focus Group) Results: In the focus group's feedback on mitigating risks associated with blockchain applications, three (3) of the 20 respondents specified that they knew nothing about the extenuation of risks. At the same time, five (5) implied that there was every probability that this could be achieved. However, two (2) indicated that it would not be possible to accomplish the feat, while nine (9), or 47.4%, specified that the risks associated with blockchain could be alleviated. When organisations collaborate on a shared vision of preventing or reducing cyber-attacks to the barest minimum, it can be realised (Farion et al., 2019; White & Daniels, 2019).

Table 4.12

Focus Group - Mitigation of risks associated with Blockchain applications

Levels	Counts	% of Total	Cumulative %
Do not know	3	15.8 %	15.8 %
May be	5	26.3 %	42.1 %
No	2	10.5 %	52.6 %
Yes	9	47.4 %	100.0 %

Reasons for their Choices: The reasons submitted by the respondents varied from using cryptography to ***monitoring the network***. Others believed ***every risk could be mitigated***, while one respondent stated that; ***the standards and policies should be built around the blockchain network***.

Mixed Results: The overall result on the risk mitigation showed that there is a belief among some respondents that the risks associated with blockchain/cryptocurrency/Bitcoin applications can be effectively addressed through a combination of technology, proper management, and oversight. There was a strong perception that mitigating risks in the blockchain network is as feasible as in other applications.

Data Protection through Blockchain Technology

To restore confidence in blockchain protection against cyber-attacks, Hasanova et al. (2019) asserted that identifying the potential weaknesses and impending cyber threats would provide possible countermeasures and fortifications against cyber-attacks. Researchers revealed that blockchain is a viable technology to protect data, networks, and devices by adopting a single blockchain application to integrate and coordinate the standardisation of all possible solutions (Matthew, 2019).

Quantitative Results: How well would blockchain security applications protect data against cyber terrorisation? Was one of the questions respondents provided positive feedback. 57.8% of the respondents were confident that blockchain applications would curb cyber threats, while 20.6% were unaware of that possibility. However, 14.1% do not consider that the protection would not hold sway against cyber fears, while 7.5% were probable, as shown below:

Table 4.13

Data Protection by Blockchain Applications Against Cyber Threats

Levels	Counts	% of Total	Cumulative %
Do not know	157	20.6 %	20.6 %
May be	57	7.5 %	28.1 %
No	107	14.1 %	42.2 %
Yes	440	57.8 %	100.0 %

Qualitative (Focus Group) Results: The focus group almost aligned with the feedback of the survey questionnaire result regarding data protection using blockchain applications. Six (6), or 33.3%, were optimistic that data could be protected if blockchain technology is adopted, while eight (8), or 44.4%, probably believed this feat could be accomplished. While two (2) stated that this initiative is impossible, another two (2) specified that they were unaware of this implementation.

Table 4.14

Focus Group - Data Protection by Blockchain against cyber threats

Levels	Counts	% of Total	Cumulative %
Do not know	2	11.1 %	11.1 %
May be	8	44.4 %	55.6 %
No	2	11.1 %	66.7 %
Yes	6	33.3 %	100.0 %

Reasons for their Choices: The respondents' choices range from using cryptography to protect transactions against cyber-attacks to uncertainties ***surrounding the blockchain technology network***. Avoiding vulnerability by the users was a serious concern, especially when two of the respondents claimed that ***they lost some investments in cryptocurrency due to hacking***. While one has not experienced any issue with the assets, the other respondents stated they do not know anything.

Awareness of the functionality of blockchain technology in protecting data against cyber threats can be achieved if a widespread acclamation of the features of blockchain applications is embarked upon (Lis & Mendel, 2019). Lee (2019) maintained that blockchain's decentralised and transparent structure makes it impossible for a single player within the network to revise the ledger, thus portraying the technology as resilient and indestructible in the system security landscape.

Mixed Results: The overall result on data protection showed that blockchain technology is an enabler to protect and ensure data privacy for the users. Coincidentally, the Nigerian

Government has established the Nigeria Data Protection Commission (NDPC) to provide the legal framework for the practice of data protection and protection of private information in Nigeria. The Data Protection Act will stimulate the practice of data protection by safeguarding the rights of the citizens and seeking consent from appropriate sources before data collection.

Confidence in the Protection of Blockchain Platform

The responses of the participants showed the extent to which their confidence could be built up in the protection of their transactions under the blockchain platforms bearing in mind the data protection laws in various countries (Savirimuthu, 2020). Researchers have explored the cloud-based "*Data Protection as a Service*" as a means of significantly reducing the individual application development efforts in protecting data while providing the leverage for speedy software development and preservation (Song et al., 2012).

Quantitative Results: The respondents' confidence in using blockchain to protect data against cyber-attacks was 23.0%, 29.2% were unsure of the feasibility of this protection, and 7.3% expressed the likelihood of successful defence. However, a chunk of 40.4% does not inspire confidence that transaction data would be protected, as displayed below.

Table 4.15

Confidence in the Protection of Blockchain against cyber attacks

Levels	Counts	% of Total	Cumulative %
Do not know	223	29.2 %	29.2 %
May be	56	7.3 %	36.5 %
No	309	40.4 %	77.0 %
Yes	176	23.0 %	100.0 %

Following the results from the feedback provided by the respondents on the implication of using blockchain applications to protect and mitigate cyber-attacks, which is the first research question, it is apparent there was a solid connection between operationalising blockchain transactions in the network and susceptibility to the risks of any possible attacks hence it is pertinent to protect every device, data and network that is exposed to the internet (Alkhalifah et al., 2020; Lee, 2019). Cyber security is paramount if any organisation wants to participate in or transact payment services or e-commerce online or store data in the cloud (Singh et al., 2018; Das et al., 2020). It was systematically perceived that cyber-attacks have become the norm as there would always be room to attempt or hack cyberspace, particularly when it involved payment and the transfer of funds (Lis & Mendel, 2019).

Qualitative (Focus Group) Results: Confidence in the payment system boosts trust among the participants, and the zeal to continue will stimulate the ever-open room for improvement. In the focus group feedback table, as displayed below, the results showed the various levels of confidence of the respondents. When the probability of those confident was added to others who affirmed that protection is possible, the rate is a little over 77%. The rest was for those who may not know about the possibility and non-possibility.

Table 4.16

Focus Group-Confidence in Blockchain Protection Against Cyber Attacks

Levels	Counts	% of Total	Cumulative %
Do not know	2	11.1 %	11.1 %
May be	8	44.4 %	55.6 %
No	2	11.1 %	66.7 %
Yes	6	33.3 %	100.0 %

The confidence that blockchain technology protects against cyberattack threats was guaranteed by 33.3% of the focus group respondents. In comparison, 44.4% were likely to hold on to this school of thought, 11.1% specified that they do not know anything about confidence, and 11.1% stated that they have **no** faith.

Reasons for their Choices: The explanations were based on their opinions and variance. One respondent stated that "Cryptography" would stimulate confidence on the part of the blockchain participants, while another respondent stated, "***The information on the blockchain cannot be changed. The transaction undergoes a series of confirmations, thereby implanting its origin and destination on myriads of computers, ensuring that none of its data can be reproduced nor deleted***", and another indicated that: "***The world keeps turning***", implying that there would always be room for improvement. "***Blockchain technology is still evolving, and so nothing is certain***", was the perception of one of the respondents. Another specified that:" ***I don't know", while one stated that: "Adequate security of vital infrastructure***" and another: "***There has not been an issue for now***".

A respondent stated, "***Like all other banking systems, your code and pin will always protect your transactions***" should suffice for any blockchain participants. The response of another goes like this: "***There's the 51% vulnerability; by launching a 51% attack, an attacker can manipulate and modify the blockchain information***", and another respondent claimed that they: "***Lost some of my coins/token to hacking***". A respondent's opinion goes this way: "***There has been a case of hackers stealing funds based on the 51% rule", and another thus: "I use a safe and secure wallet***" for data protection. However, seven respondents did not provide feedback on this question.

Mixed Results: On the confidence that blockchain technology will protect data against cyber-attacks, the overall result indicated that on average, participants were convinced that this was feasible for implementation, especially with the assurance expressed by the focus group respondents in their remarks. Some participants were confident that the current features and attributes of the blockchain technology should suffice for protection against cyber-attacks.

Hypothesis-1

There is a relationship between blockchain payment applications and cyber security vis-a-vis cyber-attacks.

The payment system was desirable to cyber attackers because of the financial implications. Since there was an established affiliation between payment and blockchain technology, cyber security protects the transaction data in the network platform. So, it was a tripartite cycle of using **blockchain** technology to facilitate **payment** while applying **cyber security** to protect the network from cyber-attacks (Hasanova et al., 2019).

Mixed Results: The overall results drawn from research question-1 and the responses from the participants implied assuredly that there was a firm relationship between the provision of cybersecurity to safeguard transactions in the payment applications against cyber-attacks. There is no payment platform without security else the network would be exposed to all manner of attacks. The results proved that cyber security was inevitable in any cloud-based application especially when it was connected to a blockchain technology implementation proposition where payment is a critical factor.

Research Question-2:

How can Blockchain Technology facilitate payment and other financial application issues in the Nigerian financial industry?

Payment facilitation was a critical factor in the blockchain technology network as the purpose was to ensure an efficient and simplified process in funds movement and operational cost reduction (Das et al., 2020). They postulated that all relevant security features, such as confidentiality, data integrity, validity and immutability, must be entrenched in adopting blockchain technology for payment. The Indian digital payment is the means whereby transactions are effected through a favourable supervisory milieu, digitalised payment service providers and boosted customer involvement, as posited by (Sumathy & Vipin, 2017).

Perception of an Efficient Blockchain Payment Application

Central banks are the financial regulators and should be in a clear position to regulate digital currency in any country. Digital regulation could also be made through a proxy acting as the supervising body to regulate digital financing through strategic policies that would drive the process in Indonesia (Darma & Noviana, 2020). They expressed that the introduction of digital transactions has facilitated the emergence of digital marketing for the micro, small, medium and enterprise markets, thereby reducing the use of cash transactions.

Table 4.17

Perception of an Efficient Blockchain Payment Application

Levels	Counts	% of Total	Cumulative %
Agreed	482	63.1 %	63.1 %
Disagreed	91	11.9 %	75.0 %
Neutral	191	25.0 %	100.0 %

Quantitative Results: The respondents proved that blockchain technology could stimulate efficiency in the payment system as 63.1% concurred with this analogy, while 11.9% differed, and 25.0% were unbiased in their feedback. The result affirmed that blockchain technology could be embraced to facilitate payment among Nigerian financial institutions.

Table 4.18

Focus Group-Perception of an Efficient Blockchain Payment Application

Levels	Counts	% of Total	Cumulative %
Agree	7	36.8 %	36.8 %
Neutral	6	31.6 %	68.4 %
Strongly agree	5	26.3 %	94.7 %
Strongly disagree	1	5.3 %	100.0 %

Qualitative (Focus Group) Results: On the focus group's feedback, 36.8% agreed that blockchain technology would undoubtedly improve the efficiency of the payment system, and 31.6% were neutral in their responses. In comparison, 26.3% declared they strongly agreed, while only 5.3% strongly disagreed.

Reasons for Choices: The reasons provided for their selections indicate that some respondents agreed that digitisation would enhance the payment system. Others stated that it would reduce time, cost and cash transactions. A particular respondent posited thus: "***In the area of payment confirmation, since blockchain technology is a trust-less protocol, its proof of work is awesome when payments are made the recipient on getting the first confirmation can rest assured that such transaction can never be reversed so you can make payment for goods and services with ease and assurance of payment***". Another expressed thus: "***The blockchain is seamless, has reduced costs for transactions, is faster, requires less labour input and Immutable***".

Mixed Results: Overall, the results especially from the remarks from the focus group participants have shown that there is some optimism about the potential of digital currency to improve the payment system in the financial industry. However, despite the expression of some uncertainties and questions about its implementation and effects, the coast is still clear that using blockchain technology to enhance the payment system is the way to go.

Payment System Improvement Using Blockchain Technology

The impact of blockchain technology on the payment system cannot be overemphasised as far as innovative technology is concerned. Mehrländer (2018) is of the firm view that the incursion of blockchain technology in cross-border inter-bank payment has caused intermediary banks to fade away from the payment process. She opined that decentralising the cross-border inter-bank payment process would go an extensive way to resolve long outstanding issues in the

Nigerian financial system. As a matter of perception, Dolinski (2018) collaborated with this view when he implied that all the lingering problems would gradually become archaic with the use of blockchain technology for payment transactions.

Quantitative Results: Almost a similar response was delivered when respondents were asked if there would be an enhancement in the payment system when blockchain technology is deployed, as 60.3% agreed that it would facilitate an efficient payment system in the Nigerian financial landscape. In contrast, 11.6% indicated a negative response, while 20.4% retorted that they did not know, and 7.8% showed that it could be a possibility in their response, as shown below:

Table 4.19

Would implementing Blockchain Technology improve the payment system?

Levels	Counts	% of Total	Cumulative %
Do not know	155	20.4 %	20.4 %
May be	59	7.8 %	28.1 %
No	88	11.6 %	39.7 %
Yes	459	60.3 %	100.0 %

Qualitative (Focus Group) Results: The motivation for the payment system was the unveiling of digital currency by the Central Bank of Nigeria; hence, it wasn't reflected in the above tables. However, 44.4% acknowledged that the digital currency's success would impact the digital currency transaction process and open up the space for others to key into the initiative. While 33.3% were probable in their response, 22.2% stated they did not know.

Table 4.20

Focus Group - Would implementing Blockchain improve the payment system?

Levels	Counts	% of Total	Cumulative %
Do not know	4	22.2 %	22.2 %
Maybe	6	33.3 %	55.6 %
Yes	8	44.4 %	100.0 %

Mixed Results: Overall, it showed that there was a general belief among respondents that blockchain technology has the potential to facilitate an efficient payment system in the Nigerian financial industry despite the uncertainties expressed by a few participants (average of 21%) who claimed that they do not know the possibilities of the improvement. The possibility of an improved payment system was critical in meeting the objectives of this study.

Optimism about the Blockchain Technology Benefits

The result clearly showed that the mindset of the participants was geared towards using digital currency to transact their business. The benefits of blockchain technology depend on the scope of implementation, which implies that some benefits could be targeted to ensure optimal deployment value (Alexopoulos et al., 2019). One could argue that though the benefits cannot be realised when the technology has not been implemented, the fact that others using the technology could attest to it shows the practicality of reality. Since blockchain technology was relatively novel, realising the benefits would be a gradual process considering the level of awareness among the people. However, the optimism among the participants about blockchain technology shows a positive signal of a brighter future despite the uncertainty surrounding the implementation and government policies. Many in society have strong reservations about the way to go as far as technology is concerned. However, if the feedback is anything to go by, it has shown that the possibility of investment and participation in blockchain technology portrays a good omen for the country.

Quantitative Results: The reaction was almost comparable to whether participants were optimistic about the benefits of implementing blockchain technology, as 57.2% replied in the affirmative, while the other responses aligned with the feedback provided above. A closer look at the two tables would attest to this fact, as shown below:

Table 4.21

Optimism about the benefits of implementing Blockchain Technology

Levels	Counts	% of Total	Cumulative %
Do not know	161	21.3 %	21.3 %
May be	61	8.1 %	29.3 %
No	102	13.5 %	42.8 %
Yes	433	57.2 %	100.0 %

Qualitative (Focus Group) Results: From the benefits accrued from blockchain implementation, the focus group responded with 61.1% agreeing, 16.7 indicating that they are in the unknown, and another 16.7% implying the probability of it happening. However, only 5.6% expressed their disagreement.

Table 4.22

Focus Group - Are you optimistic about the benefits of Blockchain?

Levels	Counts	% of Total	Cumulative %
Do not know	3	16.7 %	16.7 %
May be	3	16.7 %	33.3 %
No	1	5.6 %	38.9 %
Yes	11	61.1 %	100.0 %

Reasons for their Choices: The reasons offered included the fact that it would improve the country's economy, a better decision than the current one, and "**It will lead to greater transparency in transaction activities**", according to one respondent.

Another respondent stated, "**If the banking institution can be well managed, blockchain challenges can be managed too.**"

Mixed Results: Overall, the results especially considering the remarks from the focus group respondents showed that most respondents (an average of 59%) were optimistic about accruing the benefits of implementing the blockchain technology. Despite this overwhelming result, an average of 9.1% of the respondents thought that the possibility was quite remote, while an average of about 12% of the participants were probable on achieving this feat, though on average, 19% do not know about the feasibility.

The CBN's Introduction of Digital Currency

The Central Bank of Nigeria eventually launched the digital currency (e₦aira) in November 2021, and the reaction from the population was very encouraging. In light of this, the response to the research questions on using blockchain to facilitate the payment system was positive. The participants strongly believe that the payment system would be boosted due to the introduction of digital currency (Holotiuk et al., 2019). As a matter of contemporary globalization, Isaksen (2018) contended that blockchain would drive cross-border trade among various countries across the globe. Generally, the results affirmed that digital currency is gradually gaining ground, especially in the developing world and the approach is being emulated by developing countries including African countries. Issues surrounding digital currency optimization and design standards are still being modernised with caution (Qian, 2019).

Quantitative Results: With the implementation of the ***e~~N~~aira*** by the Central Bank of Nigeria, as anticipated, 68.6% of the participants affirmed that it would inspire efficient payment in cross-border trade, remittances and revenue tax collection, especially in the unbanked and rural areas. However, 7.0% contradicted negative feedback, 17.7% stipulated that they did not know how it would impact the financial industry, and 6.7% postulated that it could be possible.

Table 4.23

Would CBN's introduction of digital currency stimulate the payment system?

Levels	Counts	% of Total	Cumulative %
Do not know	135	17.7 %	17.7 %
May be	51	6.7 %	24.4 %
No	53	7.0 %	31.4 %
Yes	522	68.6 %	100.0 %

Qualitative (Focus Group) Results: There was no negative response to the feedback from the focus group respondents, while 44.4% concurred that the introduction of digital currency would stimulate the payment system. However, 33.3% were probable, while 22.2% indicated they did not know. The result aligned comparatively with the result of the quantitative data.

Table 4.24

Focus Group - Would CBN digital currency stimulate the payment system?

Levels	Counts	% of Total	Cumulative %
Do not know	4	22.2 %	22.2 %
Maybe	6	33.3 %	55.6 %
Yes	8	44.4 %	100.0 %

Mixed Results: The results from the respondents significantly and positively answered the question on blockchain technology stimulating the payment system in the Nigerian financial industry. On average, the confidence that the CBN introduction of digital currency was reflected in their responses when over 55% affirmed this possibility. The probability that the CBN digital currency would stimulate the payment system averaged 20% among the respondents. This was a clear indication that the objectives of the study would be achieved when blockchain technology is implemented.

Hypothesis-2:

There is a relationship between conventional payment and blockchain.

The hypotheses asserted that there was undoubtedly a relationship between payment and blockchain technology which was substantiated by (Wong & Maniff, 2020; Nikiforova et al., 2019). Blockchain technology leverages financial technology to enhance efficiency in the payment system, which means there is a strong affinity between the payment system and blockchain technology (Chang et al., 2020).

