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POSSIBLE IMPACT AND POTENTIALS OF BLOCKCHAIN TECHNOLOGY IN NIGERIA

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Abstract

Nations with developing and emerging economies as Nigeria need to stimulate awareness and adoption of emerging technologies to expedite effective and efficient service delivery. One of such emerging technologies is the blockchain technology. Blockchain technology is a trending technology in the world of the internet of things (IOT). It offers distinct advantages in the world of database technology as it provides for the trustless recording of transaction data without relying on a third party, aid transparency and security. Beyond these, the recent development of blockchain 2.0 and 3.0 has shown its potential in other sectors outside cryptocurrency; such as in health and education sectors, as well as in corruption management and as a democratic tool. This paper seeks to review existing literature, case studies, and real-world applications of blockchain technology across various sectors, focusing on its potential impact on Nigerian economy. Through a comprehensive review of relevant literature, the paper aims to throw light on how blockchain technology can be used to improve transparency in the mode of transactions in Nigeria, improve electoral processes, and education management systems. As well as help in the reduction of corrupt practices.

Keywords: Africa, Blockchain, Blockchain 3.0, Blockchain Technology, Nigeria.

1.0 INTRODUCTION

Over the years, we have witnessed technological advancements across different sectors/industries, which have become rapidly accepted universally. The enormous advancements in technology have had an impact on many facets of the society. As digital integration grows, several sectors in the 21st-century are fully transitioning to the digital age, abandoning the old ways in favor of the technological one (Collins & Halverson, 2018). One of such technology is the blockchain technology. Although it is still in its early stages, blockchain technology has gained popularity in modern societies and it's rumored to be the next big thing, much as the internet was in the 1990s (Emmanuele, Mitsuhiro, & & Masatsugu, 2003).

The emergence of blockchain technology is one of the greatest digital revolutions in the 21st century, the opportunities it offers are not only limited to digital currencies but can as well play

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huge role in every sector of the society such as the education, voting, and healthcare sectors (Rawat, Doku, & Garuba, 2019). Blockchain technology has significant benefits over database technology in that it allows for the trustless recording of transaction data without the need for an existing intermediary, such as a bank in the case of financial transactions. It provides its participants with a highly secure ledger system (Romanello, 2021).

The blockchain can be termed as a public ledger, where all record of committed transactions is recorded in a set of blocks. Additional blocks are regularly added; thus, this chain expands. For user security and ledger consistency, asymmetric cryptography and distributed consensus techniques have been employed. Decentralization, persistency, anonymity, and auditability are four fundamental properties of blockchain technology. With these characteristics, blockchain can significantly reduce costs and increase efficiency (Zheng, Xie, Dai, Chen, & Wang, 2017). The absence of efficient formal institutions, rules, laws, and regulations, as well as their enforcement, can be addressed (Romanello, 2021). Although adopting blockchain technology is feasible in the face of appropriate law. Though, it might be a challenge for a regulatory body to control a new and developing technology like blockchain (Romanello, 2021). It is also important to note that cryptocurrencies are a small part of what represents the potential of this technology (Romanello, 2021). It is in light of this, that this paper gives an overview of blockchain technology, its need in Nigeria, and some possibilities that it can provide in Education, Voting, Healthcare sector, and Business industries.

2.0 OVERVIEW OF BLOCKCHAIN TECHNOLOGY

Mougayar (2016) outlines three distinct definitions of blockchain: one from a technical perspective, another from a business standpoint, and the third from a legal angle. Here are the explanations for each of these definitions.

a. From technical point of view, blockchain can be defined as a back-end database designed to store a distributed digital ledger accessible to peers and the public (Mougayar, 2016).
b. From business point of view, blockchain is described as a platform enabling asset exchange and transactions among involved parties without relying on a trusted third party as an intermediary in the transaction process (Mougayar, 2016; Bashir, 2017).
c. From legal point of view, blockchain acts as a mechanism capable of validating transactions, rendering intermediaries unnecessary (Mougayar, 2016)

According to Anders & Jørgen, (2016), Blockchain can also be programmed to automatically trigger transactions using smart contract technology. One major reason as to why Blockchain technology is so useful is because it solves the double-spending problem, using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions. The concept of blockchain can be used not only in cryptocurrency and financial sectors, it would not be wrong to argue that its potential could extend far beyond digital money.