Mixed Result: Overall, there was a clear relationship between the current payment system and the blockchain-induced payment application. The relationship revolved around the modalities for payment transaction processing. Both methods of payment involved the transfer of funds from a debtor to a creditor who is the beneficiary.

Research Question-3:

How can the Central Bank of Nigeria regulate blockchain technology?

Generally, regulating blockchain technology by the global central banks has been a knotty issue since most participants are not directly under their supervision but by the money deposit banks. Four (4) questions were derived from the research question on the possibility that the Central Bank of Nigeria would successfully regulate the blockchain technology process. One of the questions below seemed to convince 51.0% of the respondents that the

Central Bank of Nigeria can control the blockchain technology network even if achieving that purpose through proxy established bodies who will take up that responsibility. Artemov et al. (2017) proposed that a framework should be put in place to regulate the blockchain technology transaction process; otherwise, it would engender uncertainty in the global financial system and the Nigerian financial industry. Schellekens (2019) pointed out that regulating blockchain-related payment transactions was paramount to ensuring systemic financial stability as the advantages outweighed the drawbacks.

CBN Regulation of Blockchain Platform

On the contrary, Afzal and Asif (2019) expressed that blockchain pundits believe that non-regulation makes blockchain technology effective. However, Yeoh (2017) maintained that a minimum regulation portends well for the blockchain industry, if not now but for future innovation trends. There were effective responses on the possibility of regulating the blockchain technology process from the respondents. Some blockchain professionals believed that regulation would infringe on the users' privacy and possibly scare away potential investors.

Table 4.25

Are you convinced that CBN can regulate the process, even remotely?

Levels	Counts	% of Total	Cumulative %
Do not know	100	13.1 %	13.1 %
May be	37	4.9 %	18.0 %
No, not sure	236	31.0 %	49.0 %
Yes, I do	388	51.0 %	100.0 %

Quantitative Results: The feedback results showed that 51.0% believed the Central Bank of Nigeria could regulate the blockchain network. However, 31.0% of the participants were cynical about this possibility. Comparatively, 13.1% submitted that they discerned nothing about the regulatory capability, and 4.9% held it would likely be possible for the regulatory bank to supervise the network. The results revealed that regulation by the CBN could regulate the blockchain network through the implementation of policies or proxy regulation of a consortium of companies.

Table 4.26

Focus Group - Are you convinced that CBN can regulate the process?

Levels	Counts	% of Total	Cumulative %
Do not know	2	10.5 %	10.5 %
Maybe	5	26.3 %	36.8 %
No	4	21.1 %	57.9 %
Yes	8	42.1 %	100.0 %

Qualitative (Focus Group) Results: The focus group participants' response was almost in tandem with the survey questionnaire respondents in that 42.1% believed the blockchain network could be regulated. In comparison, 26.3% think that there is a probability that the regulatory process could be successful. 21.1% did not believe that regulation would be possible, while 10.5 indicated they knew nothing about it.

Reasons for their Choices: The explanations proffered for their selections include the statistical fact that "***remote regulation through a proxy is possible, there would be an increase in new standards"***, "***Any government does not own it, so the regulation will only be to a smaller percentage***"; "***Not the way it currently exists. The current model does away with the need for regulation***"; "***New legislation should be made to regulate the Virtual currency in Nigeria***". "***Regulation would be difficult because the blockchain is built on the decentralisation system***". A respondent inferred that "***blockchain could be regulated through the financial institutions when the relevant agencies play their respective roles according to the laws establishing them"***.

Mixed Results: Overall, there were some debates about the feasibility of regulating the blockchain and cryptocurrency network, with some respondents in the focus group expressing optimism in their remarks about the possibility of regulating the platform. However, on average, about 46.5% affirmed that regulation was feasible while an average of 15% of respondents were probable about the regulation.

Hope for a Feasible Regulation by the CBN

There was abundant hope about the possibility of regulating the blockchain platform as implied from the results of the participants. The regulation process was likened to the data protection supervision process as opined by Crutzen et al. (2019) stressing that there needs to focus on why and how the regulation process was implemented.

Table 4.27

Is there any hope that Blockchain/Cryptocurrency can be regulated?

Levels	Counts	% of Total	Cumulative %
Do not know	109	14.3 %	14.3 %
May be	43	5.7 %	20.0 %
No	81	10.6 %	30.6 %
Yes	528	69.4 %	100.0 %

Quantitative Results: It was optimistic that (69.4%) of the respondents seemed hopeful that the Central Bank of Nigeria could regulate the blockchain technology network, while 10.6% were pessimistic about that possibility. However, 14.3% showed they do not know how blockchain could be "*controlled*", though 5.7% inferred that regulation could be probable. Yeoh (2017) postulated that regulatory issues can be determined strategically through cooperation with relevant stakeholders in the financial industry. With almost 70% affirmation of a positive regulation from the respondents, it was indeed achievable that the blockchain network could be regulated. This was a pointer to the fact that the objectives of implementing the blockchain technology coupled with a literature review on already implemented regulations.

Table 4.28

Focus Group - Please state your opinion on how CBN can regulate

Opinions	Counts	% of Total	Cumulative %
By setting up standards and limits	1	7.7 %	7.7 %
The concept of cryptocurrency is decentralisation, so regulations are, to an extent	1	7.7 %	15.4 %
Constant engagement with stakeholders	1	7.7 %	23.1 %
Governments should allow citizens to operate cryptocurrency in banks, open a crypto account, and utilise deposits and withdrawals seamlessly through their wallets to monitor each transaction.	1	7.7 %	30.8 %
I believe it should be self-regulated. No need for a central regulatory body	1	7.7 %	38.5 %
I think that when the right people do the work, things will go well	1	7.7 %	46.2 %
Involve key personnel in every industry.	1	7.7 %	53.8 %
Legislation and specialised monitoring	1	7.7 %	61.5 %
New knowledge	1	7.7 %	69.2 %
No thought yet.	1	7.7 %	76.9 %
Regulation would be complicated because the blockchain is built on a system of decentralisation	1	7.7 %	84.6 %
Regulators need to sit down with stakeholders to be able to draw up regulations for the industry	1	7.7 %	92.3 %
Remote regulation	1	7.7 %	100.0 %

Specified above were the respondents' sentiments on how regulation of blockchain technology can be operative: Responses can be connected to the research question on regulating blockchain transactions and the research study topic, "**The Effects of Implementing Blockchain Technology in the Central Bank of Nigeria**".

Qualitative (Focus Group) Results: Each of the 13 respondents provided reasonable comment on why and how it is vital to regulate the blockchain platform revealing what they feel should be the consequences of an actionable blockchain implementation.

Mixed Results: The overall results showed remarkable anticipation for a regulated blockchain technology implementation as most participants especially the focus group respondents made significant remarks to buttress their choices. The results implied that the implementation of blockchain technology should be accompanied by appropriate regulation, which is possible.

On "***whether the inability of the Central Bank of Nigeria to regulate the blockchain network would be a showstopper to its implementation***",

Quantitative Results: The results showed a significant leap of 51.5% where the respondents believed that the failure to execute regulatory functions would be a setback in the implementation of blockchain technology. Despite 19.1% stating that they were unsure that it would be an impediment, 29.4% supposed that it may or may not abort the regulatory process, as they claimed ignorance of the abortion of the implementation.

Table 4.29

Would regulation be a showstopper to Blockchain implementation by CBN?

Levels	Counts	% of Total	Cumulative %
Do not know	221	29.4 %	29.4 %
No	144	19.1 %	48.5 %
Yes	387	51.5 %	100.0 %

Mixed Result: Regulation of the Blockchain/Cryptocurrency network has been a thorny issue for global central banks. The focus group participants were asked this question and their opinions aligned with the affirmation that regulation would play a significant role in the blockchain implementation process. This result was pertinent to ensure the decency and integrity of the process.

The results emanating from the respondents were mixed feelings considering the importance of central control by the authority in the traditional system. No participants would want to be regulated to ensure privacy is not infringed. However, it is essential to note that no system can develop without some elements of supervision. In a normal society, privacy was well respected to the extent that any infringement was not encouraged. However, regulation cannot be ignored in a system involving technology.

Upturning the Ban on Cryptocurrency Bank Accounts

To forestall a cryptocurrency crisis, the CBN mandated the deposit money banks to close all the accounts being used for trading in the market. When the participants were asked if there was the possibility of the CBN unbanning the closure of the accounts, the results are as stated below:

Quantitative Results: The results showed a positive perception as confirmed by 66.1% of respondents that the introduction of the digital currency would facilitate the removal of restriction placed on those bank accounts. Furthermore, 76.0% of the respondents also affirmed that there is every likelihood that the banned policy would be unbanned in the light of launching the digital currency.

Table 4.30

Will the CBN overturn the ban on Cryptocurrency bank accounts?

Levels	Counts	% of Total	Cumulative %
Do not know	151	20.0 %	20.0 %
May be	45	6.0 %	25.9 %
No	60	7.9 %	33.9 %
Yes	500	66.1 %	100.0 %

Mixed Results: The overall results especially from the focus group respondents, indicated that the future of blockchain technology is hinged on appropriate regulations to ensure a stabilised market. The prospect of blockchain technology is tied to how the initiative is implemented from the beginning, which would eventually impact all the stakeholders including the Central Bank of Nigeria.

Hypothesis-3

Does blockchain explain the relationship between centralised and non-centralised regulations?

The hypotheses of variance in the relationship between centralised and non-centralised regulations showed a clear-cut difference. The non-centralised sector was private, while the Central Bank of Nigeria regulates the centralised process based on its established act. However, there is no relationship between a standalone blockchain network not connected to the web and the internet blockchain network. Similarly, there would be no basis for a financial institution not licensed to function in the financial system controlled by the Central Bank of Nigeria.

Mixed Overall Results: Overall results indicated that the operational platforms of blockchain technology were different from the conventional network the society is used to. The structure of centralization and decentralization platforms forms the basis of the level of authority. Indeed, there was a relationship between both platforms in the operation of the processes.

The results from the respondents answered the research questions relating to how cybersecurity applications can be developed to mitigate cyber-attacks, enhance an efficient payment system in the blockchain platform and provide the modalities for the regulation of the network to ensure compliance with policies and a stabilised system where there were decency and orderliness.

4.4 Evaluation of Findings

The findings of the data collected attested to this study's conceptual theory vis-a-vis the research questions and hypothesis in all ramifications as this section describes the titbits of the results in the previous segment according to the research questions and hypothesis. Detailed explanations of the anticipated and conflicting results were extensively considered in the evaluation of the findings. A two-pronged approach was adopted in evaluating the findings, which are attaining the objective of the study and applying the implementation proposal of the blockchain technology system. This has given the researcher the room to provide a detailed interpretation of the results, programmatic utilization, and effective integration from determining factors of the findings (Schulberg & Baker, 1968).

Demography - Participants' Background Findings

The findings from the demographic results spanned critical information that the participants were willing to divulge without any reservations including gender, age, employment/business status, employment/business level, business role, number of years the organisation has been in operation, and number of years the participant has been in the organisation. The findings provided by the respondents were necessary to answer the research questions as it would be important to the respondents' level of awareness and interest in some pertinent demographic information.

Gender Information: The gender findings did not reveal anything new when compared to other research studies. The ratio of the male to female was almost 3:1, which in most cases was dependent on the ratio of male and female in the organization. Fox (2020) posited that in most societal studies, gender is always a crucial issue because of the disparity and classified social features of the topic. He admitted that features such as religion, economy, social responsibility, behaviour, culture and tradition have a way of influencing the participation of genders especially females in surveys. These attributes also have a means of influencing their choice and responses in the survey. These findings indicated that gender equality was still an ongoing process as far as blockchain interest is concerned. The males are on the front burner of the blockchain landscape though few women are so passionate about the technology.

When Di Vaio et al. (2022) conducted a study on "***Blockchain technology and gender equality – A systematic literature review***", they opined that blockchain technology has the propensity to link the world and ensure gender equality and financial inclusion with its characteristics to promote transparency, efficiency, decentralization, which are the features of blockchain technology. However, they perceived that insufficient consideration has been given to gender equality in blockchain-based applications, especially in the area where the females' capabilities correspond to the technologies. Little or no attention was being directed to creating these opportunities for the female gender to key in to reduce or mitigate the risks and overbearing burdens associated with the gender gaps.

This finding explicitly implied that the males are still dominant in managing blockchain enterprises though credit must be given to the females who were also players in the network. It was observed that most females were not being provided the opportunity to participate in emerging technologies perhaps due to the challenges listed above. However, (Koohzad et al., 2019) suggested that politeness strategies should be introduced to ebb up the participation of females. Access to several managerial positions for the female gender will create opportunities for them to exhibit their leadership styles as suggested by (Cuadrado et al., 2008). Gender participation was a true representative part of the demographic information of this study.

Age Group Information: Age was not a critical factor in the participation of respondents in this study, unlike other clinical-related research that is dependent on the age of the participants. The minimum age set by the Research Ethics Application Form (REAF) was 18 years, which is regarded as the commencement of adulthood. However, the minimum age of the participants was 22, while the maximum age was 59. The average age of 40 indicates that all participants were in the working group category. The focus group age information showed that the minimum age was 18 years old, the maximum was 57 years old, and the average age was 37.5 years. **This finding indicates that the participants were adults who knew the implications of engaging in the blockchain technology business.**

The sports sector has age-related feature that influences the choice of participants in most categories except sports such as golf and others that do not require age classification. However, in lawn tennis, and football among others, age is a critical factor due to the strenuous activity of players required in the sport. (Eime et al., 2016) posited that sports participation is an energic activity that is dominated by the age of young participants despite the health benefits, they observed that it decreases with age. They emphasised that the pattern of sports participation is typically dependent on the age and gender of the participants to the extent that the peak period is the starting age for some sports. However, this was not the case with participation in blockchain technology as the investment in the platform is open to all adults irrespective of age. On the clinical side, some diseases such as Parkinson's syndrome and cancer diseases are peculiar to the elderly and have started cascading to the younger ones (Ludmir et al., 2019; Macleod et al., 2018).

Employment/Business Status: The essence of the employment/business status was to gauge the grade of those employed and the business position of the participants and discern the suitability of responding to the survey questionnaires. While almost all the non-focus group participants were employed, the focus group respondents were all engaged in one business or the other but mostly in the blockchain technology-related business. The engagement of the participants contributed to the value of data collected and analysed in the previous chapter. The impact of employment status in research was exemplified by (Johnston et al., 2023) in their study on "***employment status and the on-demand economy***", where they emphasised that the flexibility to work schedule increases the drive to work hours and the ability to sustain the determination of the employees, which implied better operational efficiency. The employment status of the participants contributed to the efficiency of this study particularly in the data analysis. The employment status of the participants has a way of influencing their intention psychologically through their ***perceived behavioural control, subjective norm and attitude*** (Kolvereid, 1996).

Business/Employment Level: The business/employment level gauges the participant's status category at work, with the senior/executive management recording more than half of the respondents, while other categories of employed staff were also represented, including junior staff. The impact of this was similar to the employment and business level in the previous section. It was perceived that the quality of the responses from the senior and executive management was higher compared to the other management levels. The findings revealed that the business and employment level have a relationship with the output of the employee in terms of their productivity according to (Harter et al., 2002).

Business Role: From the researcher's findings, the business role of the participants varied among the several professions stipulated and it impacted this study regardless of the responsibilities of the participants (Sastry, 2011). The diversity of the participants' various professions coupled with business roles facilitate development in numerous organizations, the influence on this study inclusive (Fisman & Khanna, 2004). The business role has a way of couching the choice of the employees and business players, especially in decision-making, transitioning and sustainability (Loorbach & Wijsman, 2013). What this implied was that the business role of the participants contributed to the decisions made in this study.

Operational Years of the Organization: The findings from the respondents showed that the years of operation of the participant’s organisations had an impact on the participants’ years of experience in the organizations. Some organizations in the startup stage are being manned by experienced participants. The longer the operational years of the organization, the longer the years of sustainability in the business world provided the corporate governance policies are strictly adhered to (Kuckertz & Wagner, 2010). The main organization where most of the participants work has been in business for the past sixty (60) years, which impacted their decisions in this study.

Participants’ Years in the Organization: The essence of identifying the respondents' years of experience in their respective organisations was to decipher their level of competence and value to their employer. Findings revealed that there was a correlation between the number of years the organisations had been in operation and the number of years of the participants. Experience plays a fundamental role in the career of an employee especially when so many years have been spent in building the career. The more experienced a participant is, the more the likelihood that the quality of decision-making would be very high in terms of loyalty and satisfaction over the years (Bennett et al., 2005).

4.4.1 Findings and Research Questions

As indicated in the previous chapter, the findings were extracted from the respondents’ results aligned with the conceptual framework of blockchain technology. Furthermore, the result findings were also in tandem with the literature review in chapter two of the dissertation. The effects of implementing blockchain technology were narrowed down to the research questions and hypotheses on three critical areas: cyber security, payment, and regulations, from which the survey questionnaires were built. Others are the extent of blockchain awareness and the prospect of implementation in the financial industry. Much as the interpretation was deduced straight from the study results, however, very few unanticipated and conflicting responses were explained distinctly as part of the results.

Blockchain Status

Before answering these research questions, it was pertinent to identify whether the participants were aware and knowledgeable of blockchain technology. As a result, a section on blockchain status was developed in the survey questionnaires to get feedback on the participants' perception of blockchain technology.

Blockchain Technology Awareness: The participants' awareness of blockchain technology and cryptocurrency, including Bitcoin, was quite encouraging, as over 90% affirmed that they were aware of it. This verdict was a clear signal that the participants were conversant with blockchain technology and in an excellent position to respond to the survey questionnaires, which will translate to research questions ripostes. The focus group finding was expected to climb closer to 96% apparently because most of the participants were either operators or investors of blockchain technology. Kramer (2019) opined that blockchain technology was among the newest innovations in technology that is beneficial to many organizations, therefore the tendency to attract public awareness is relatively very high. The findings also revealed and proved that users are more interested in the characteristics of what blockchain technology can offer especially in social media, where it is being perceived as a useful tool that is easy to use

(Mnif et al., 2021). They explained that social media users were more interested in the benefits of blockchain technology than the drawbacks, where there were positive outlooks with convincing passions of trust and bliss among the social media players. The findings have shown that there was significant blockchain awareness circulating in the air among internet users, especially through the social media world.

Blockchain Technology Knowledge: Findings showed that the knowledge of blockchain technology has become more profound than just awareness. Expectedly, the focus group findings showed that all the participants know blockchain technology spread across the different strata. This is not surprising as the focus group participants are players in the cryptocurrency market. So, before a participant would think of investing, such an investor must have at least a basic knowledge of the cryptocurrency. The knowledge of blockchain technology is deeper than the awareness hence one can find the class of participants in the focus group. Dannen (2017) pointed out that many societies' most worrying imperfections could become the realm of blockchain-focused apps.

The impact of a blockchain-enabled digital economy can facilitate a knowledge-based financial industry that is driven by efficiency and transparency that can spur and align a community-based financial inclusive and integrated participatory approach to stimulate the collective acumen for contributory ideas, data, governance and management of projects (Ducrée, 2020). However, Dymek et al. (2019) contended that the findings of their study have indicated that knowledge of blockchain technology is more commonly sourced from the internet than other media. They maintained that specialised knowledge of blockchain technology is perceived to be a work tool for technological and social transformation.

The findings have proved that most of the participants were not only aware of blockchain, but some also especially those in the focus group were knowledgeable about the cryptocurrency (Bitcoin) and the basic concept involved in the trading.

4.4.2 search Question-1:

What are the current blockchain applications that are developed on cyber security to mitigate cyber-attacks?

The Capability of Cryptography: Cryptography was the core cyber security component of blockchain technology as it was used to ensure data privacy, access control, digital signature and authentication (Menezes et al., 2019). The findings from the results indicated that over 40% were not in the know if cryptography would be strong enough to protect and secure blockchain technology transactions. This finding clearly showed that the participants were technically deficient in the capabilities of cryptography hence the result manifested. However, a little over 30% were not sure if the capability would be able to secure the blockchain platform. Again, the lack of knowledge of cryptography contributed to the result of this finding, while over 20% were confident of the efficacy of cryptography. The confidence is attributable to the knowledge the participants must have possessed on the functionalities of cryptography.

In layman's terms, cryptography focuses on the technique of protecting and securing data transactions between two protocols thereby ensuring data integrity, confidentiality and encoding (Barakat, 2018). The researcher is sure that if the participants were to know this basic concept, their choices would have been swayed to positive responses. The finding from the focus group respondents was far better in terms of positivity due to the basic knowledge of cryptography they must have had.

Blockchain Cyber Security Applications: Several cyber security applications were developed to protect transactions in the blockchain network. These applications are to fortify the blockchain platform against cyber-attacks in any guise. Expectedly, the findings showed that an average of about two-thirds were positive about the use of cyber security applications to protect data against cyber-attacks. Apart from Cryptography, several cyber security applications such as Anonymous Signatures, Consensus Algorithms, Hash Chained Storage, and Non-Interactive Zero-Knowledge Proof are being used to fortify blockchain technology. Most of them may not be as popular simply because they are software programs that function along with other operating systems in the blockchain platform. Razaque et al. (2021) proffered that the deployment of a web-based blockchain-enabled cybersecurity system will prevent the threats from cyber-attacks. A deployment such as this will be unknown to many blockchain players. Lin et al. (2020) proposed ***Monero*** and ***Zerocash*** systems as solutions to strengthen the protection of privacy in a decentralised payment platform.

Risk mitigation against cyber-attacks: Uncertainties are part of every life process, let alone every system. An average of 55% of the participants were sure that blockchain cyber security applications were secure enough to mitigate against risks associated with cyber-attacks. The rest of the respondents were either not sure of the possibilities or they may not be aware of the efficacies of the applications. The knowledge gaps could be responsible for their choice. Cyber security risk management is a policy-driven system used to mitigate risk, observe the process of self-protection, and perfect the imperfect capability to prove loss (Öğüt et al., 2011). Cyber security risk management is a taxonomy of operational risks stored on the system to mitigate risk (Cebula & Young, 2010). They are all classified as cyber security applications developed to protect the blockchain network through the mitigation of risks.

Blockchain Data Protection Applications: Cyber security companies develop web applications to protect data against cyber-attacks. Findings from the participants about the possibility of these applications protecting data against cyber-attacks showed that the responses tallied with those of the previous question on risks. , as close to 60% believed that these designated applications could protect transaction data against cyber-attacks. The others were pessimistic about the possibility. There are cyber security applications designed to protect data transactions. This category of cyber security systems adopts the "***trusted consensus mechanism***" to synchronize modifications in data, which makes it feasible to create a "***tamper-proof digital platform***" for sharing and data storage. This application system is accomplished on structured block connection to validate and warehouse data (Feng et al., 2019). "**Access control mechanism**" is another form of cyber security data protection system where only authorised users are permitted to access and share information in the blockchain platform. The system also includes the capability to protect data through accessibility techniques (Devi Parameswari & Mandadi, 2020).

According to Zhang et al. (2020), blockchain-based cyber security and data protection systems are progressively drawing close consideration in most industries if not all. Systems such as privacy protection and data traceability are significantly gaining ground in blockchain-based applications in data cyber security protection. A blockchain-based ***sensor data protection system*** (SDPS) was proposed by Chanson et al. (2019) to ensure sufficient sensor information integrity while simultaneously securing adequate personal privacy. They proffered that the system leveraged data protection certification, which ensures tamper-proof data warehousing, processing and exchange of IoT sensor-controlled data efficient, privacy and scalable approach.

Identity information system signifies an individual level of a person, which became an incarnation of our identity and epitomises the basis of authentication according to Sim et al. (2019). He posited that the system was designed to control and protect personal identity to avoid unfortunate misconstruction and inappropriate misconduct while adopting the ***General Data Protection Regulation*** (GDPR) requirements (Giannopoulou, 2021).

The above-mentioned cyber security systems were some of the numerous applications used in the blockchain network in response to the research question. These systems were designed to provide cyber security and protect data in the blockchain platform.

Hypothesis-1: There is a relationship between blockchain payment applications and cyber security vis-a-vis cyber-attacks.

Indeed, there was a connection between blockchain technology payment applications and providing cyber security to protect transactional data against cyber-attacks. It was envisaged that cyber-attacks were inevitable where cross-border payment and funds were being moved from one country to another. The following research question provided more details on blockchain payment, emphasising securing every payment application with cyber security. Berry (2022) opined that digital currencies are characterised by ransomware-related attacks through the extortion of payment from organizations and individuals in the manner of Bitcoin, Ethereum, and other cryptocurrencies. He maintained that cyberspace was exposed to all manner of questionable relationships between cryptocurrency owners with pseudonym identities and payment transactions. He surmised that there is a correlation between payment transactions and cyber-attacks, which necessitated the provision of secure cyber security. Furthermore, he questioned if cyber-attacks would exist without digital currency trading. Findings have shown that there are current worries within payment and cyber security as related to blockchain-based operations in tracking financial recklessness, which is attracting audit scrutiny and financial regulations (Demirkan et al., 2020).

4.4.3 search Question-2:

How can blockchain technology facilitate payment and other financial application issues

in the Nigerian financial industry?

The financial spectrum was the core of blockchain technology, where payment occurred unseemly in a secured and decentralised manner. In addition, blockchain technology is one of the best platforms to have emerged for the payment system. Cryptocurrency thrives on the movement of funds for investors and operators. Findings have assuredly shown that blockchain technology can be applied to facilitate payment in various sectors of the industry including areas that are less related to the financial domain. The literature review in chapter two has indicated that there are all aspects of operations in the sphere of life where blockchain technology can be applied to provide financial services are part of the deliverables. Through the findings, the researcher has categorised these payment services as stated below.

Facilitation of Payment by Blockchain Technology: From the revelation of the findings, a little over 63% of participants were able to respond positively that blockchain technology could facilitate an efficient payment system in the Nigerian financial industry. While almost 12% disagreed, 25% were neutral about the concept. This is an indication that blockchain technology can facilitate the payment industry. (Kakushadze & Russo, 2018) amplified this analogy by stating that blockchain technology could facilitate payment in the areas of designated data markets where payment transactions can take place, keeping historical data to aid the payment process and the use of blockchain technology to stimulate the payment process through the use of unknown cryptographic keys among users, which they referred to as ***keyless payment***. A research study conducted by Khadka (2020) revealed that blockchain technology has the potential to boost and transform the efficiency of several sectors of the banking and payment industry, including trade finance, capital markets, financial reporting and cross-border payment. He posited that the implementation of blockchain technology has brought innovative ways of making payment that enhances faster trade process, secured ledger, smart contract and numerous other inventions. However, he surmised that there are some obstacles which are normal in every new process believing that these challenges will improve the efficiency of the blockchain payment implementation.

Current Payment System Improvement through Blockchain Technology: The findings that blockchain technology would improve the challenges afflicting the current payment system were received with over 60% affirming this assertion even as the remaining less than 40% showed some probabilities and pessimism due to lack of adequate knowledge. However, that there are misgiven does not imply that the implementation would be a failure even though many banks are wary of implementing blockchain technology (Lind et al., 2017). It is worth mentioning that the current payment systems are already being enhanced to meet the present challenges to perfect the payment system in the banking industry (Zhang et al., 2019). ***FastPay*** is a blockchain-based payment system that guarantees fast and secured payment while combining the features of IoT to accomplish this feat (Hao et al., 2018). They demonstrated that the prototype of the FastPay system proved that it was effective in promoting a fast payment process. Token payment systems such as Bitcoin and Ethereum were still the most broadly used in the digital payment industry. However, recent blockchain systems such as those mentioned above, Zerocash or Monero leveraged to improve privacy in the payment landscape as proposed by Androulaki et al. (2020). They presented a privacy-driven token management system that was built on Hyperledger Fabric to facilitate the current payment initiatives. The scheme was procured under the ***computational assumptions in the random oracle model and bilinear classes***.

Findings have shown that cryptocurrency is accepted as legal tenders in some countries even as different countries have diverse approaches to the recognition of digital currency at corporate and state levels. (Taufiq et al., 2018) researched the factors influencing the adoption of blockchain technology for the Indonesian payment system. They proposed an innovative model of implementing blockchain technology for their payment system in their banking industry. Nikiforova et al. (2019) inferred that developed countries like Japan have given legality to cryptocurrency, while the USA accepted bitcoin as one of the financial instruments, but has yet to consent to it as a currency. In Europe, bitcoin is regarded as a security, while the UK deemed it as a private fund and China prohibited the use of cryptocurrencies for banks and government agencies but permitted it for individuals. The essence of these digital currency recognitions is to facilitate efficient payment and financial services across borders including the impact of blockchain technology on financial services (Holotiuk et al., 2017; Holotiuk & Moormann, 2017).

Benefits of Blockchain-based Payment System: The findings indicated that most participants were of the assured view that the benefits of adopting a blockchain-based payment system would be accomplished. The respondents that may have implied pessimism and doubt about the blockchain technology benefits on the payment system must have indicated their opinion without adequate knowledge of the expectations. These benefits were clearly stated in the literature review. (Raddatz et al., 2023) submitted that the benefits of an efficient payment system are more dominant than the other benefits of blockchain technology. They opined that much as many participants may not have been aware of these benefits, the fact remains that many enterprises especially the banking industry have a strong view of adopting blockchain technology for their payment system.

CBN Digital Currency: Findings affirmed that the CBN digital currency (e₦aira) was introduced to stimulate the payment system in the country's financial industry. Hence over 70% of the participants affirmed that the CBN digital currency stimulates the payment system, including cross-border and remittances. Already, remittances have started being received through the e~~N~~aira from the international money transfer operators (IMTO) even though the funds are so little. However, since many IMTOs have been approved by the Central Bank of Nigeria, it is expected more revenue inflows from offshore are being received into the country. Details of the CBN digital currency were provided in the literature review of chapter two.

Hypothesis -2 There is a relationship between conventional payment and blockchain.

The findings have shown that there was indeed a clear relationship between blockchain technology and payment. This concept was bolstered by Wong and Maniff (2020) when they posited that blockchain technology is an enabler in stimulating the payment system. Chang et al. (2020) stressed that payment is boosted when blockchain technology is adopted to develop the application, which signifies a robust connection between both processes. The above findings on blockchain technology promoting efficiency in the payment system were corroborated by Holotiuk et al. (2019) when they amplified the impact of this innovative technology on the payment industry. Details of this relationship were provided extensively in chapter two of the literature review. The fact remains that blockchain technology was introduced to enhance the conventional payment system to another financial revolution. Bott (2017) explained that the correlation between blockchain technology and the traditional payment system was to stimulate the process and digitize the money from the central banks. He proffered that the adoption of blockchain technology has opened the door for a digital economy where efficiency and secured markets have been brought to bear.

4.4.4 search Question-3:

How can the Central Bank of Nigeria regulate blockchain technology?

Regulation is a complex issue in the financial sector, especially when participants are not playing according to the rules. It beholds the regulating bodies to comply with laws and regulations to avert financial anarchy. The importance of regulation propelled the researcher to develop four questions from the research question. Several researchers have proposed various frameworks to regulate the blockchain network to ensure decency in the system. However, this is more easily supposed than implemented when considering the decentralised arena of blockchain technology.

The proposal by Artemov et al. (2017) that structures should be established to supervise the blockchain network to ensure participants comply with the instructions to avert a systemic financial crisis. According to Yeoh (2017), an unregulated financial system, no matter how minimal, induces financial chaos and total shocks, triggering economic downtime amidst a financial crisis. However, Afzal and Asif (2019) had a contrary opinion when they posited that it would be needless to regulate a decentralised platform where participants were bound to the game's rules.

Regulation of Blockchain Technology: Findings showed that more than half of the participants were convinced that the blockchain platform could be regulated while the rest shared about those in doubt, probable and knew nothing about the feasibility. Various remarks were proffered by the participants for their choices, which aligned with the general perception of researchers on blockchain regulation. Insights (2018) provided a detailed perception of the regulation of blockchain and cryptocurrency. As much as regulation was possible, they wondered if the blockchain could be regulated independently of cryptocurrencies since the decentralization factor is more visible in cryptocurrencies. Another factor was the absence of ethical principles, which places people at risk of exploitation, abuse and at the mercy of cyber-attacks. A more critical factor was the absence of corporate governance principles, which would result in the absence of a well-developed framework coupled with trustworthiness and stability. They proposed the following factors to curtail any cyber-attack and provide sustainable regulation: formulation of standards and good governance including interoperability to protect the vulnerable end-users from cyber criminals, negligence, mismanagement and fraud. They also proposed the horizontal and vertical modes of regulation, where the horizontal regulation connotes the supervision of the hierarchical infrastructural layers including the blockchain platform, application tools such as cryptocurrency and the ledger process. Stakeholders view the horizontal approach with cynicism and disapproval. The vertical regulation was centred on the cryptocurrency transactions that operate within the blockchain centralized platform where the process is controlled by the certified authority. Such a process includes the transactions that are conducted using wallets and payment service providers.

Another method of blockchain regulation was proposed by Treleaven and Batrinca (2017) through the concept of what they termed "***Algorithmic Regulation***" developed on "***Algorithmic Trading Systems***", which is to stream a combination of social network, compliance and other policies data to generate encrypted compliance reports using executable system programs that were used in developing the blockchain applications. Their proposal consisted of five key areas including A front-end program linking the regulatory handbook labelled "***Intelligent Regulatory Advisor***", an online monitoring program – "***Automated Monitoring***" to track market and consumer infractions in the social media, A cloud-based "***Automated Reporting***" program with big data analytics and compliance messaging, a smart contract program to encode regulations and impact assessment before implementation, and an "Automated Regulation" program using innovative mathematical procedures and blockchain mechanism to monitor compliance. The algorithmic regulation system facilitates regulatory and compliance in financial services decision-making.

Two regulatory solutions were offered by Li et al. (2019) to stabilize user privacy and regulate the cryptocurrency-based blockchain. One possible solution was the "***decentralized group signature***" where a manager is assigned to build and manage the actual payment player in a transaction group. The second solution was based on certifiable encryption where the group manager who may not be an active user will have the administrative privilege to track all questionable transactions through an encrypted device.

The Hope of Blockchain Regulation: The findings have shown that close to 70% of the participants were hopeful that the blockchain network could be regulated while the rest were shared among the likely hopeful, the not too hopeful and not aware of the possibility. The discovery from the focus group respondents varied as their thoughts were sought directly from the question. Expectedly, the findings from their opinions could be linked to the research question and the topic of the study. The views expressed by the focus group respondents are stated in the appendix section. There are proposals for the government to develop an appropriate framework to regulate the distributed ledger technology, DLT in parallel with the evolvement of new deployments of blockchain applications (Kakavand et al., 2017). They cautioned that the regulators should leverage the benefits of blockchain technology and react speedily to potential flaws in the system.

Transfer agents should be identified where they would use the blockchain application to monitor and keep track of stakeholders' activities in the securities market. However, caution should also be exercised to ensure that the blockchain market is not strained with multiple supervisory frameworks that would turn around to stifle development in the process. The regulatory approach should be to implement uniform policies to encourage and stimulate innovation and investment. Yadav et al. (2022) posited that the involvement of the government in the blockchain-based cryptocurrency process was an indication that the process of regulating it has commenced through the assessment of strengths and weaknesses of how the incorporation in our daily routine is carried out. They perceived that government control of the process and how the benefits impact the markets and the global space through the implementation of policies and standards was the way to go.

The development of blockchain was predicated on the regulatory recognition of the technology and it is pertinent to determine the present state in respect of the application and usage from a regulatory and business standpoint (Brophy, 2020). He opined that most continental regulatory bodies have commenced the process of formulating testing mechanisms for blockchain technology and fintech applications. The role of government to protect and safeguard the investments of consumers from predictable fraud and other financial malpractices is another approach to regulating the process holistically (Girasa, 2018). Auer (2019) maintained that a regulatory framework termed "***embedded supervision***" was the visible way to regulate the blockchain markets through compliance with regulatory policies and standards. He pointed out that this approach would improve the quality of data at the disposal of the supervisors and ease the administrative load for the players. He proposed four principles of embedded supervision which include the fact that the process must be established by supporting institutions and operative legal system, applicable to decentralised platforms that accomplish financial process finality, considered within the automated supervision structure of the financial market accord and facilitate cost-effective compliance along with a level-playing arena for all stakeholders (Azgad-Tromer, 2018).

Two examples of embedded supervision were mentioned, "***LBchain***" and Federal Reserve Bank of Boston's "***supervisory node case study***". These are blockchain-based sandboxes that seek to entrench regulatory infrastructure in the blockchain market. The benefits include real-time monitoring, low cost of operation, in-depth intuitions into the adoption of core models and sustained detection of potential fraud and abuses in the system.

Could Non-Regulation Forestall Implementation? Findings from the question: '*If the* *inability to regulate blockchain technology could prevent its implementation*' showed that over half of the participants affirmed that this was possible while the rest was shared among those who did not know the modality and others who felt it would not stop the implementation. From the findings, it is understandable that regulation was a critical factor in determining their responses. The broad perception was that why implement what you cannot regulate? This question brings us to implementing the digital currency (e₦aira), where the CBN empowered the financial institutions to extend the app to their numerous customers. In carrying out this instruction, there were areas in the registration process where bank customers must provide their bank details, such as the name and account of their bank and their biometric verification number. Boreiko et al. (2019) believed that the blockchain market where tokens are instruments of investment can be brought under the rules of engagement.

A market without rules and regulations is exposed to a lawless arena where anarchy reigns. Herian (2018) posited that there have been several propositions about the regulation of the blockchain market considering the decentralized structure of the platform. He maintained that a sustained regulation was dependent on the environment and operational space as there were significant distinctions between regulating to resolve intrusion of privacy and collaborative enterprise regulation., which he believed is the basis of the regulation enigma. The former was market-based regulation to ensure financial efficiency and protect consumer interest while the latter was regulation for social concerns, philanthropy, and communal deliberation. He mentioned the regulatory framework that is based on the protection of stakeholder rights, domestic, transnational and international pacts, which is quite at variance with the previous framework. Exploring a different regulatory framework, Daluwathumullagamage and Sims (2020) demonstrated that a corporate governance-based regulation will promote complete transparency, which most companies may not be comfortable with and thus cause anxiety among the stakeholders. Limited transparency will infringe on a transparent regulation and bungle the corporate governance required in operating the market.