Anders & Jørgen, (2016), further posit that, blockchain can also be viewed as a gigantic google doc spreadsheet that represents a registry of tangible and intangible assets like currency, documents or physical property. In essence a blockchain is a distributed ledger where each block in the chain contains a number of transactions, and every time a new transaction occurs on the blockchain, a record of that transaction is added to every participant's ledger.

Studies from Crosby, et al., (2016) says a blockchain is a peer-to-peer electronic network and a distributed database of transactions or public ledger of all records or digital events that has been executed and shared among participating parties.

Linn & Koo, (2016) point that blockchain is a digital technology for the present and future generation, and entails transparency and trust for transactional applications. Table 1 shows a summary of the different generations of blockchain.

Table 1. Development of Blockchain (Baiod, Light, & Mahanti, 2021)

GENERATION	KEY FEATURES	EXAMPLE APPLICATIONS
Blockchain 1.0	Focus on decentralized and secure peer-to-peer transactions	Bitcoin
Blockchain 2.0	Automated and trustless transactions	Ethereum, Smart Contracts
Blockchain 3.0	Explores applications in Web 3.0, Metaverse, DeFi	Health records management, Digital identity verification, Smart cities

The application of digital currency (i.e Bitcoin) represents Blockchain 1.0. It was the first application of blockchain technology that was implemented by Nakamato, (2008). This version enabled the distribution, issuance and transaction of digital cryptocurrencies. Examples of Blockchain 1.0 implementation are cryptocurrencies such as Bitcoin, dogecoin and Litecoin. Today, there are hundreds of cryptocurrencies available in the crypto space (Mukherjee & Pradhan, 2021).

The next development in blockchain technology was Blockchain 2.0, which expanded by enabling users to develop Smart Contracts that will run on the blockchain technology. In simple terms, Smart contracts are set of instructions that are automated only when certain conditions are met. Ethereum was the first and commonly used blockchain-based platform that supports smart contract (Li, Jiang, Chen, Luo, & Wen, 2017). The next level of blockchain technology was Blockchain 3.0, which has a broader scope in terms of industries and sectors it can incorporate. In another terms, this means blockchain has applications extension in a broader set of industries outside finance and economics (Aras & Kulkarni, 2017).

Blockchain's goal according to Gatteschi, et al., (2018), was to eliminate the need for middlemen in the transfer of online payments between parties. The researchers revealed that Blockchain serves as an underpinning ledger for documenting Bitcoin transfers by utilizing cryptographic procedures for payment authentication and non-repudiation.

2.1 THE STRUCTURE OF BLOCKCHAIN

A blockchain is made up of blocks, which each block containing the information of all transactions data, its own hash value (a unique cryptographic value consisting of characters and numbers generated through a complex computational algorithm), and a pointer to the hash of the block that came before it (Aneesa, 2022).