Structured Regulation Process: Findings have shown that where regulation was not feasible, most regulating bodies banned or restricted the operation of cryptocurrencies in their countries. The CBN placed a ban on the operation of cryptocurrency accounts by the deposit money banks, DMB. When participants were asked if the CBN would lift the ban placed on the bank accounts used for cryptocurrency operation to establish a structured regulatory process for the implementation of the blockchain network. Findings indicated that over two-thirds agreed with the proposal, while less than 8% disagreed. However, 6.0% believed this feat could be possible, and 20% indicated they were unaware. The ban is yet to be lifted, but the digital currency is being regulated through the structure put in place for the banks. To avoid the issue of placing a ban or restriction, Collomb et al. (2019) proposed a principle-based regulatory framework that is predicated on a profound risk analysis to provide an efficient mode of addressing the supervision of digital coin offerings. They perceived that regulation should be focused on risk analysis instead of functional equivalence. They surmised that blockchain technology can be adopted as a regulatory tool by integrating specific into the fabric of the system to drive compliance with financial regulation (Cumming et al., 2019).

Blockchain technology can be adopted as an application tool for regulation technology as proffered by De Filippi and Hassan (2018). They opined that code can be used as the prevalent way to regulate the conduct of internet users since computer code can enforce compliance more proficiently than legal code. An example of using code in smart contracts was illustrated by them as several contractual transactions get swapped into smart contract codes. The process was phased in such a way that legal rules were integrated into the code on one part and the advent of regulation by code on the other aspect. They argued that this regulatory structure is driven by what they termed “***soft law***” which is a mix of technical rules and contractual treaties to supervise the conduct of the users, which was corroborated by Blemus (2018). Peláez-Repiso et al. (2021) proposed the development of tax regulation using blockchain technology and cryptocurrency in their study. The concept proffered was the ***self-sovereign identity*** and smart contracts where the virtual currencies are not under the control of central authorities but devised means whereby the tax component can be regulated (Stazi, 2021).

Hypothesis-3 Does blockchain explain the relationship between centralised and non-centralised regulations?

The findings have shown a strong relationship between centralised and decentralised regulation processes, as most participants claimed that regulation of blockchain technology was possible even if it was minimal. Currently, the digital currency implemented by CBN is being regulated through the banks, which are customers of the apex bank. The difference between decentralized and centralized systems is in their mode of operation. So, it was with the mode of regulation. While the centralised platform is being regulated traditionally by the central authority, the decentralised system is regulated in various ways as enumerated above. The relationship between the two platforms also extends to the ethics of operations as posited by (Fitzgerald & Phillips, 2006).

Null Hypotheses: There is no relationship between blockchain technology and unconnected, virus/malware-infested systems and unlicensed financial institutions.

There is no visible relationship if a participant's system is not connected to the blockchain network. The same applied to financial institutions that were not licensed by the CBN to operate in the financial market. Systems infected with malware and viruses cannot affect the blockchain network if they are not connected. The relationship was based on a connection between both parties.

4.4.5 Summary of Chapter Four

Chapter 4 surmises the trustworthiness of data collected and analysed to ensure reliability and validity. The data must also meet the other criteria of credibility, confirmability, limitations, transferability and dependability. The variable constructs of the data were also highlighted. The results from the data analysis were broken down into quantitative and qualitative data with emphasis on the demographic information from both methods. The demographic data include the gender, age, employment/business status, employment/business level, employment/business role, the number of years the organization has been in operations and the number of years the participants have been working in that organization.

The results aligned with the participants' blockchain perception, including their awareness, status and knowledge of blockchain technology. The results were also associated with the research questions and hypothesis covering the areas of blockchain cyber security, blockchain payment systems and blockchain regulation. The findings were evaluated with the participants' demographic information and research questions/hypothesis, including the null hypothesis based on blockchain cyber security, blockchain payment system and blockchain regulation.

CHAPTER 5: IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSIONS

5.1 Introduction

This chapter is the concluding stage that encompasses an overview of the study titled: "**The Effects of Blockchain Technology Implementation in the Central Bank of Nigeria**" and the research study's implications, recommendations, and conclusions. References were made to the previous chapters two, three and four.

5.1.1 verview of Chapter Five

This chapter was separated into four sections, along with subsections where necessary. The first section was about the implication of the research study, which included the problem and purpose statements, research methods, limitations and the inferences surrounding the research questions and hypothesis. The second section provided appropriate recommendations for applying research findings considering the literature review. The third section concerned future research vis-a-vis the findings and conclusions from the entire research study.

5.1.2 Limitations

The limitations associated with this study were not uncommon in any scholarly research work, as they posited a link between the respondents' real-life experience and the output by showcasing their insights through their expressions in the focus group.

It was worth noting when Hughes et al. (2019) construed that a classic research testimony must mirror the limitations and envision the participants' personal experience, which was reflected in chapter three of the data analysis phase of the study. The key constriction was the researcher's inability to get sufficient responses from the participants in the blockchain market.

Assumptions: The researcher assumed that all respondents must have heard or had slight knowledge about blockchain technology, and most questions would be responded to by the participants, especially the underlying technical ones.

Of the targeted sixty proposed respondents, only twenty could participate despite the several reminders forwarded within the limited period available. A particular focus group was adamant about providing feedback despite the numerous messages reminding them of the need to respond. One could argue that their survey questionnaires were over fifty and composed of several open-ended questions requiring detailed responses. Another critical drawback was the restriction of getting feedback from the Central Bank of Nigeria staff though it was spread across the various branches in all the states of the country.

Delimitations: There were compliance restriction policies for only staff of the CBN in the mailing platform as the link could not be forwarded to non-staff. The scope of participants was constrained to executive/senior staff. In data analysis, shortcomings in the knowledge of blockchain terms were noticed in the feedback from a few respondents, especially in the focus group aspect, where some participants did not respond to some questions. However, a few that responded were not equipped with the knowledge to react appropriately.

5.2 Implications

The effects of the research findings were extracted from the research questions to interpret the appropriate deductions logically. The research questions were used to develop the survey questionnaires to collate data from the respondents.

5.2.1 Implications from Research Question-1: *What blockchain applications have been developed on cyber security to mitigate cyber-attacks?*

Several cyber security software packages were and are still being developed to protect applications on the internet, including blockchain applications. **Cryptography** is the fundamental security component used in protecting transactions in the blockchain network through digital authentication, access regulator and data seclusion (Menezes et al., 2019). The feedback from the respondents on the question: "***If they are confident that cryptography is robust enough to protect and secure blockchain technology transactions***", was reasonable as almost one-third of the respondents agreed that cryptography would provide the needed cyber security to protect transactions in the blockchain network, which to the researcher is considerably low. There are other cyber security apparatuses; however, cryptography has proven to be a robust web security application. Perhaps, little is known by most of the respondents about cryptography, but the confidence exhibited in their responses revealed their sureness.

However, almost half of the respondents in the focus group also indicated certainty about cryptography's efficacy. This finding implies a guarantee that cryptography is suitable enough to protect and provide data privacy to the players. Besides, about 60% of the respondents in another related survey questionnaire were optimistic that cyber security applications could conveniently protect against cyber-attacks in the blockchain network.

Mitigating risks to avert cyber-attacks is part of providing cyber security. Risks are natural uncertainties which every functional system must deal with. When participants were asked if cyber-attack risks can be mitigated, close to 60% responded that it was feasible as it would assuage the systems of any disruption capable of causing severe reputational damage. The focus group respondents provided various reasons to bolster their choice that mitigating risks against cyber-attacks is a sure way to provide cyber security.

The Implication of Data Protection Applications: Data protection applications are other forms of providing cyber security in the network. When participants were asked about the conviction of their data being protected, close to 60% believed that safeguarding data against cyber-attacks is entirely possible. There were instances where respondents had limited knowledge of some of the survey questionnaires, and as a result, they implied in their selection that they did not know what was at stake. This limitation was evident in the feedback from the respondents in the focus group, as about 33.3% indicated that data protection was feasible, and 11.1% believed that they did not know anything about it.

This limitation was palpable on the confidence level concerning protection against cyber-attacks as only a paltry 23% indicated that they were confident about it, which was considerably low compared to the 40.4% that affirmed a lack of confidence. A little over 33% was recorded among the focus group respondents, which showed a 10% increase. This limitation implied that participants may not be adequately aware of the data protection process, prompting their responses this way. Cyber security is critical to resolving some of the problems associated with implementing blockchain technology, as this was also dealt with in the literature review of chapter two.

5.2.2 Implication of Hypothesis-1: ***There is a relationship between blockchain payment applications and cybersecurity vis-a-vis cyber-attacks***.

Payment and funds movement are being facilitated by blockchain technology. Cyber security applications to protect these transactions against cyber-attacks have created a relationship in the system. This wrangling implied that much as there would always be attempts to distort the payment system flow by cyber attackers, there would also be a provision of cyber security applications to fight against these cyber-attacks.

5.2.3 Implication of Research Question-2: *How can blockchain technology facilitate payment and other financial application issues in the Nigerian financial industry?*

Payment is the fulcrum of the financial system, as debit and credit are the accounting process of all transactions. Payment is a means of debiting an account to credit the beneficiary's account. Blockchain technology facilitates this process seamlessly, devoid of any disruptive challenge.

The Implication of Facilitating Blockchain Technology Payment: In Survey questionnaires on whether blockchain technology can facilitate the payment system, 63.1% agreed to this possibility, which was an endorsement that blockchain technology implementation is the right way. The focus group participants responded similarly, as only about 5.3% disagreed. It was evident from these findings that blockchain technology would enhance and stimulate the payment system in the financial industry. A related survey questionnaire asked the participants whether blockchain technology would improve the payment system, and 60.3% affirmed this was possible. About 44.4% also agreed with this school of thought among the focus group respondents though 33.3% implied that this improvement was likely.

The Implication of Achieving the Benefits of Blockchain-based Payment Systems: When systems are implemented, there are possibilities that the project could succeed or fail, primarily when the expected benefits or services are not being delivered. When participants were asked if the benefits, including financial inclusion and financial interventions, could be realised, 57.2% indicated optimism in their feedback. In comparison, a little over 60% avowed among the focus group participants of this accomplishment. The conclusion from these results was that there was every possibility that the positive effects of using blockchain technology to facilitate payment are achievable and should be encouraged.

The Implication of CBN Digital Currency: The Central Bank of Nigeria launched the Central Bank Digital Currency CBDC labelled (**e₦aira**). Before the launch, participants were asked in one survey questionnaire if the CBDC would stimulate the payment system through cross-border transactions, trade financing, and remittances. Close to 70% believed this would happen; however, the reality was that this expectation was undermined by usage as the level of participants using digital currency was relatively very low.

This limitation could be attributable to a lack of adequate awareness by the regulating body. Millions of users may not know how to use digital currency. The number of people having internet facilities on their smartphones could be admissible low, not to consider the number of people without smartphones in rural areas. There was no negative response among the focus group participants, as about 44.4% concurred that this was achievable.

5.2.4 Implication of Hypothesis-2: ***There is a relationship between conventional payment and blockchain*.**

The findings have bolstered the postulation of Wong and Maniff (2020) that blockchain technology stimulates the payment system when implemented successfully. This stimulation was corroborated by Chang et al. (2020) when they expressed that blockchain technology enhances the payment system. This theory implies that there will always be a relationship between the old payment system and the new, as most blockchain technology payments were developed from the previous designs. There cannot be a cut-over to the new without the old system. Conventional and blockchain payments share the same process of debit and credit but the way this payment operation is consummated may differ.

5.2.5 Implication of Research Question-3: ***How can the Central Bank of Nigeria regulate blockchain technology?***

Regulation in the financial system has always been complicated because money is involved. Some participants were bent on circumventing the rules to satisfy their selfish interests and defraud others. Ironically, there were complaints from customers of the Banks about one issue or the other involving over deductions in their bank accounts. If supervisory issues exist in the current payment system, there could be more or fewer issues depending on how blockchain technology is implemented. Afzal and Asif (2019) pointed out that regulation was unnecessary when participants were complying with the rules. However, when there is distrust in business, there always be systemic infractions that would cascade to a nation's economy.

Lack of regulation was the basis upon which the deposit money banks were banned from accelerating payment for cryptocurrency trading as expressed by Onyekwere et al. (2023) in their study on the "***Adoption and sustainability of Bitcoin and the blockchain technology in Nigeria***". They rightly pointed out that the ban triggered about a 90% upsurge in cryptocurrency/blockchain postings and frequent electronic transfers within two years after the ban. The government and other financial stakeholders can leverage the findings and recommendations of this study to implement the regulation of blockchain technology, especially the cryptocurrency platform. Before lifting the ban, the government should set up a stakeholder committee involving the technology and financial players to enlighten the public about the benefits of blockchain technology and the cyber security tips they need to protect their investments. This awareness would stimulate the implementation and adoption of blockchain technology to improve the revenue generation of agencies of government through the recent tax transformation committee set up by the government.

The Implication of Regulating Blockchain Technology: Supervising unknown people in the system is problematic. When participants were asked the survey questionnaire about how convinced they are that the Central Bank of Nigeria can regulate the blockchain platform, 51% of the respondents implied they were convinced about that possibility, but how could this be achieved? It was 42% among the focus group respondents, and the reasons indicated were that proper regulation could be gained through proxy firms. Remote regulations through the financial institutions were also mentioned, and some believed that participants should be compelled to follow laid down policies and standards. However, some believed that regulation can only be minimal in a decentralised environment when participants abide by the rules, even as others proposed new legislation to stimulate proper system supervision. The findings pointed to the fact that regulation is feasible as it formed the basis of this study which is the effects of implementing blockchain technology.

The Hope of Blockchain Regulation Implication: Respondents were asked if hope is alive in regulating the blockchain platform; close to 70% were confident and hopeful that this is achievable. There were various suggestions from the focus group feedback provided in chapter four. The conclusion was that there is hope that the Central Bank of Nigeria, like any global central bank, can supervise the blockchain network no matter how minimal. Currently, the digital currency introduced by the CBN is being regulated through the Banks as they are serving as the medium through which their customers could connect to the digital currency platform. Perhaps being hopeful indicates that there is already light at the end of the tunnel, even though dreams cannot actualise anything unless they are implemented. The steady rise in the adoption of cryptocurrencies as stated above has propelled many to be interested in blockchain technology implementation in Nigeria.

The Implication of Non-Regulation Forestalling the Implementation? Participants were questioned if non-regulation could inhibit the implementation of blockchain technology. The finding showed that over 50% were sure this would not be a going concern. The Know Your Customer (KYC) policy would stimulate the appropriate supervision when adequately implemented. The results connote that a system that is not being regulated cannot stop the implementation of improving the system.

The Implication of having a Structured Regulation Process: When a structured regulatory process is implemented, it stimulates smooth supervision of the entire process. As mentioned earlier, the Central Bank of Nigeria prohibited the use of registered bank accounts for cryptocurrency transactions. So, participants were asked if the CBN would remove the restriction once a structured regulatory process is implemented. To this question, 66.1% were specific in their feedback that this process may be overturned. Though the embargo is yet to be lifted, there is every possibility that a controlled regulatory process could invalidate this ban with time.

From the preceding, regulation is possible by providing standard policies, and legislation and establishing an organisation to supervise the financial institution through an act proposed by the CBN. An organised framework would promote proper regulation of the blockchain platforms.

5.2.6 Implication of Hypothesis-3: *Does blockchain explain the relationship between centralised and non-centralised regulations?*

The findings have shown a strong correlation between regulating centralised and decentralised platforms. Much as it is easier to control the centralised system as is presently being done through the Banks, it would be difficult but not impossible to do the same when the decentralised network is not strictly under one’s control. It means that regulation is the keyword for both platforms, so there must be a relationship.

5.2.7 Null Hypothesis: ***There is no relationship between blockchain technology and unconnected, virus/malware-infested systems and unlicensed financial institutions.***

The null hypotheses have no relationship between connected participants in the blockchain network and those not connected. As a result, there would be no relationship as the basis for an association is for all participants to be in the blockchain network. So, it is with any non-licensed organization to participate in the system, and only designs connected to the blockchain network will have any relationship.

5.3 Potential Limitations to the Results

Some limitations encountered in the survey questionnaires and data collection phases were highlighted in previous sections. However, other glaring limitations were noticed during the results of the data analysis.

5.3.1 While analysing the data, the participants did not answer some questions due to the leverage they had to choose any question to avoid. Some write-ups in the “other” options were not evident regarding the impact on the data.

5.3.2 On the focus group feedback, as the questions were open-ended, few did not respond to some vital questions for the above reasons. Some responses did not align with the questions being answered even with that.

5.3.3 The phobia of being cyber-attacked was a major challenge among the participants that influenced their responses especially when their electronic devices could render a system vulnerable and deadlocked in the end.

5.3.4 Because some fields were not formatted, particularly the “Age”, some respondents entered the “+” sign to indicate that they were more than the specific figures revealed. Alphabets were also entered where numbers were expected.

The results addressed the problem statements, which to a large extent, they did, especially those mentioned in the literature review in chapter two. However, cyber security applications are being enhanced to fortify these cyber-attacks. However, these cosmetic issues were easily amended without affecting the integrity or validity of the data. Some problems highlighted in the previous section, such as the number of participants expected in the focus group, also had an insignificant limitation on the result. Over sixty focus group, participants were contacted with the survey questionnaires, but only twenty responded. A higher number would have expanded the scope of the feedback.

5.4 Interpretation of Results

The results were largely expected based on the blockchain knowledge of most participants. Unexpected or conflicting results were those “off” the question mark due to a lack of knowledge of the terms at stake, such as cryptography, cyber security, and cyber-attacks. Some respondents who did not read the questions thoroughly or were ignorant of what was expected did not satisfactorily provide appropriate answers. However, the spirit of the letter was glaring in their feedback. When this study was in progress, the CBN launched the digital currency on a centralised platform, as it were. Digital currency is a legal tender used to transact payment and, in rare cases, make a transfer as most people have yet to register and key into the process. Cyber security was adequately provided to forestall any cyber-attacks, and so far, no intrusion into the digital currency portal has been noticed. Regulation, in this case, is not an issue as the banks' current regulatory policies still suffice. The results were based on “as is”, as they were collected raw from the respondents.

The implication to practice was already being felt with the launching of the e₦aira, as millions of people were yet to be registered. Invariably, there were issues with the widespread usage, which was below expectations. This lack of use was a critical effect of the post-implementation of blockchain technology, which is the topic of the study as it is not yet Uhuru when one considers the euphoria that attended the launching. So, if millions of potential users are yet to be registered, the benefits of financial inclusion, cross-border payment and trade financing may be a pipe dream.

5.5 Recommendations for Application

The essence of this section was to make appropriate recommendations for the application of this study and draw from the findings vis-à-vis the literature review of chapter two. As stated in the previous chapters, the findings result from the data collected and analysed explicitly in chapter three. The recommendations would span from the demographic and the research question findings.

Recommendations from Demographic Information

The number of males who participated in the survey was more than twice that of females. The suggestion would be for more females to be sensitised about the benefits of blockchain technology to society and their importance in participating in the platform. Their participation stimulated the financial inclusion that blockchain technology should promote. It was a well-known fact that despite their large population, the women in Nigeria were less exposed and enlightened because scarcely were they allowed to be educated as some in a particular region were given out to marriage at an early age.

Based on the findings' age information, anyone above 18 was recommended to participate in blockchain technology. There was no age barrier to any willing adult instead of being exposed to the "***yahoo-yahoo***" fraudulent business. The youths, in particular, were encouraged to take advantage of this opportunity as blockchain technology is a job-generating market where participants decide the areas of opportunities and partake. Aged people and the retired should also occupy themselves with the opportunity as it was said that business has no age.

If fully engaged persons show interest in blockchain technology, what should those seeking opportunities do then? The blockchain technology business can be committed on a part and full-time basis, depending on one's availability. The unemployed and those seeking opportunities should take their participation in the industry very seriously. For the fully employed, getting other sources of revenue would not be too much as everyone should have a minimum of four sources of income so that in difficult times one can at least survive on one or two sources. Business was open to all and sundry, not just for a particular level or status or even the role of one in society. The number of years one has spent in an organization is immaterial, provided such a person is not taking advantage of the opportunities at their disposal. It was even better for people with high and low status or societal roles to participate in their business thoroughly. People should realise that every big thing seen today started small, so it is essential to start somewhere and be determined to see it to fruition.

5.6 Recommendations from Research Questions Findings

5.6.1 *Research Question-1: What are the current blockchain applications that are developed for cybersecurity to mitigate cyberattacks?*

Cyber security is everyone's business as long as one participates in cyberspace. It has become pertinent for participants to be aware of cyber security tips such as phishing so that they would not be vulnerable to cyber attackers. Cyber security was akin to the security one provides for his household, especially the premises surrounding the house. Ignorance of hackers' devices has made many victims of their nefarious activities. As long as one is a player on the internet, one must be alert and cautious about what happens online. (Gulati et al., 2020) opined that cyber-attacks are getting more byzantine second by second, and one needs to go the extra mile to thwart their efforts as more business activities are taking place increasingly. They stated that one needs to be proactive and step ahead of their planned deeds.

The awareness and knowledge of blockchain/cryptocurrency (Bitcoin) showed over 92% of the feedback. This cognizance indicated that more needs to be done, particularly among uneducated people who reside in the suburbs. We are in an era where ignorance is not an excuse, so the government should extend computer literacy to all. The more they are well-informed, the better they take proactive measures to avert any attack. Employers of labour should also be encouraged to educate their staff on the intricacies of cyber security to protect the assets of the organizations and themselves.

The awareness of cyber security applications developed to mitigate cyber-attacks showed that a little over half of the respondents know of it. However, the researcher recommends that 20.6% of the respondents who claimed they do not know and 14.1% of others who responded “No” be targeted in the sensitization. Among the focus group respondents, only about 5% were aware, as against 35% who did not know and 60% who implied “No”. If this was the case among the blockchain players, one can imagine the level of cyber security knowledge among other categories.

On the risk mitigation, the findings indicated that the level of awareness was average, leaving behind many participants who were not aware. The sensitization should also cover how to mitigate risks in a business environment. People must be trained to keep up-to-date with technological development, especially in threats and cyber security. (Bouveret, 2018) postulated that cyber risk is increasing and is becoming an ongoing concern.

Sensitization on awareness of data protection is vital as it was perceived that many people would be interested in how to protect their data from unscrupulous individuals. There is an average of people who are utterly ignorant of the activities of blockchain technology. Respondents' confidence in protecting their data is still shallow (23%) and should be raised as a red flag. Efforts must be made through their organizations' awareness programs to sensitize their staff and ensure compliance to ensure integrity in the workplace.

Hypothesis-1 ***There is a relationship between blockchain payment applications and cybersecurity vis-a-vis cyberattacks***.

It was evident from the findings that there was a tripartite relationship between blockchain, cyber security and cyber-attacks. This relationship should be sustained by drawing a caution line and cyber security awareness to protect against cyber-attacks. Every anti-malware, anti-virus and anti-ransomware should be installed and updated when due. Every payment system in cyberspace was exposed to cyber-attacks, so cyber security applications should be implemented to protect data.

5.6.2 Research Question-2*: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?*

It was observed from the findings that implementing blockchain technology payment applications was easy, but the capability to sustain it is challenging to achieve. A good blockchain-based payment application should be acquired with good references and recommendations from current and experienced users.

The perception from the findings on blockchain payment applications was high (63.1%), which is quite encouraging, but efforts must be put in place to ensure an efficient system. Payment seminars, workshops and conferences should be organised to keep abreast of workers in various organizations and the private sector. The Central Bank of Nigeria must showcase in multiple arenas the digital currency to enlighten the population about their participation since 60.3% of the respondents believe that digital currency has come to stay and, therefore, all hands must be on deck to ensure its perfection. The full benefits cannot be accomplished if the populations were unaware or registered to participate in the digital currency portal; all efforts and funding would go down the drain. So, efforts should be geared towards reaching out to the users with incentives to participate.

Hypothesis-2: There is a relationship between payment and blockchain technology

The findings affirmed the relationship between payment and blockchain technology, which enables payment transactions. This relationship must be sustained to get the best out of the product. As stated in chapter two of the literature review, the essence of the implementation was the efficiency of the payment system (Chang et al., 2020).

5.6.3 *Research Question-3: How can the Central Bank of Nigeria regulate blockchain technology?*

This research question showed that 51% of the respondents believed that the Central Bank of Nigeria could regulate the blockchain technology platform if well-coordinated. The respondents suggested various proposals in the focus group feedback, including establishing standards and policies to handle the process. Others suggested regulation by proxy, where a consortium of information system auditors, bank examiners and banking supervisors should be established to scrutinise the activities of the financial institutions to regulate them.

The Banks are currently regulated in digital currency activities as they are the medium through which the services are rendered to the end-users (bank customers).

Generally, among blockchain participants, no one wants to be controlled in the system since one of the outstanding benefits of blockchain is the decentralised features that enable each player to participate without any third-party controller. A group of researchers opined that a charter having a regulatory structure should be established to monitor and supervise the ongoing transactions in the blockchain platform (Artemov et al., 2017). They firmly believe that non-regulation would cause a systemic crisis in the economy of any nation if not handled well. Some respondents proposed new legislation to regulate cryptocurrency rather than restricting the banks from operating bank accounts for their customers.

Agree that the decentralised model does not encourage regulation; however, a minimal regulatory structure that would apply surveillance on specially designated players' accounts should be sponsored. A particular respondent proposed thus: "***Blockchain could be regulated through the financial institutions when the relevant agencies play their respective roles according to the laws establishing them"***. The onus will now lie on how well the central banks would effectively regulate the financial institutions to ensure that participants are not shortchanged. The fear of this suggestion was the unethical practices between the banks and some preferred customers.

About 70% of the respondents were still hopeful that the Central Bank of Nigeria can and will be able to regulate the blockchain platform. The researcher aligns his hope with the respondents' belief that nothing is impossible if things are done correctly. However, some suggestions from the focus group respondents were not detailed enough to guide the regulatory process as stipulated below:

Setting up standards and limits

The concept of cryptocurrency is decentralisation, so regulations are, to an extent

Constant engagement with stakeholders

Governments should allow citizens to operate cryptocurrency in banks, open a crypto account, and utilise deposits and withdrawals seamlessly through their wallets to monitor each transaction.

I believe it should be self-regulated. No need for a central regulatory body

I think that when the right people do the work, things will go well

Involve key personnel in every industry.

Legislation and specialised monitoring
New knowledge
No thought yet.
Regulation would be complicated because the blockchain is built on a system of decentralisation
Regulators need to sit down with stakeholders to be able to draw up regulations for the industry
Remote regulation

Some die-hard respondents still believed that even without regulation, the blockchain platform can self-regulate without the intervention of a third party. 51.5% are confident that non-regulation would not be a distraction, but the researcher disagreed because the system would be exposed to systemic infractions that would be financially suicidal to contemplate.

The belief that a well-structured regulatory strategy and relevant stakeholders in the financial industry can be developed to regulate the blockchain market should not be jettisoned. This view was held by over 60% of the respondents. The researcher affirmed that developing a strategy was not the problem; implementing it would be the primary concern. A plan is worthless if it is not executed.

Hypothesis–3: There is a difference between the centralised and decentralised regulation processes.

Identifying the variance in a centralised system's regulation process would help proffer how to regulate the decentralised platform. The difference might be wide apart because the decentralised approach was a private-led network, while the central banks supervise the centralised system. There was nothing to worry about if a player is unlicensed by the central banks; that player cannot participate in the blockchain market. The same applied to any system not connected to the network or infected with malware, as there were no significant issues.

5.7 Recommendations for Future Research

Blockchain technology research was a relatively recent entrance into the global research world compared to research studies ongoing for donkey years. Indeed, this research study would significantly contribute to the financial institutions, CBN inclusive, academic researchers and professional organizations where blockchain technology is becoming a critical factor in the financial landscape. It is assumed that no research study has an end to itself as several researchers would continue to build on the study with time.

5.7.1 Study's Importance to the Researcher: This study reflected the researcher's desire to acquire a post-doctoral degree after the master's degree in ***Advanced Information Technology and Business Management***. The desire was so strong that I searched for a university to meet my yearning while still maintaining full-time work. The researcher applied for an online Doctor of Information Technology (DIT) program at a university in the United States of America; however, the cost was overwhelming, so I couldn't even commence successfully. A university in South Africa was reluctant to grant me admission after several attempts. I realized that if I insisted on pursuing admission in those countries, perhaps I would still be at the teaching level due to the COVID-19 pandemic because part of the requirements was to visit the universities at least twice a year. The process of passing through various institutions of learning to arrive at Unicaf University is an indication that there will always be room for improvement in future research. The technology world is evolving and there are many potentials to tap into. Therefore, it is recommended that future research should be targeted at blockchain technology, Internet of Things, Fintech and other digital technologies.

5.7.2 CBDC Revolution: When the researcher commenced this study, what crossed my mind was a dissertation on voice biometrics, but I stepped back when blockchain technology began to gain ground globally. When the Central Bank of Nigeria considered the possibility of implementing the central bank digital currency (CBDC), I opted to focus my dissertation on blockchain technology bearing in mind the challenges I encountered in the then Banking & Payment System Department, where I was redeployed to work. The payment system was quite challenging, so the thought of a new strategy to enhance the current one began to cross my mind. I opted to work independently of the committee set up on the CBDC to compare notes along the line. Blockchain technology was a unique platform to replace the present system where payment is the core and vital process of the Bank. **The CBDC is a vast area for research recommendations especially when it is still at the embryonic stage in terms of applying it to all financial transactions** (Fernández-Villaverde et al., 2021). He emphasised that the central banks could adopt the CBDC not just to eliminate fiat cash, but to engage in comprehensive intermediation through direct access to customers besides the institutional consumers while competing and regulating with the commercial banks. **This is a unique area for further research on the possibility of adopting CBDC optimally to meet contending objectives** (Ozili, 2023).

5.7.3 Further Payment System Research: The most critical problem is the payment system challenges, involving funds transfer, cross-border payment, monetization of forex to local currency, and forex sales to financial institutions and government establishments. The issues revolved around the execution of these initiatives as there were cases of delayed processing of funds, non-receipt of funds by the beneficiaries and non-impartation of one part of monetization as against two levels. The real-time gross settlement (RTGS) system was an application that performs the transfer of inter-bank and third-party funds in local currency only. These challenges need drastic action hence the proposal to suggest the implementation of blockchain technology. It was perceived that blockchain technology should be able to resolve the lingering issue and provide an efficient payment system. **Beyond the implementation of blockchain technology, future research should be focused on proposing the way forward for the resolution of these issues and improving the digital payment dimensions of the Internet of Things**.

My previous proposal was biometric voice access, but it was later discarded even though it was somehow relevant to the payment authentication due to the importance of blockchain technology and the value it would add to the payment system when implemented successfully. The absence of relevant financial infrastructure made the proposal's change imminent and inevitable. **The recommendation of adopting biometric voices as an added value in the identification of consumers in future research would boost the implementation of blockchain technology**.

5.7.5 Future Research on Cyber Security Applications: The use of cryptography to secure transactions was the most crucial reason why blockchain technology was eventually considered. Besides, blockchain technology was projected to be the primary payment channel where secured transactions and flexibility of funds movement would be guaranteed (Zhong et al., 2019). On the forex process, it was believed that funds transfer, monetization and third-party payment are pertinent processes that blockchain technology would surely be able to handle. Despite the automation of some manual processes, the manual submission of payment mandates still exists. The delayed syndrome in the payment cycle, reversal of outstanding payments to balance the reconciliation books, high cost of operation and the comfort zone imbroglio were the issues that proposed blockchain technology germane. Beyond cryptography, further research is available to improve the adoption of other cybersecurity applications to fortify the blockchain technology platform. The dependability of cryptography to secure payment and promote efficiency in the payment system was fundamental in the choice of the study. Cryptography is formidable in securing transactions and ensuring data privacy and authentication (Signorini et al., 2018). **However, future research on cryptography is still recommended to improve the security functionality along with other security applications.**

5.8 Recommendations for Future Research Findings

The kernel of this section is to make appropriate future recommendations in line with the findings from the research questions in previous chapters. Future research was always an opportunity to improve on existing studies because there would be room for improvement especially when systems were involved.

The recommendations for future research would extend to all relevant areas of the results and findings.

5.8.1 mendations for Future Research - Demographic Information

Gender: The recommendations for future research on demographic information should be directed to the involvement of a comparable number of females, as it was perceived that females were more populated than males. **This inclusion can be achieved when women-dominated areas are targeted for future research on their participation in financial inclusion**.

Institutions/Students: Academic institutions, including universities, polytechnics, colleges of education and some adult schools, can also be targeted for future research. Most adults above 18 dominate these areas and should be interested in blockchain technology. **These tertiary institutions' students, lecturers and non-academic staff would benefit from future research**. Business was not restricted to any particular age, so older people can also be targeted for future research.

Targeted Stakeholders: All workers, including fully and partly employed, total businesspersons, the unemployed and those seeking opportunities, can be targeted for future research. We have many unemployed people, which is about 35% of our population, according to the (Business Day, 2022) report. This report was scary; one can only imagine what these unemployed persons would do daily. **These teeming populations can be targeted in future research to engage them in blockchain technology**. Another perspective research was for those engaged in small, medium and enterprises (SMEs) as they ought to form the bulk of the small businesses.

5.8.2 mendations from Future Research Questions

Research Question-1: What are the current blockchain applications developed on cybersecurity to mitigate cyberattacks?

Recommending future research on cyber security would not be too much because of its importance in the scheme of things. Further research was necessary for all participants to be ahead of the cyber attackers as there will always be new devices being perpetuated by them. It was expedient that as hackers try different devices to attack systems, cyber security experts should counter and be ahead of them.

Additional research can be planned considering the respondents' over 90% awareness of blockchain technology. Therefore, it was assumed that among the literates, the knowledge of blockchain technology can be factored into future research on how to reach out to the illiterate population, particularly in the higher land and village communities. The added study can be organised to spread cyber security tips and methods of protecting the devices they use to connect to the internet.

As emphasized in chapter two and the previous sections, a person well-versed in the security implications of the environment surrounding the devices was more open to being cautious of any impending attack. Even if the user was not erudite about some technicalities concerning the devices, such a person can be advised to ask questions about what to do at any given time; for example, when a phishing message is forwarded to the device, such an operator can be counselled through further research as to what to do next.

From the findings on the awareness of cyber security applications, the respondents who indicated that they “do not know” the survey questions can also be targeted for further research on how they can be well informed. For instance, the 20.6% of respondents who claimed ignorance of what some of the survey questionnaires were all about could be a source of future research, including the participants who were unsure in their feedback and those who responded negatively.

Another example was from the focus group participants, where 35% claimed they “do not know”, and a whopping 60% indicated the opposite of yes when survey questionnaires were asked about their level of cyber security. It was a severe concern when operators of blockchain technology were feigning ignorance about cyber security. Therefore, the researcher would strongly suggest that additional research be planned to target such respondents and more in the future.

Concerning the findings on risk mitigation, the awareness level was average, implying that many participants and non-participants may not be acquainted with the issue. Considering this, further research on how to brief the populates can be prepared in future while emphasizing how to alleviate uncertainties as players in the blockchain network. This future research is paramount to keep abreast with the increase in cyber-related risks (Bouveret, 2018).

Future research should also be targeted for participants on how to protect their data from intruders. Findings showed that respondents' confidence in data protection was as low as 23%, which should be a source target for future research. If the users' confidence is low, as inferred from the feedback, then there is every possibility that they would be vulnerable to any attack on their data. More research can be targeted at these participants in the future.

Hypothesis–1 ***There is a relationship between blockchain payment applications and cyber security vis-a-vis cyber-attacks***.

Further research on the relationship between payment in the blockchain network and cyber security was highly recommended to inform them of security developments in the financial world. Future research should focus on providing more security tips and measures to prevent cyber-attacks from affecting systems. As medical people would say, "***prevention is better than cure,***" as it was more appropriate to research being proactive on protection than reacting to restore the system. Many files, including the server's operating system, would have been corrupted during restoration. And if there are no up-to-date backups, the system will be restored to its back-dated state.

Research Question-2***: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry?***

Future research on promoting efficiency in the blockchain payment system cannot be overemphasised because of the complexity of the movement of funds. Though the findings indicated that 63.1% of the respondents were averse to using blockchain technology to facilitate payment, it was vital to establish that future research on facilitating payment using blockchain technology is crucial to stimulate proficiency in the payment system.

The respondents were overwhelmingly affirmative (60.3%) of the digital currency introduced by the Central Bank of Nigeria to enhance the payment system in the financial industry. Future research can be targeted at improving the efficacy of digital currency, especially in widespread usage. The usage was abysmally low, perhaps due to inadequate sensitization. More research can focus on enlightening the users and prospective participants on the initiative's benefits. The digital currency was supposed to be another option for making payments in business transactions rather than focusing on cash payments.

Hypothesis-2: There is a relationship between payment and blockchain technology

The respondents' findings confirmed a relationship between blockchain technology and payment. Over 70% of the activities in the blockchain platform are hinged on facilitating payment from one party to the other, including investments in cryptocurrencies. It would not be out of place to accentuate that blockchain without payment facilities would be moribund since payment is an active transaction involving funds' movement. So future research should be intensified on building the relationship between payment and blockchain technology to enhance efficiency in the payment system, as also stressed in chapter two of the literature review (Chang et al., 2020).

Research Question-3: How can the Central Bank of Nigeria regulate blockchain technology?