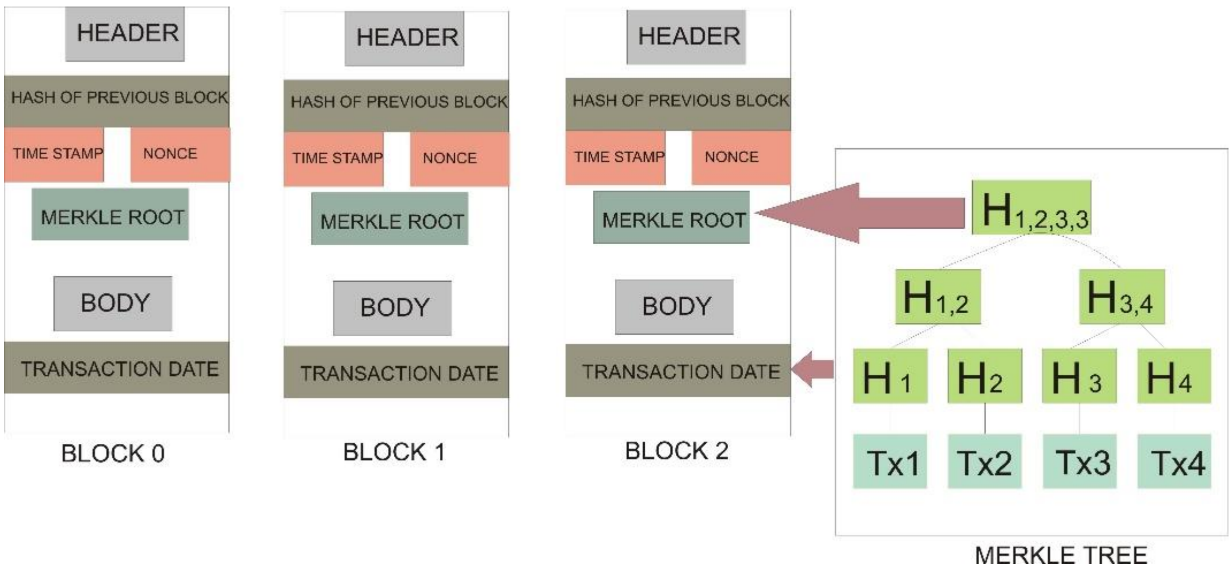

Figure 1. The Structure of Blockchain (Liang & Liang, 2020)

A block is composed of a header and a body as shown in figure 1, where a header contains a reference hash of previous block links these blocks to each other, a timestamp, Nonce and the Merkle root. The Merkle root, stored in a block's body, represents the root hash of a Merkle tree. Using the example of the 3rd block, containing only four transactions, as an example to illustrate the structure of a Merkle tree.

For example, in a scenario like the Blockchain network, where trust may be lacking, transactions are validated and authenticated using digital signatures based on asymmetric cryptography (Zheng, Xie, Dai, Chen, & Wang, 2017). Each participant in the network possesses a pair of private and public keys. The public key, accessible to all participants and distributed across the network, is utilized for decryption. Meanwhile, the transaction is signed or encrypted with the private key, enabling subsequent decryption.

2.2 HOW BLOCKCHAIN WORKS?

In a decentralized Blockchain network, nodes utilize private key cryptography-based digital signatures to initiate transactions, which represent the transfer of digital assets as a data structure among peers. A pool of unconfirmed transactions stores all transactions, while a Gossip protocol facilitates their propagation throughout the network. Peers then select and validate these transactions based on predetermined criteria (Karame, Androulaki, & Capkun, 2012); (Kroll, Davey, & Felten, 2013); (Nakamoto S. , 2008).

2.2.1 CONSENSUS

Gad, Mosa, Abualigah, and Abohany (2022) discuss the concept of consensus agreement, tracing its origins to the context of war strategy where generals must agree on a course of action to avoid mission failure. They emphasize the challenge of achieving consensus in distributed networks like blockchain, where nodes cannot be centrally verified for identical ledgers. Consensus protocols are crucial for ensuring node consistency and coherence of data, thereby addressing issues like double-spending and the Byzantine Generals' Problem (Zheng, Xie, Dai, Chen, & Wang, 2017). Common consensus algorithms such as Proof-of-Work (PoW), Proof-of-Stake (PoS), and Practical Byzantine Fault Tolerance (PBFT) are highlighted as mechanisms for achieving agreement in decentralized networks (Gramoli, 2020).

Furthermore, the authors outline the process of validating a transaction in the blockchain network, which involves broadcasting the transaction on a peer-to-peer network, using algorithms like Elliptical Curve Digital Signature (ECDS) for validation, creating a new block for the ledger, and appending it to the existing blockchain once verified. They emphasize that consensus mechanisms like ECDS help in ensuring the authenticity of transactions and preventing issues like double-spending. Figure 2 demonstrates the blockchain process.