The regulation of the blockchain technology platform is as important as paying for goods and services. The findings disclosed that over 50% of the respondents were optimistic that the central banks could regulate the blockchain platform, but the research question is how this can be achieved. In chapter three, various solutions were proffered in analysing the respondent data, and proposals were also opined in the literature review chapter.

Future research can be targeted on the submission that a **regulation framework** should be established to develop standards and policies for regulating the blockchain network. Further research in future can also target the proposal of using **proxy syndicates** to regulate the blockchain process on behalf of the central banks. As suggested in the previous section, the consortium would comprise information technology professionals, system audit, bank financial examination, and supervision, including law enforcement agencies.

Additional research in future should focus on establishing a **regulating charter** with an appropriate structure to evaluate and administer the happenings in the blockchain platform. Future research can concentrate on how to avert a possible **systemic crisis** with minimal regulation by introducing **regulatory strategies** and ensuring their implementation and compliance. Further research should also target the suggestion of a respondent that financial institutions could be mandated according to the relevant laws and guidelines to regulate the activities of their customers in the blockchain industry. The attention here is on how the central banks would effectively control the financial institutions vis-à-vis a decentralised platform. This measure can be adequately achieved when all participants are mandated to open accounts with the financial institutions and ensure that the game is played according to the rules.

Findings revealed that approximately 70% of the respondents were still expectant that the Central Bank of Nigeria should be able to regulate the blockchain platform. The researcher aligned his hope with the respondents' belief that nothing was impossible if things were done correctly. Further research on developing a strategy to regulate the blockchain industry can still be achieved in the future, as findings revealed that over 60% of the respondents indicated this feat is possible. It was essential to state that future research should also include the procedure to implement the strategy.

Hypothesis-3: There is a difference between the centralised and decentralised regulation processes.

Future research can identify the difference between the regulation processes of centralised and decentralised systems. The study should focus on the current process used to regulate the centralised platform to determine the complexities of the decentralised scheme.

5.9 Conclusions

This study was titled “**The Effects of Implementing Blockchain Technology in the Central Bank of Nigeria**”, with research questions based on the impact of blockchain technology on the payment system, the role of cyber security applications in the blockchain technology platform and how the blockchain network can be regulated.

The study's objective was to propose the implementation of blockchain technology to stimulate the payment system for efficiency, ensure the application of cyber security and facilitate the regulation of the platform in the Central Bank of Nigeria.

The conclusion of this study aligned with the findings of the result with specific reference to the research questions. The conclusive result was a playback of the research problem and significance of the study vis-à-vis the contributing factor of the literature review section and application as expressed in the previous chapters.

5.9.1 for Demographic Information

Findings from the gender of the participants confirmed that the number of males was twice more than the females as the results indicated that the difference between the males and females was 44.8%, while the ratio was 18:7. The difference among the focus group respondents was pronounced as the ratio between the males and females was 17:3, a significant variance of 70%. Therefore, it was established that the males were more than doubly involved in blockchain operations than the females.

It was long-established right from the onset of this research study that the minimum age of the participants would be 18 years, as this was initiated and confirmed in the Unicaf Research Ethics Committee (UREC) final research ethics application right through chapter one to chapter three when it was finalised. However, from the findings, 22 years was the minimum age of the participants, as most were in the working group, while the maximum was 59 years. However, the minimum age of the participants in the focus group was 18 years, while 57 was the maximum age. Therefore, it is confirmed that the age of the participants was within the adult range of 18 to 59.

The researcher concluded from the results that most (99%) of the participants were fully employed, while the others were either into full business engagement or partly into employment and business, with the rest seeking opportunities. The business/employment level of the participants revealed that they were involved in senior/executive management, junior and middle management, and corporate and SME businesses, among others specified in the focus group category, as clearly stated in chapter four. However, among the focus group respondents, a student was recorded. The business roles of the participants included information technology management, banking administration, financial management, accounting management, and research and statistics management. Other business roles include legal, medical, project, and strategic management. The different business roles are listed in the appendix segment.

It was resolved from the findings that the number of years the organization has been in operation ranged between 3-100 years, while the average year was a little over 59 years. The participants' period in their organizations oscillated between two (2) months and sixty-three (63) years, while the average year was ten years and seven months. However, the number of years the organizations had been in business in the focus group respondents was vacillated between zero years/months. Some of them are still seeking opportunities and are 72 years old.

The average years were approximately 19, while the number of years the participants have been in the organizations ranged between zero and 35 years, the maximum number of years a public servant should spend in the civil service. The average was approximately nine years. Convincingly, one could affirm that the ages of all the participants were within the stipulated age of adulthood, which was a requirement to ensure that children below 18 were not incorporated into the survey scheme.

5.9.2 for Research Questions

5.9.2.1 Conclusion for Research Question-1:

What are the current blockchain applications that are developed for cybersecurity to mitigate cyberattacks?

The researcher established from the results that cyber security was inevitable to protect data against cyber-attacks. Desktop computers, laptops, smartphones and tablets were the standard devices used to connect to the internet, and these were the means through which cyber-attacks are perpetuated. Every computer device connected to the web without any protection was exposed to cyber-attacks as the spread of these attacks increased and became more complex (Gulati et al., 2020). They opined that cyber-attacks must be overwhelmed with security measures to avert any attack due to the system's vulnerability. Liang et al. (2019) posited that there was a pertinent need to develop a relevant strategy for protecting data. Data protection was about being offensive against possible cyber-attacks by implementing security policies, anti-malware/virus applications and business continuity.

From the findings, the researcher concluded that most (91%) participants were already aware of blockchain technology through their brief knowledge of cryptocurrency or Bitcoin. In the case of the focus group, 95% of them knew about blockchain technology, as most, if not all, were already operators and investors.

Despite the vague knowledge about cryptography, the conclusion was that few (23.2%) participants still believe this component can protect data in the blockchain network. This result was expected as over 40% claimed they knew nothing about cryptography functionality. The researcher is sure that more would have approved of its efficacy if the participants knew the role cryptography plays in the blockchain network. This aspect was elaborated upon in the literature review of chapter two. However, the conclusion in the focus group was that almost half of the respondents affirmed that cryptography was strong enough to secure data in the blockchain network. The reasons for their choices were germane and were published in chapters three and four.

On the perception that cyber security applications can alleviate cyber-attacks, the researcher concluded from the acuity result agrees with almost 60% of the respondents. However, the findings in the focus group negated this perception as over 50% were of the contrary view that cyber security applications can handle data security. My take on this could result from a lack of adequate knowledge of what these cyber-security applications were developed to do. Despite this opinion and the reasons tendered by their choices, the conclusion is that cyber security applications were designed to protect the system and prevent any possible attacks.

Cyber risks are critical factors that should be considered seriously to provide relevant mitigation against them (Bouveret, 2018). Since nearly 60% indicated that cyber risks linked to blockchain technology could be mitigated, the researcher submitted that proper modalities should be implemented to alleviate the fear of the risks.

Developing data interruption systems to prevent invasion and traverse cyber-attacks intermittently is the basis for securing and maintaining data integrity (Ajayi & Saadawi, 2020). However, it may be challenging to detect coordinated attacks pre-emptively to avoid divulging the network to susceptibilities. Even when they have been seen early enough, complete data protection is still not sure-proof. The *Bayesian Inference Mechanism* was a blockchain-based disseminated structure proposed by Ramanan et al. (2020) to detect synchronized repeated attacks through broad secluded data. Farion et al. (2019) proposed a collaborated entity formed by notable organizations and shared a vision of data protection and reducing cyber-attacks to the barest minimum.

The researcher shared the conclusion for the focus group respondents' choices when they proposed using cryptography as the basis for the network, ensuring that the risks are mitigated by establishing standards and policies as control around the blockchain platform (White & Daniels, 2019).

The researcher concluded that data protection could be secured through the execution of blockchain security applications, as almost 60% of the respondents affirmed their confidence in this implementation. Hasanova et al. (2019) opined that to sustain confidence in blockchain data protection against cyber-attacks, impending weaknesses and cyber threats must be identified, and counteractions must equally be provided to combat them. According to Matthew (2019), one of the measures was to adopt a unique blockchain security application to interface and harmonise the calibration of potential solutions as most researchers implied that blockchain was a feasible technology for protecting systems. The conclusion remains even though only about one-third of the focus group respondents concurred with this feat and the point made by Lee (2019) that the decentralised nature of the blockchain coupled with the transparency feature was enough protection as no lone participant can distort and alter the ledger because of the resilient and durable structure of the blockchain system. However, their comments on their choices tend to agree with the researcher’s conclusion. The position of Lis and Mendel (2019) was that the general perception of the ability of blockchain to protect data effectively was facilitated through the awareness of the blockchain's capability to achieve it.

Despite the findings from the focus group respondents, which revealed that about 40% indicated a lack of confidence in blockchain's ability to protect data against cyber-attacks, the researcher’s conclusion remained firm that blockchain is a cyber-security enabler. Besides, the comments made by some of the respondents put paid to this conclusion as a particular respondent reinstated that it takes time for an evolving system like blockchain to stabilize. However, another respondent emphasized that the current state of blockchain technology looks steady even amid several attempts to hack into the system.

Sequel to the results presented by respondents on the consequence of using blockchain applications to safeguard and alleviate cyber-attacks, the researcher concluded, following the opinion of Alkhalifah et al. (2020), that it was evident that any blockchain operation is exposed to the risk of being attacked because of the connection of so many devices to the network. Incidentally, some of these devices might be infected with malware or viruses, and when connected to the network, there would be risks of being tainted if, on the other hand, the network is not protected (Lee, 2019). Singh et al. (2018) cautioned all organizations participating in the blockchain network to provide cyber security for their systems so as not to be the weakest link in the platform, corroborated by Das et al. (2020). The researcher professed that cyber-attacks had become a part of the system life as attempts are constantly being made to hack into the payment transactions supported (Lis & Mendel, 2019).

Conclusion for Hypothesis–1

There is a relationship between blockchain payment applications and cyber security vis-a-vis cyber-attacks.

The researcher established a multidimensional relationship between payment using blockchain technology, cyber security and cyber-attacks, apparently because of the multilateral functionalities involving the three parties. Cyber security would not be without cyber-attacks, implying that blockchain payment could not function without intermissions, which is expected in every system. The forced relationship between the tripartite parties was compelled by their objectives of what they want to achieve even if it is fraudulent.

5.9.2.2 Conclusion for Research Question-2:

How can blockchain technology facilitate payment and other financial application issues in the Nigerian financial industry?

The researcher's conclusion on using blockchain technology to facilitate payment was, at this moment, established in this study. Das et al. (2020) affirmed that promoting efficient payment is one of the crucial objectives of blockchain technology as all functional characteristics, such as validity and confidentiality, were factored into the process. Another essential characteristic is digital regulation by the central banks, which Darma and Noviana (2020) maintained could be possible by establishing an organization to focus on supervising and monitoring the activities of the financial institutions. The organization should comprise tested and experienced professionals in various fields, including law enforcement agencies. They opined that digital regulation could not be isolated in light of digital transactions in the financial market, especially in the micro, small, medium and enterprise (MSME) arena, as achieved in Indonesia.

The researcher has concluded that blockchain can facilitate efficient payment through the necessary structure adopted in the decentralised platform. This approach became pertinent when over 63% of the respondents asserted that blockchain technology could promote the efficiency of payment on the forum. The same approval was indicated among the focus group respondents. Their choices showed that while some respondents agreed that blockchain would improve digitisation in the payment system, others were confident that it would also reduce the cost of operations and cash transactions, including time reduction. A particular respondent affirmed that it was immutable and a "***trust-less protocol***" is used to facilitate irreversible payment and assure the payee and the payer.

The respondents' feedback reaffirmed the conclusion when asked if deploying blockchain technology would boost the payment system, as a little over 60% affirmed that it would. Mehrländer (2018) opined that third-party in-between financial institutions declined when blockchain technology emerged, especially in cross-border transactions. It was perceived that blockchain payment would eliminate bottlenecks in the global payment process, as corroborated by Dolinski (2018).

The researcher concluded that the digital currency launched by the Central Bank of Nigeria was the right way to go, as 44.4% agreed it would stimulate the payment system. However, the researcher observed that the usage was still shallow because few participants had keyed into the initiative. Registration is mandatory for anyone to use the app, but people are not registering. The researcher believed that with adequate awareness, 33.3% of respondents sceptical about digital currency may join the bandwagon and register, perhaps including part of the 22.2% that claimed they knew nothing about digital currency.

The researcher shared the optimism of 57.2% of respondents, which indicated that the benefits of deploying blockchain technology, such as financial inclusion and intervention, would be accomplished, while the other responses also aligned with their sentiments. The digital currency labelled **e₦aira** has the researcher's conclusion. Almost 70% of the respondents said it would stimulate efficient payment in remittances, cross-border financing, revenue collection, and trade finance, particularly among rural dwellers. However, Isaksen (2018) firmly believed that the blockchain would stimulate cross-border trade across the world's nations.

The focus group respondents also supported the researcher's conclusion when over 60% of them approved that the benefits of blockchain technology would be achieved without any doubt when implemented successfully. The reasons the respondents tendered also attested to the researcher’s conclusion, which many believed would improve transaction transparency and a well-managed payment system.

The findings from the participants confirmed the researcher’s conclusion that blockchain technology would stimulate the payment system; hence there was a pertinent need to implement it. This sentiment was supported by Holotiuk et al. (2019) when they opined that digital currency always boosts the payment system. It was reassuring that 44.4% of the focus group respondents had no contrary view to this conclusion.

Conclusion for Hypothesis-2

There is a relationship between Payment and Blockchain Technology

The researcher concluded from the results that there was a relationship between blockchain and the payment system, which was corroborated by Wong and Maniff (2020). As established by the researcher, the hypothesis was indisputably a relationship between payment and blockchain technology, which was validated by Nikiforova et al. (2019). However, Chang et al. (2020) pointed out that the financial arena was driven by Blockchain technology to enhance the efficiency of the payment system, which indicates an existing handshake between both.

5.9.2.3 Conclusion for Research Question-3:

How can the Central Bank of Nigeria regulate Blockchain Technology?

In the results of the respondents, the researcher concluded that regulation of the blockchain platform was possible, and they went further to proffer ways to embark on this phenomenon. However, (Afzal & Asif, 2019) contended that the blockchain does not need any regulation as it is self-regulated and functional. Yeoh (2017) suggested that the blockchain would need a minimum regulation to ensure participants comply with the policies. Most respondents, especially from the focus group, shared these researchers' postulations.

As a confirmation of the researcher's conclusion, over 50% of the respondents admitted that the Central Bank of Nigeria could effectively regulate the blockchain platform. Over 40% shared the same sentiment as the focus group participants. They proffered many reasons why the regulation should be possible such as regulating the blockchain platform through a proxy by setting up a consortium of professionals to handle that aspect, legislating new standards and policies to control the platform, and regulations through the financial institutions being regulated by the Central Bank of Nigeria. However, emphasis was placed on ensuring that standards and policies complied with the market rules. On the other hand, some respondents believed that regulating the blockchain platform would be difficult due to the decentralised nature of the structure, as the model does not encourage regulation.

The researcher was optimistic about almost 70% of the respondents' hopes, which affirmed that the Central Bank of Nigeria could and should regulate the blockchain industry. The several comments made by the focus group respondents were included in chapter four and under the appendix section.

Would the inability of the Central Bank of Nigeria to regulate the blockchain industry be a deterrent to its implementation? Over 50% of the participants responded that it would be a hindrance. This declaration was because many respondents may be unaware of the decentralised blockchain structure features. However, about 20% believed it would not halt the blockchain regulation. The researcher can conclude that with how the digital currency was implemented, almost 30% who claimed they knew nothing about the process might be convinced to change their minds.

With the launching of the digital currency (e₦aira) by the Central Bank of Nigeria, the researcher concluded that the applicable charter must have been implemented to promote a certified regulatory framework.

Conclusion for Hypothesis–3

There is a relationship between the regulations of centralised and decentralised systems.

The researcher has concluded that there was a connection between the regulations of the centralised and decentralised platforms. There was a significant difference in the regulation process, but the relationship is noticeable in the central banks' regulation of financial institutions.

The researcher concluded on the **null hypothesis** that there was no relationship whatsoever between the standalone systems that are not connected to the blockchain network. This null hypothesis implied that any device not linked with the internet-based blockchain has no rapport. The same conclusion also extends to financial institutions that the central banks do not license that cannot participate in the blockchain platform as there was no basis for any relationship.

5.10 Conclusion of Previous & Current Chapters

Conclusion of Chapter One: Summarily, chapter one was a collation of the background and rationale of the study, the aims, objectives, significance and nature of the study, including the statement of the research problem, research questions, design and methodology, and the scope of the study. These were recapped at the beginning of this chapter.

Conclusion of Chapter Two: This chapter was the literature review of blockchain technology that provides details of the methodology adopted, including the historical perspective of blockchain technology with appropriate definitions and background information. Current trends of blockchain technology with emphasis on central bank digital currency (CBDC) were detailed in the literature review, including the impact of blockchain technology on the payment industry's cyber security. Previous and current research studies, including the future direction of blockchain technology, were comprehensively covered in this chapter.

Conclusion of Chapter Three: This chapter was quite elaborate since it encompassed the research problem and purpose statement, research approach and methodology, including the data collection tool, sample population and focus group. Other sections include "material/instrumentation of the research tools used; ethical principles adopted, steps adopted for data collection", Jamovi, the statistical software used to develop survey questionnaires, the data analysis method, and the focus group.

Conclusion of Chapter Four: The reliability and validity of the trustworthiness of data were comprehensively highlighted in this chapter. Also included were the findings' results, evaluation of the findings involving the demographic information and research questions. Summation of the findings based on blockchain intrusion into cyber security, payment system and regulations were the concluding portion of the chapter.

Conclusion of Chapter Five: This was the last and conclusive chapter with an overview of the "problem statement, purpose statement, research method, limitations and ethical considerations", research implications, interpretation of results, recommendations for application and future research. Reflection of why the study was selected, its importance, research problem, and significance were also included. Lastly, recommendations and conclusions based on the demographic information and research questions were contained within this chapter.

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APPENDICES

Appendix A: Blockchain Technology Survey Questionnaire

Introduction

Please you are invited to complete the following questionnaire which aims at examining the **effects of implementing blockchain technology in the Central Bank of Nigeria**.

The questionnaire should only take about 7 minutes to complete and it includes 30 questions. Your responses are anonymous and will not be identified with you in any way.
I am committed to ensuring your voluntary participation in the research project and guaranteeing there are no potential risks and/or harms to you. You have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility and your identification.

You may skip any question that you find intrusive or offensive, but it will help me if you respond to as many questions as you feel comfortable with, to enable me to provide a holistic statistical result. Blockchain is simply a system of recording shared information of value among online peers in a way that makes it difficult to change without necessarily going through a third-party intermediary such as a bank. Blockchain is basically a digital ledger of transactions in digital "assets" generally, which could include "cryptocurrency" that is duplicated and distributed across the entire network of computer systems. Cryptocurrency is a digital or virtual currency designed to work as a medium of exchange. It uses cryptography to secure and verify transactions as well as to control the creation of new units of a particular cryptocurrency such as Bitcoin.

Globally, blockchain technology is gradually transforming the financial landscape in terms of decentralization, transparency, low cost of operations, secure and immediate transfer of funds, but, regulation is an aspect that is of serious concern to most central banks and this is where the challenge is of pertinent attention.
However, given the fact that Cryptocurrency have not been adopted officially across the financial industry in Nigeria, this study attempts to identify the effects of implementing blockchain technology in the Central Bank of Nigeria and propose the way forward for the implementation and regulation to ensure policy compliance within the entire blockchain network.

The objective of the survey is to assess the spread of blockchain/cryptocurrency knowledge and identify the effects of implementation in the Central Bank of Nigeria and Nigeria financial industry, examine the extent of regulating the blockchain network and explore the viability of adopting digital currency.

Consent

*I **have read** the foregoing information about this study, or it has been read to me. I **have had** the opportunity to ask questions and discuss it. I **have received** satisfactory answers to all my questions and I have received enough information about this study. I understand that I am free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of my participation in this study. I understand that my data will remain anonymous and confidential, unless stated otherwise. I consent voluntarily to be a participant in this study.*

❍ Please tick to consent * Required

Please complete all questions and make sure you follow the instructions for each question.

Participant's Background

Q1 What is your Gender? Please choose one option.

❍ Male (1)
❍ Female (2)

Q2 What is your Age? Write the exact age in years.

Q3 What is your current employment/business status? Please choose one option.

❍ Fully Employed (1)
❍ Full Business Engagement (2)

❍ Partly Employed/Business Engagement (3)
❍ Seeking Opportunities (4)
❍ Retired/Pensioner (5)

Q4 Please select one of the following that describes your Business/Employment level

❍ Junior Management (1)
❍ Middle Management (2)
❍ Senior/Executive Management (3)
❍ Corporate Business (4)
❍ SME Business (5)
❍ Others (6) Please specify ____________________

Q5 Which of the following best describe your role? Please choose one option.

❍ Financial Management (1)
❍ Banking Administration (2)
❍ Accounting Management (3)
❍ IT Management (4)
❍ Research & Statistics Management (5)
❍ Others, please specify (6): ______________________

Q6 How many years has your organization being in operation? Write the exact number in years/months.

- -------------------------------

Q7 How many years have you spent in the organization? Write the exact number in years/months.

- ------------------------------

Blockchain Status

Q8 Are you aware of Blockchain/Cryptocurrency/Bitcoin?

❍ Yes (1)
- No (2)

Q9 If ‘Yes’, how did you get to know about Blockchain/Cryptocurrency/Bitcoin? You may choose more than one option.

❍ Internet (1)
❍ Email (2)
❍ Seminar/presentation (3)
❍ Training (4)
❍ Work (5)
❍ Colleague/Friend (6)
❍ Others, please specify (7): ____

Q10 How will you assess your knowledge of Blockchain/Cryptocurrency/Bitcoin? Choose one option.

❑ Very low (1)
❑ Average (2)
❑ High (3)
❑ Very high (4)
❑ Do not know (5)

Q11 What level of participation are you on Blockchain/Cryptocurrency/Bitcoin? You may choose more than one option.

- ❑ Investor (1)
- ❑ Operator (2)
- ❑ Investor & Operator (3)
- ❑ Information Analyst (4)
- ❑ Enthusiast (5)
- ❑ Not a Participant (6)
- ❑ Others (7) Please specify…….

Q12 If giving the opportunity, how likely are you to invest in cryptocurrency this year? Select one option.

- ❍ Extremely likely (1)
- ❍ Very likely (2)
- ❍ Somewhat likely (3)
- ❍ Not so likely (4)
- ❍ Not at all likely (5)

Q13 Do you think that the gait of Cryptocurrency adoption by CBN will in turn raise the participation by the public? Please choose one option.

- ❍ Yes (1)
- ▪ No (2)
- ❍ May be (3)

Q14 Do you think there is need for further technical advances, awareness and training on Blockchain/Cryptocurrency generally? Please choose one option.

- ❍ Yes (1)
- ▪ No (2)
- ❍ May be (3)

Q15 Have you made any investment on blockchain/cryptocurrency/Bitcoin or other virtual coins before the prohibition to Banks of cryptocurrency transactions and facilitation of payment for cryptocurrency exchanges by the CBN?

- ❍ Yes (1)
- ▪ No (2)
- ❍ May be (3)

Q16 Is there any possibility that you will invest in cryptocurrency after the ban is lifted? Please choose one option.

- ❍ Yes (1)

- No (2)
- May be (3)

Blockchain Cybersecurity

Q17 Blockchain/Cryptocurrency/Bitcoin uses cryptography to secure and verify transactions? Do you believe, this is strong enough to secure the network against cyberattack? Choose one option, please.

- Yes (1)
- No (2)
- Do not know (3)

Q18 Are you aware of any Blockchain/Cryptocurrency application that is developed on cybersecurity to mitigate cyberattack? Please choose one option.

- Yes (1)
- No (2)
- Do not know (3)

Q19 Do you believe that the risks associated with Blockchain/Cryptocurrency/Bitcoin applications can be mitigated? Please choose one option.

- Yes (1)
- No (2)
- May be (3)

Q20 Do you perceive that the Blockchain/Cryptocurrency/Bitcoin applications can be protected against cyber threats? Please choose one option.

- Yes (1)
- No (2)
- May be (3)

Q21 Are you confident that transactions in Blockchain/Cryptocurrency/Bitcoin are well protected against cyberattacks? Please choose one option.

- ❑ Yes (1)
- ❑ No (2)
- ❑ May be (3)

Blockchain Payment Application

Q22 It is perceived that Blockchain Technology (digital currency) can be used to facilitate efficient payment system in the Nigerian financial industry. Do you agree with this perception? Please choose one option.

- ❑ Agreed (1)
- ❑ Disagreed (2)
- ❑ Neutral (3)

Q23 CBN stated recently that they propose to introduce digital currency by October 1, 2021. Are you certain that this would stimulate the payment system (cross-border trade, remittance improvement and revenue tax collection) in the Nigerian financial industry? Please choose one option.

- ❑ Yes (1)
- ❑ No (2)
- ❑ May be (3)

Q24 Do you perceive that implementing blockchain technology (digital currency) in the payment system would improve the current challenges plaguing the payment landscape? Please choose one option.

- ❑ Yes (1)
- ❑ No (2)
- ❑ May be (3)

Q25 Are you optimistic that the benefits of implementing blockchain technology such as financial inclusion, monetary policy effectiveness, targeted social intervention and macro management improvement, would outweigh the challenges? Please choose one option.

- ❍ Yes (1)
- ▪ No (2)
- ❍ May be (3)

Blockchain Regulation

Q26 Generally, are you hopeful that the Blockchain/Cryptocurrency network can be regulated? Please choose one option.

❍ Yes (1)
▪ No (2)
❍ May be (3)

Q27 Regulation of the Blockchain/Cryptocurrency network has been a thorny issue for global central banks? Are you convinced that CBN can regulate the process, even remotely? Please choose one option.

❍ Yes, I do (1)
❍ No, not sure (2)
❍ May be (3)

Q28 Are you hopeful that the CBN would overturn the recent ban on Cryptocurrency and adopt its implementation with the purpose of putting a structure in place to regulate the process? Choose an option.

❑ Yes (1)
❑ No (2)
❑ May be (3)

Q29 Do you perceive that inability of the CBN to effectively regulate the blockchain technology would be a showstopper to its implementation? Please choose one option.

❍ Yes (1)
▪ No (2)
❍ Do not know (3)

Q30 What is your opinion on the future prospects for Blockchain/Cryptocurrency/Bitcoin should CBN successfully implements the digital currency? Please choose one option.

❍ Has an enormous potential (1)
❍ You are certain about the future prospects (2)
❍ Appears to have some potential (3)
❍ May not sustain momentum and fade away eventually (4)
❍ No opinion (5)

I appreciate you for taking few minutes out of your busy schedule to participate in this survey.
Best Regards.
Christopher Olomukoro

Blockchain Technology Survey Questionnaire – Focus group

Introduction

Please you are invited to complete the following questionnaire which aims at examining the effects of implementing blockchain technology in the Central Bank of Nigeria.
The questionnaire should only take about 20 minutes to complete and it includes 52 questions. Your responses are anonymous and will not be identified with you in any way.

I am committed in ensuring your voluntarily participation in the research project and guaranteeing there are no potential risks and/or harms to you. You have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility and your identification.

You may skip any question that you find intrusive or offensive, but it will help me if you respond to as many questions as you feel comfortable with, to enable me to provide a holistic statistical result.

Blockchain is simply a system of recording shared information of value among online peers in a way that makes it difficult to change without necessarily going through a third-party intermediary such as a bank. Blockchain is basically a digital ledger of transactions in cryptocurrency that is duplicated and distributed across the entire network of computer systems.

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The objective of the survey is to assess the spread of blockchain/cryptocurrency knowledge and identify the effects of implementation in the Central Bank of Nigeria and Nigeria financial industry, examine the extent of regulating the blockchain network and explore the viability of adopting digital currency.

Consent

*I **have read** the foregoing information about this study, or it has been read to me. I **have had** the opportunity to ask questions and discuss it. I **have received** satisfactory answers to all my questions and I have received enough information about this study. I understand that I am free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of my participation in this study. I understand that my data will remain anonymous and confidential, unless stated otherwise. I consent voluntarily to be a participant in this study.*

❍ Please tick to consent

Please complete all questions and make sure you follow the instructions for each question.

Participant's Background

Q1 What is your Gender? Please choose one option.

❍ Male (1)
❍ Female (2)

Q2 What is your Age? Write the exact age in years.

Q3 What is your current employment/business status? Please choose one option.

❍ Fully Employed (1)
❍ Full Business Engagement (2)

❍ Partly Employed/Business Engagement (3)
❍ Seeking Opportunities (4)
❍ Retired (5)

Q4 Please select one of the following that describes your Business/Employment level

❍ Junior Management (1)
❍ Middle Management (2)
❍ Senior/Executive Management (3)
❍ Corporate Business (4)
❍ SME Business (5)
❍ Others (6) Please specify ____________________

Q5 Which of the following best describe your role? Please choose one option.

❍ Financial Management (1)
❍ Banking Administration (2)
❍ Accounting Management (3)
❍ IT Management (4)
❍ Research & Statistics Management (5)
❍ Others, please specify (6): ______________________

Q6 How many years has your organization being in operation? Write the exact number in years/months.

- -------------------------------

Q7 How many years have you spent in the organization? Write the exact number in years/months.

- ------------------------------

Blockchain Status

Q8 Are you aware of Blockchain/Cryptocurrency/Bitcoin?

❍ Yes (1)
▪ No (2)

Q9 If 'Yes', how did you get to know about Blockchain/Cryptocurrency/Bitcoin? Choose one option.

❍ Internet (1)
❍ Email (2)
❍ Seminar/presentation (3)
❍ Training (4)
❍ Work (5)
❍ Colleague/Friend (6)
❍ Others, please specify (7): ____

Q10 How will you assess your knowledge of Blockchain/Cryptocurrency/Bitcoin? Choose one option.

❑ Very low (1)
❑ Average (2)
❑ High (3)
❑ Very high (4)
❑ Do not know (5)

Q11 Please state how you intend to improve your knowledge of Blockchain/Cryptocurrency/Bitcoin

- --
- --
- --

Q12 Is your organization currently implementing—or does it plan to implement—Blockchain technology? Please choose one option.

❑ Yes, we are currently implementing Blockchain technology (1)
❑ Yes, we plan to implement Blockchain technology within the next 12 months (2)
❑ No, but we are seriously investigating the possibility of implementing Blockchain technology (3)
❑ No, and we have no plans in the foreseeable future for using Blockchain technology (4)
❑ Do not know (5)

Q13 If yes above, in what area does your organization plan to implement Blockchain technology?

- --
- --
- --

Q14 To what extent is your organization currently using Blockchain technology? Choose one option.

- ❑ We are currently experimenting with Blockchain (i.e., to validate the potential of Blockchain solutions, evaluate use cases, etc.) (1)
- ❑ We are developing prototype applications (2)
- ❑ We now have Blockchain applications in production (3)
- ❑ We expect to have Blockchain applications in production within the next 12-24 months (4)
- ❑ Do not know (5)

Q15 Please specify the extent your organization have done using Blockchain technology

- --
- --
- --

Q16 What benefits specific to your organization/industry do you hope to obtain from using Blockchain Technology? (Please select all that apply.)

- ❑ Improved business efficiency (1)
- ❑ Identifying new ways of automating business processes among partners (2)
- ❑ Better transaction integrity and visibility (3)
- ❑ Increased transaction speed (4)
- ❑ Better data protection provided by Blockchain's ability to eliminate points of failure in business networks (5)
- ❑ Lower transaction cost (6)
- ❑ Stronger working relationship with partners (via better collaboration, etc.) (7)
- ❑ Enabling new business models (e.g., in contract management, financial transaction management, identity management, etc.) (8)
- ❑ Time savings (i.e., reducing time required for settling disputes, finding information, and verifying a transaction, leading to quicker settlement and deliveries, etc.) (9)
- ❑ Reduction of risks (i.e., by eliminating the risk of collusion, tampering, and unintentional leakage of information, etc.) (10)
- ❑ Please specify others____(11)

Q17 Do you think that Blockchain technology will dramatically disrupt the industry or line of business that your company or organization operates in? Please choose one option.

- ❑ Yes (1)
- ❑ May be (2)
- ❑ No (3)
- ❑ Too early to tell (4)
- ❑ Do not know (5)

Q18 Please, in what areas do you think there would be this dramatic disruption?

- --
- --
- --

Q19. In which industries and domains do you see Blockchain Technology having the most significant impact? (Please select all that apply.)

- ❑ Banking (1)
- ❑ Digital rights management (2)
- ❑ Finance and Accounting (3)
- ❑ Government (4)
- ❑ Healthcare (5)
- ❑ Insurance (6)

- ❑ IoT – *Internet of Things* (7)
- ❑ Legal (8)
- ❑ Manufacturing (9)
- ❑ Media and Entertainment (10)
- ❑ Retail (11)
- ❑ Supply chain and Logistics (12)
- ❑ Trade (13)
- ❑ Do not know (14)

Q20 Please specify the reasons for your selection above

- --
- --
- --

Q21. What are the biggest adoption challenges to your organization's efforts to utilize Blockchain Technology? (Please select all that apply)

- ❑ Blockchain is still an emerging technology (1)
- ❑ Lack of understanding just what Blockchain can do/is good for (2)
- ❑ Identifying applicable use cases that are relevant, cost-effective, and practical to implement for our particular business or industry (3)
- ❑ Lack of experts skilled in Blockchain technology (4)
- ❑ Lack of industry standards (5)
- ❑ Regulatory constraints (6)
- ❑ Privacy and security considerations (7)
- ❑ Limited market for available Blockchain solutions (8)
- ❑ Manufacturing (9)
- ❑ Media and Entertainment (10)
- ❑ Retail (11)
- ❑ Supply chain and Logistics (12)
- ❑ Trade (13)
- ❑ Others, please specify……………………………………………. (14)

Q22. What level of importance do you attach to the development of industry standards and practices for supporting Blockchain platforms, applications, and commercial products? Choose one option, please.

- ❑ Very important--industry-standards and practices will be crucial to the successful adoption of Blockchain into end-user organizations and commercial enterprises (1)
- ❑ Important--standard frameworks and practices have a role to play in the successful adoption of Blockchain into end-user organizations and commercial enterprises (2)
- ❑ Not of much importance—Blockchain technology is unstoppable and its adoption by end-user organizations and commercial enterprises will be widespread (3)
- ❑ Do not know (4)

Q23 What level of participation are you on Blockchain/Cryptocurrency/Bitcoin? Choose one option.

- ❑ Investor (1)
- ❑ Operator (2)
- ❑ Investor & Operator (3)
- ❑ Information Analyst (4)
- ❑ Enthusiast (5)
- ❑ Not a Participant (6)
- ❑ Others (7) Please specify…….

Q24 Please what is your aspiration in participating in Blockchain/Cryptocurrency/Bitcoin in the next five years?

- --
- --
- --

Q25 If giving the opportunity, how likely are you to invest in cryptocurrency this year? Select one option.

- ❍ Extremely likely (1)
- ❍ Very likely (2)
- ❍ Somewhat likely (3)
- ❍ Not so likely (4)
- ❍ Not at all likely (5)

Q26 Please specify the reason for your choice above

- --
- --
- --

Q27 Do you think that the gait of Cryptocurrency adoption by CBN will in turn raise the participation by the public? Please specify your reasons below.

- --
- --
- --

Q28 Do you think there is need for further technical advances, awareness and training on Blockchain/Cryptocurrency generally? Please choose one option.

❍ Yes (1)
▪ No (2)
❍ May be (3)

Q29 Please specify how you think the above can be achieved

▪ --
▪ --
▪ --

Q30 Have you made any investment on blockchain/cryptocurrency/Bitcoin or other virtual coins before the ban placed by CBN? (If no, please proceed to Q32)

❍ Yes (1)
▪ No (2)
❍ Do not know (3)

Q31 Please specify the reason for your choice above

▪ --

Q32 Any cryptocurrency investment after the ban by CBN? Please choose one option.

❍ Yes (1)
▪ No (2)

Q33 Please specify the reason for your choice above

Blockchain Cybersecurity

Q34 Blockchain/Cryptocurrency/Bitcoin uses cryptography to secure and verify transactions? Do you believe, this is strong enough to secure the network against cyberattack? Choose one option, please.

❑ Yes (1)
❑ No (2)
❑ Do not know (3)

Q35 Please specify the reason for your choice above

- --
- --

Q36 Are you aware of any Blockchain/Cryptocurrency application that is developed on cybersecurity to mitigate cyberattack? Please choose one option.

❑ Yes (1)
❑ No (2)
❑ Do not know (3)

Q37 Please specify any cybersecurity application on Blockchain/Cryptocurrency that you are aware of

- --
- --
- --

Q38 Do you believe that the risks associated with Blockchain/Cryptocurrency/Bitcoin applications can be mitigated? Please choose one option.

❑ Yes (1)
❑ No (2)
❑ Do not know (3)

Q39 Please specify the reason for your choice above

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- --
- --

Q40 Are you confident that your transactions/investments in Blockchain/Cryptocurrency/Bitcoin are well protected against cyberattacks? Please choose one option.

❑ Yes (1)
❑ No (2)
❑ Do not know (3)

Q41 Please specify the reason for your choice above

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- --
- --

Blockchain Payment Application

Q42 It is perceived that Blockchain Technology can be used to facilitate efficient payment system in the Nigeria financial industry. Do you agree with this perception? Please choose one option.

- ❑ Yes (1)
- ❑ No (2)
- ❑ Do not know (3)

Q43 Please specify the reason for your choice above

- --
- --
- --

Q44 CBN stated recently that they propose to introduce digital currency by the end of 2021. Do you believe this would stimulate the payment system in the financial industry? Please choose one option.