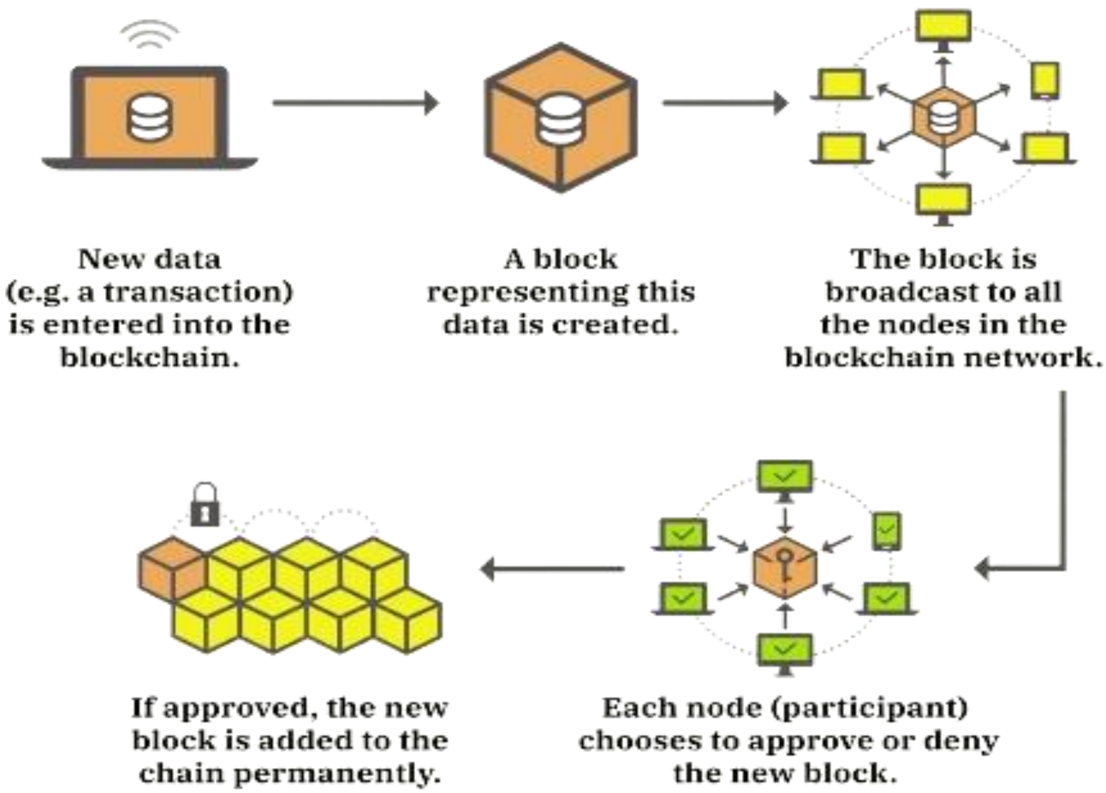

Figure 2. Blockchain Process (Gabriel & Rodriguez, 2022)

2.3 CHARACTERISTIC OF BLOCKCHAIN

According to Zheng, Xie, Dai, Chen, & Wang, (2017), some of the main characteristics of blockchain are as follows:

a. DECENTRALIZATION: Decentralization in transaction systems shifts from centralized authorities to peer-to-peer (P2P) blockchain networks, eliminating the need for trust in intermediaries. This paradigm reduces costs and improves efficiency by leveraging blockchain's consensus mechanisms. While there are trade-offs like higher server and energy costs, the benefits of decentralization, such as enhanced security and efficiency, outweigh these drawbacks. Blockchain's consensus algorithms maintain data consistency across distributed networks, rendering third-party intermediaries unnecessary.

b. IMMUTABLE: Transactions undergo validation within a short timeframe, and if miners detect any unauthorized transaction, it will be rejected from inclusion in the blockchain. Once a transaction is added to the blockchain, it becomes immutable, meaning it cannot be deleted or altered thereafter.

c. ANONYMITY: In order to preserve anonymity, users can engage with a Blockchain network using multiple randomly generated addresses within the system (Wang et al., 2017). Being decentralized, the Blockchain does not track or record users' private information through a central authority. This trustless environment offers the possibility of a degree of anonymity.

d. AUDITABILITY: In a Blockchain network, transactions are recorded and validated using a digital distributed ledger and timestamp. This enables easy auditing and tracing of previous records if any node in the network is accessed (Yu et al., 2018). For instance, in Bitcoin, it is feasible to systematically trace all transactions, ensuring the audibility and transparency of the Blockchain's data state. However, tracing the origin of money becomes challenging when it passes through numerous accounts.

2.4 TYPES OF BLOCKCHAIN

In practice, blockchain technology can typically be classified into the following categories (Zheng et al., 2017):

a. Public Blockchain: A public blockchain is openly accessible to all participants in the network, allowing anyone to verify transactions and participate in the consensus process. Examples of public blockchains include Bitcoin and Ethereum (Bashir, 2017).

b. Private Blockchain: In a private blockchain, participation is restricted to authorized nodes with stringent access controls managed by authorities. Examples include Hyperledger Fabric, developed by the Linux Foundation (Antwi, et al., 2021)

c. Semi-Private Blockchain: A semi-private blockchain combines elements of both public and private blockchains. In this context, authorized nodes are predetermined, often reflecting business-to-business partnerships. The data is partially decentralized, and examples of this model include consortium blockchains such as Hyperledger and R3CEV (Bashir, 2017).