- ❑ Yes (1)
- ❑ No (2)
- ❑ Do not know (3)

Q45 Please specify the reason for your choice above

- --
- --

Q46 Do you believe that the benefits of implementing blockchain technology would outweigh the challenges? Please choose one option.

❍ Yes, I do (1)
❍ No, not sure (2)
❍ Do not know (3)

Q47 Please specify the reason for your choice above

- --
- --
- --

Blockchain Regulation

Q48 Generally, do you believe the Blockchain/Cryptocurrency network can be regulated? Please choose one option.

❍ Yes (1)
▪ No (2)
❍ Do not know (3)

Q49 Please specify the reason for your choice above

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- --
- --

Q50 Regulation of the Blockchain/Cryptocurrency network has been a thorny issue for global central banks? Please specify in your own opinion how this can be achieved.

- --
- --
- --

Q51 What is your opinion on the future prospects for Blockchain/Cryptocurrency/Bitcoin should CBN decides to approve the implementation? Please choose one option.

❍ Has an enormous potential (1)
❍ You are certain about the future prospects (2)
❍ Appears to have some potential (3)
❍ May not sustain momentum and fade away eventually (4)
❍ No opinion (5)

Q52 Please specify the reason for your choice above

- --

- ---
- ---

I appreciate you for taking few minutes out of your busy schedule to participate in this survey.

Best Regards.

Christopher Olomukoro

Appendix B: Frequencies of Age

Frequencies of Age

Levels	Counts	% of Total	Cumulative %
22	1	0.1 %	0.1 %
23	1	0.1 %	0.3 %
24	5	0.7 %	0.9 %
25	1	0.1 %	1.1 %
26	13	1.8 %	2.8 %
27	16	2.2 %	5.0 %
28	15	2.0 %	7.0 %
29	16	2.2 %	9.2 %
30	21	2.8 %	12.0 %
31	22	3.0 %	15.0 %
32	30	4.0 %	19.0 %
33	42	5.7 %	24.7 %
34	26	3.5 %	28.2 %
35	41	5.5 %	33.7 %
36	29	3.9 %	37.7 %
37	33	4.5 %	42.1 %
38	38	5.1 %	47.2 %
39	28	3.8 %	51.0 %
40	39	5.3 %	56.3 %
41	32	4.3 %	60.6 %
42	30	4.0 %	64.6 %
43	24	3.2 %	67.9 %
44	15	2.0 %	69.9 %
45	21	2.8 %	72.7 %
46	19	2.6 %	75.3 %
47	17	2.3 %	77.6 %
48	13	1.8 %	79.4 %
49	15	2.0 %	81.4 %
50	12	1.6 %	83.0 %
51	13	1.8 %	84.8 %
52	9	1.2 %	86.0 %
53	18	2.4 %	88.4 %
54	17	2.3 %	90.7 %

Frequencies of Age

Levels	Counts	% of Total	Cumulative %
55	9	1.2 %	91.9 %
56	16	2.2 %	94.1 %
57	15	2.0 %	96.1 %
58	19	2.6 %	98.7 %
59	10	1.3 %	100.0 %

Frequencies of Focus Group Age

Levels	Counts	% of Total	Cumulative %
18	1	5.3 %	5.3 %
20	2	10.5 %	15.8 %
22	1	5.3 %	21.1 %
25	1	5.3 %	26.3 %
28	1	5.3 %	31.6 %
29	1	5.3 %	36.8 %
31	1	5.3 %	42.1 %
39	2	10.5 %	52.6 %
44	1	5.3 %	57.9 %
45	2	10.5 %	68.4 %
47	1	5.3 %	73.7 %
49	2	10.5 %	84.2 %
50	1	5.3 %	89.5 %
56	1	5.3 %	94.7 %
57	1	5.3 %	100.0 %

Appendix C: Business-Employment Level/Status/Role

Business-Employment Level

Levels	Counts	% of Total	Cumulative %
Clerk	1	0.1 %	0.1 %
Corporate Business	3	0.4 %	0.5 %
Driver	1	0.1 %	0.7 %
JUNIOR CADRE	1	0.1 %	0.8 %
JUNIOR STAFF	2	0.3 %	1.1 %
Junior	1	0.1 %	1.2 %
Junior Management	147	19.5 %	20.7 %
Junior Staff	1	0.1 %	20.8 %
Junior staff.	1	0.1 %	20.9 %
Middle Management	193	25.6 %	46.5 %
SENIOR STAFF	1	0.1 %	46.6 %
SENIOR SUPERVISOR	1	0.1 %	46.8 %
SME Business	1	0.1 %	46.9 %
Senior/Executive Management	399	52.8 %	99.7 %
junior staff	1	0.1 %	99.9 %
senior supervisor	1	0.1 %	100.0 %

Business-Role

Levels	Counts	% of Total	Cumulative %
Banking supervision and regulation	1	0.1 %	0.1 %
IT Management	15	2.1 %	2.2 %
Financial Management	155	21.6 %	23.9 %
Banking Administration	298	41.6 %	65.5 %
Bank supervisor	1	0.1 %	65.6 %
consumer protection	1	0.1 %	65.8 %

Business-Employment Level

Levels	Counts	% of Total	Cumulative %
Account Management	36	5.0 %	70.8 %
Secretarial role	1	0.1 %	70.9 %
AUDIT	2	0.3 %	71.2 %
Facility Management	2	0.3 %	71.5 %
support services	1	0.1 %	71.6 %
Research & Statistics Management	59	8.2 %	79.9 %
Investment Management	1	0.1 %	80.0 %
project management	1	0.1 %	80.2 %
Project Management	2	0.3 %	80.4 %
auditing	1	0.1 %	80.6 %
Operations	3	0.4 %	81.0 %
Engineering	1	0.1 %	81.1 %
project manager	1	0.1 %	81.3 %
Facility Management	1	0.1 %	81.4 %
Maintenance	1	0.1 %	81.6 %
Bank Examiner	1	0.1 %	81.7 %
Bank Examination	1	0.1 %	81.8 %
68	1	0.1 %	82.0 %
Security	5	0.7 %	82.7 %
Facilities Management	1	0.1 %	82.8 %
Processing disposal	1	0.1 %	83.0 %
Medical	5	0.7 %	83.7 %
Security personnel	1	0.1 %	83.8 %
Medical services	1	0.1 %	83.9 %
Security	5	0.7 %	84.6 %
Business management	1	0.1 %	84.8 %
Administration	1	0.1 %	84.9 %
Security service	3	0.4 %	85.3 %
Developmental function	1	0.1 %	85.5 %
Security and service management	1	0.1 %	85.6 %

Business-Employment Level

Levels	Counts	% of Total	Cumulative %
Driver	1	0.1 %	85.8 %
Governance, Risk and Compliance	1	0.1 %	85.9 %
operations	1	0.1 %	86.0 %
Driver	1	0.1 %	86.2 %
Inventory and Record Management	1	0.1 %	86.3 %
Development Finance	6	0.8 %	87.2 %
Operations Management	1	0.1 %	87.3 %
Banking Supervision	1	0.1 %	87.4 %
Physical Security	1	0.1 %	87.6 %
Customer Service	1	0.1 %	87.7 %
CLERICAL MANAGEMENT	1	0.1 %	87.8 %
Financial Institution Regulation	1	0.1 %	88.0 %
Construction Projects/ Facilities Management	1	0.1 %	88.1 %
engineering	1	0.1 %	88.3 %
currency control	1	0.1 %	88.4 %
Security Operative	2	0.3 %	88.7 %
Inventory Officer	1	0.1 %	88.8 %
security operations and management	1	0.1 %	89.0 %
TA	1	0.1 %	89.1 %
SECURITY OPERATIVE	1	0.1 %	89.2 %
Development finance Officer	1	0.1 %	89.4 %
development finance	1	0.1 %	89.5 %
security services	3	0.4 %	89.9 %
Security Services	2	0.3 %	90.2 %
security and safety	1	0.1 %	90.4 %
security	3	0.4 %	90.8 %
Security Officer	1	0.1 %	90.9 %

Business-Employment Level

Levels	Counts	% of Total	Cumulative %
Security services	1	0.1 %	91.1 %
CURRENCY MANAGEMENT	1	0.1 %	91.2 %
Supervision of financial institutions	1	0.1 %	91.3 %
BRANCH OPERATIONS	1	0.1 %	91.5 %
Branch Operations Department	1	0.1 %	91.6 %
Driver, grade 1	1	0.1 %	91.8 %
Corporate Security Management	1	0.1 %	91.9 %
Carrying out my duty as a driver	1	0.1 %	92.0 %
Financial management assistant	1	0.1 %	92.2 %
clerk	1	0.1 %	92.3 %
Appraisal Officer	1	0.1 %	92.5 %
Treasury Assistance	1	0.1 %	92.6 %
Clerical	1	0.1 %	92.7 %
Financial regulation & supervision	1	0.1 %	92.9 %
legal	1	0.1 %	93.0 %
Medical Services Staff	1	0.1 %	93.2 %
Learning and Development	1	0.1 %	93.3 %
Medical Services	1	0.1 %	93.4 %
Medical	1	0.1 %	93.6 %
Support Services	1	0.1 %	93.7 %
Medical service provider	1	0.1 %	93.9 %
Business administration	1	0.1 %	94.0 %
Trainer	1	0.1 %	94.1 %
Inventory	1	0.1 %	94.3 %
Learning Administrator	1	0.1 %	94.4 %

Business-Employment Level

Levels	Counts	% of Total	Cumulative %
Legal	2	0.3 %	94.7 %
medical	3	0.4 %	95.1 %
Policy Analysis	1	0.1 %	95.3 %
Driving	1	0.1 %	95.4 %
Health	1	0.1 %	95.5 %
Strategy Management	2	0.3 %	95.8 %
Project Manager	1	0.1 %	95.9 %
Financial Technology Specialist	1	0.1 %	96.1 %
security management	1	0.1 %	96.2 %
Legal Services	1	0.1 %	96.4 %
Client Relationship Manager	1	0.1 %	96.5 %
Communication Strategy	1	0.1 %	96.6 %
Record Management	1	0.1 %	96.8 %
Executive Assistant	1	0.1 %	96.9 %
Human Resource Management	1	0.1 %	97.1 %
Strategy	1	0.1 %	97.2 %
trade	1	0.1 %	97.3 %
PROVISION OF LOGISTICS SERVICE	1	0.1 %	97.5 %
Business Strategy	1	0.1 %	97.6 %
Strategist	1	0.1 %	97.8 %
Security operative	2	0.3 %	98.0 %
compliance regulatory	1	0.1 %	98.2 %
SECURITY	1	0.1 %	98.3 %
Risk Management	1	0.1 %	98.5 %
strategic management	1	0.1 %	98.6 %
Project/Initiative Management	1	0.1 %	98.7 %
manager Inventory	1	0.1 %	98.9 %

Business-Employment Level

Levels	Counts	% of Total	Cumulative %
RECORD MANAGER	1	0.1 %	99.0 %
Strategy analysts	1	0.1 %	99.2 %
SECURITY	1	0.1 %	99.3 %
LEGAL	1	0.1 %	99.4 %
Currency processing	1	0.1 %	99.6 %
Branch Operations	1	0.1 %	99.7 %
security	1	0.1 %	99.9 %
Legal Officer	1	0.1 %	100.0 %

Appendix D: Focus Group Regulation Feedback

Focus group: Has the Regulation of the Blockchain/Cryptocurrency network been a thorny issue for global central banks? Please specify in your own opinion how this can be achieved.

Opinions	Counts	% of Total	Cumulative %
By setting up standards and limits	1	7.7 %	7.7 %
The concept of cryptocurrency is decentralisation, so regulations are, to an extent	1	7.7 %	15.4 %
Constant engagement with stakeholders	1	7.7 %	23.1 %
Governments should allow their citizens to operate cryptocurrency in banks, open a crypto account, and utilise deposits and withdrawals seamlessly through their wallets to monitor each transaction.	1	7.7 %	30.8 %
I believe it should be self-regulated. No need for a central regulatory body	1	7.7 %	38.5 %
I think that when the right people do the work, things will go well	1	7.7 %	46.2 %
Involve key personnel in every industry.	1	7.7 %	53.8 %
Legislation and specialised monitoring	1	7.7 %	61.5 %
New knowledge	1	7.7 %	69.2 %
No thought yet.	1	7.7 %	76.9 %
Regulation would be complicated because the blockchain is built on a system of decentralisation	1	7.7 %	84.6 %
Regulators need to sit down with stakeholders to be able to draw up regulations for the industry	1	7.7 %	92.3 %
Remote regulation	1	7.7 %	100.0 %

Appendix E: Doctoral Studies REAF – Approved

UNICAF UNIVERSITY

REAF_DS - Version 3.1AP

UNICAF UNIVERSITY RESEARCH ETHICS APPLICATION FORM DOCTORAL STUDIES	UREC USE ONLY: Application No: Date Received:

Student's Name: Christopher Olomukoro

Student's E-mail Address: chrisolomukoro@gmail.com

Student's ID #: R1802D4615352

Supervisor's Name: Dr. Bijay K. Kandel

University Campus: Unicaf University Malawi (UUM)

Program of Study: UUM: PhD Doctorate of Philosophy - Information Technology

Research Project Title: The Effects of Implementing Blockchain Technology in the Central Bank of Nigeria

1. **Please state the timelines involved in the proposed research project:**

Estimated Start Date: 16-Dec-2019 Estimated End Date: 15-Apr-2022

2. **External Research Funding (if applicable):**

2.a. Do you have any external funding for your research?

☐ YES ☑ NO

If YES, please answer questions **2b** and **2c**.

2.b. List any external (third party) sources of funding you plan to utilise for your project. You need to include full details on the source of funds (e.g. state, private or individual sponsor), any prior / existing or future relationships between the funding body / sponsor and any of the principal investigator(s) or co-investigator(s) or student researcher(s), status and timeline of the application and any conditions attached.

2.c. If there are any perceived ethical issues or potential conflicts of interest arising from applying or and receiving external funding for the proposed research then these need to be fully disclosed below and also further elaborated on, in the relevant sections on ethical considerations later on in this form.

3. The research project

3. a. Project Summary:

In this section, fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect ensure that you fully explain/define any technical terms or discipline-specific terminology (use the space provided in the box).

The purpose of the research study is to identify the effects of implementing blockchain technology in the Central Bank of Nigeria and propose the way forward for the implementation. The underlying factor of the research study is to curtail the enormous challenges of manual, slow and operational cost processes and the pertinent need to improve the payment system using blockchain technology.

The methodology of this research study is a triangulation approach of quantitative method in a proposed online questionnaire survey that would be extended to the target respondents in a single-stage, selective/judgemental sampling process who are colleagues and contemporaries in the Central Bank of Nigeria and the financial industry. In contrast, the qualitative method is an online-focused group of blockchain operators and investors with a proposed sample population of 700. The Google and Microsoft Forms, online cloud-based applications, would design a cross-sectional survey questionnaire, data capture of respondents and analyze the data accordingly within a window of 4 weeks. Research Question-1: What are the current blockchain applications that are developed on cybersecurity to mitigate cyber-attacks?

Hypotheses-1: There is a relationship between blockchain applications and cybersecurity vis-a-vis cyberattacks.

Research Question-2: How can blockchain technology be adopted to facilitate payment and other financial application issues in the Nigerian financial industry? Hypotheses-2: There is a relationship between conventional payment and blockchain. Research Question-3: How can the Central Bank of Nigeria regulate blockchain technology?

Hypotheses-3: Does blockchain explain the relationship between centralized regulations and non-centralized regulations.

Null Hypotheses: No relationship exists between blockchain technology and unconnected, virus/malware-infested systems and unlicensed financial institutions.

The expected outcome of the research study is to ascertain the effects and propose the implementation of blockchain technology as a payment medium in the Nigerian financial industry. The potential is to recommend using CBN coins to make payment transactions between financial institutions with the Central Bank of Nigeria.

3. b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (use the space provided in the box).

The significance of the research study is to examine the current payment challenges and propose possible solutions to lingering payment challenges of existing processes with the implementation of blockchain technology to facilitate fast and secure payments and appropriate regulation. The proposed blockchain technology implementation would effectively take over this application's payment channels and ensure the flexible but secured transaction of the payment process, including the net settlement transactions.

The benefits of this implementation would span from the central bank of Nigeria to all stakeholders. The services include automation of manual processes, low cost of operations, secure transfer of money among participants in a regulated decentralized network, alert notifications, real-time or immediate money transfer and protection of transactions by cryptographic signatures to facilitate significant improvement in cybersecurity. Others are ensuring that transaction data is fraud-proof, reliable and confidential; enlarge the knowledge base of the participants and sensitization of all stakeholders; effective regulation through a non-centralized remote process that facilitates compliance of policies across the entire blockchain technology network; identify research gaps and proffer future research directions of blockchain technology.

4. **Project execution:**

4.a. The following study is an:

☐ experimental study (primary research)

☐ desktop study (secondary research)

☐ desktop study using existing databases involving information on human/animal subjects

☐ Other

If you have chosen 'Other' please Explain:

10. Final Declaration by Applicants:

(a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.

(b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.

(c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.

(d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on http://www.who.int/ethics/research/en/ and to which Unicaf University aspires.

(e) In addition, respect any relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.

☐	✔ **I agree with all points listed under Question**

Student's Name: Christopher Olomukoro

Supervisor's Name: Dr. Bijay K. Kandel

Date of Application: 29-Apr-2020

Important Note:
Save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled-in copies; **do not** hand-fill and submit scanned paper copies of this application.

Appendix F: UU_GL_Gatekeeper letter – Approved

UNICAF UNIVERSITY

UU_GL - Version 2.0AP

Gatekeeper letter

Address: Central Bank of Nigeria, CBD, Abuja

Date: 05-May-2021

Subject: PARTICIPATION IN ONLINE SURVEY

Dear Sir/Ma,

I am a doctoral student at Unicaf University, Malawi.

As part of my degree I am carrying out a study on: **The Effects of Implementing Blockchain Technology in the Central Bank of Nigeria.**

I am writing to enquire whether you would be interested and willing to participate in this research.

Subject to approval by Unicaf Research Ethics Committee (UREC) this study will be using an online questionnaire survey that would be forwarded to participants through their email and WhatsApp accounts for data collection and analysis.

The purpose of the research study is to identify the effects of implementing blockchain technology in the Central Bank of Nigeria and propose the way forward for the implementation and regulation to ensure policy compliance within the entire blockchain network. "The Effects of Implementing Blockchain Technology in the Central Bank of Nigeria" is the title of the study and my Supervisor is Dr. Bijay K. Kandel.

Participants are required to respond to the email where they are expected to complete the questionnaire survey. There would be no recruitment within any premises whatsoever apart from being a respondent to the study. Every participant would be anonymous, while data collected would be strictly confidential, and children are not expected to participate. However, there would be no request for access to personal data apart from the primary data in the survey. The estimated time for the respondent to complete the study would be four (4) weeks.

Thank you in advance for your time and for your consideration of this project. Kindly please let me know if you require any further information or need any further clarifications.

Yours Sincerely,

Student's Name: Christopher Olomukoro
Student's E-mail: chrisolomukoro@gmail.com

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