3.0 DISCUSSION

POTENTIAL USES OF BLOCKCHAIN TECHNOLOGY IN NIGERIA

Blockchain technology has the potential to solve many of the challenges that Nigeria faces; such as corruption, education management, healthcare, voting and more. The subsections that follow will look at some sectors/areas where blockchain can be used to improve the quality of life in Nigeria.

3.1 BLOCKCHAIN AS ANTI-CORRUPTION TOOL

Corrupt practices such as data manipulation, security of data, concealing of facts, and money laundry are some of the impunities bedeviling Nigeria (Faith, 2023). Reports has shown how African countries make up most of those that are most corrupt in the world with Nigeria in the top 10 ranking (Richman, 2023). In Nigeria, the use of blockchain technology could greatly benefit the economy help eradicate corrupt practices (Tomslin, 2020). Blockchain has two distinct features that make it a powerful anti-corruption tool in the area of transactions record. Firstly, the security of the information and the validity of the data it controls are excellent. Blockchain eliminates the possibility of data manipulation and failure. Also, it enhances information availability, diminishing the capacity of bureaucrats to conceal specific facts (Romanello, 2021). Secondly, blockchain provides a transparent and decentralized framework for recording a series of transactions. Because transactions are stored chronologically, producing an immutable chain, blockchain creates an unalterable trail of transactions, providing for full transaction traceability. As a result, a public blockchain gives prosecutors and law enforcement officials a tool for detecting illegal conduct or wrongdoing by leaving enough digital traces to isolate corrupt behavior (Santiso, 2018). With these, blockchain enables for the reduction or elimination of integrity breaches such as fraud and corruption while also lowering transaction costs (Kshetri & Voas, Blockchain in Developing Countries, 2018a).

3.2 BLOCKCHAIN AS A DEMOCRAETIC TOOL

One of the ever-occurring challenges in our democratic process in Africa at large is the issue of vote tampering, electoral result manipulations as alleged in African countries like Nigeria, Cameroun, Kenya e.t.c. (Adejumobi, 2000). In Nigeria, Blockchain is believed to be a promising technology that can be used in the electoral process. It can be used to create voting records that are cryptographically secured. Votes recorded precisely, permanently, securely, and transparently (Kshetri & Voas, Blockchain-Enabled E-Voting, 2018b).

There have been several proposals for the use of blockchain-based voting systems. An example is the West Virginia Secretary of State's office, which made use of a blockchain-based voting system in 2018 for military personnel overseas. The system developed by Voatz, a Boston startup, utilized a mobile app and biometric authentication to allow military personnel to cast their ballots remotely. The system works by recording votes on a blockchain. A voter's identity is verified using biometric tools like a thumbprint scan and then they vote using a mobile device (Zhang, Young, & Verhulst, 2018).

Another prominent work is the one by Fusco et al. (2018), where they designed an e-voting system called Crypto-voting that uses permissioned blockchain technology. The system consists of two linked blockchains: one for recording voting procedures and voters, and the other for counting votes and providing results. The system emphasizes the anonymization of the network consensus nodes. Smart contracts handle voting procedures and results. The system enhances the efficiency of the validation phase, the allocation of the votes to the alternatives, the automatic management of electoral lists, the secure timing of voting abroad, the integration of the identification process voting secrecy, and the automatic and reliable technique to ensure voting security. Utilizing blockchain in electoral systems is purported to decrease national expenditures. Estonia is among the countries that have implemented blockchain technology in its e-voting system called KSI blockchain (Heller, 2017) .

3.3 BLOCKCHAIN IN HEALTHCARE

In the health sector, there are transactions where transparent and immutable record keeping may also be important, such a medical records or other related health data (Jillian & Luke, 2020).

In Nigeria, the healthcare industry is faced with lack of proper records. Blockchain technology is projected to improve medical record administration and insurance claim procedure, accelerate clinical and biomedical research, and develop biomedical and healthcare data ledger technology (Yoon, 2019). Moreover, blockchain technology enables patients to set restrictions for their medical data, such as granting particular researchers access to sections of their data for period of time. Through blockchain, patients can connect to other hospitals and have their medical data collected automatically (Gordon & Catalini, 2018).

MedRec, as described by Azaria, Ekblaw, Vieira, & Lippman, (2016), is a healthcare blockchain solution that utilizes public key cryptography. Employing Ethereum's smart contracts, MedRec creates representations of existing medical records. All network participants receive a copy of the blockchain. Blockchain technology facilitates automation and tracking of specific tasks, such as adding new data or altering data access rights. MedRec has also introduced a mining model involving the healthcare community within its network. This platform stands as one of the solutions for securely storing and disseminating health data using blockchain technology.

Blockchain can also play a role in ensuring quick diagnosis of diseases as observed in “Care Ai” that was launched by The European Commission in June 2018. It is a digital computer system connected to a blockchain that uses a patient’s blood sample to quickly diagnose diseases (malaria, typhoid fever, tuberculosis, etc.) without the presence of a physical doctor (Romanello, 2021). The computer system is engineered to help the invisible demographic of migrants, ethnic minorities, and those unregistered within traditional healthcare systems. So, it is possible for these invisible groups to get access to basic healthcare, and useful appropriate information without compromising their identities, for fear of deportation. In Nigeria, this will also be important for all societies, because without access to health services, these communities of persons may endanger the health status quo of the whole population (Ekekwe, 2018). In most rural areas in Nigeria, where there is little to no available medical personnel, similar approach used in “Care Ai” can be used in the diagnosis of diseases using blockchain across those regions.

3.4 BLOCKCHAIN IN EDUCATION

In Nigeria, accessing credentials, academic records and the validation of transcripts are mostly done through a vague process in the traditional educational method. This has posed several challenges in the processing and timely dispensation of certificates, student transcripts when needed and has allowed corrupt practices like bribery to creep into the process and thus deterring expansion and growth (Effiong, 2020).

Alammary, et al., (2019) highlighted over twelve categories where blockchain can be applied in education setting in his systematic review of blockchain-based applications in education. However, some applications will be discussed as they relate to the Nigerian education system.

In a world where piracy and fraud are an entity that kills the fabrics of authenticity, there is the need to generate a system when credential, certificate and achievements of students can easily be assessed and authenticated. Devine, (2015) argued that the blockchain technology can serve in this area by enabling the easily shareability of students’ academic record and certificate verification between employers and universities. For example, an academic initiative named Digital Credentials Consortium was built in 2018 for educational institutions, employers, and learners who sought a more efficient, secure, and transparent way to manage credentials and verify achievements to ease the vague process in the traditional educational method. The platform aims to provide students’ academic records digitally in a secured way, without the need of the students paying or asking their school for copies of their transcripts. The platform also holds a verified, lifelong record of students’ academic and learning achievements to share with employers when the need arises (Steiu, 2020).

Another example was the implementation of management of certificates and identities Blockchain applications used by educational institutions, with include the University of Nicosia's offering of accredited courses via verifiable certificates on the blockchain (Bartolomé, Torlà, Quintero, & Segura, 2017) and Southern New Hampshire University issuing its College for America students their bachelor's or associate degrees in a digital format on the blockchain in addition to a traditional paper format. These are already practicable ways that has already been implemented in other countries and thus can be replicated in Nigeria to ensure a better education system

3.5 OTHER APPLICATIONS AND USE CASES

Blockchain can be widely used in many fields, one of which is Business and industrial application. (Zhang & Wen, 2017) proposed a business model in which smart contracts on a Blockchain distributed database are used to perform transactions between devices. Blockchain applications could potentially serve as a tool to combat poverty in the humanitarian sector and philanthropy, as noted by Kewell et al. (2017) and Larios-Hernández (2017). Another intriguing application of blockchain technology is within the realm of social media. For instance, user-centric blockchain applications could enable end-users to assert ownership, trace, and manage all their shared content, as proposed by Chakravorty and Rong (2017). Finally, Blockchain may be employed in any circumstance where a trusted third-party is not required or a peer-to-peer system is required for transaction management as outlined by Zheng, Xie, Dai, Chen, & Wang, (2017).

4.0 CONCLUSION

Blockchain technology is a digital technology that allows people to create a digital record of transactions that cannot be altered. It is primarily used in the financial world, but it is also being explored in other fields outside finance. Based on the technology impact, the technology can be used in Nigeria, as it has the potential to help reduce corruption, electoral result manipulation, increase transparency, provide data security, and improvement of education management systems. With a very promising future, it can be observed that Blockchain technology has the potential to foster innovations and is expected to revolutionize computing in several areas such as voting, Healthcare services, Education, Business industries, and where centralization was unnatural and privacy important. Therefore, the governments need to embrace this new and disruptive technology.

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