The Role of Blockchain Technology and Cryptocurrencies in the Digital Economy

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***Abstract*—Significant developments have been made in the financial sector through cryptocurrencies specifically bitcoin towards the adoption of blockchain technology compared to other sectors. It is estimated that by 2025, 10 percent of global GDP will be on the blockchain. Over 80% of prior research work on blockchain has focused on cryptocurrencies and 20% on other sectors. Findings show that blockchain technology plays a significant role in promoting trust, enhancing social cohesion, facilitating funds transfer, Initial Public Offers (IPOs), global commerce, and elimination of the intermediaries, hence, efficiency. There is exponential growth in the application of blockchain across other spheres such as healthcare, the Internet of Things (IoT), cloud computing, and smart contracts. Implementation of blockchain technology in transportation and accommodation such as Arcade City is challenging the current Uber business model by allowing commuters to transact directly with taxi drivers. However, blockchain may not be entirely immutable as nodes with superior computing power may do anything from changing the blocks to manipulating transactions. Full adoption of blockchain technology may impose significant risks to banks ranging from cyber-attacks to loss of financial and nonfinancial data and capital investments for early adopters migrating from legacy systems.**

***Keywords*—blockchain technology, cryptocurrencies, blockchain for financial services, blockchain immutability, shared economy applications, blockchain for other sectors**

I. Introduction

Multiple studies have been conducted to assess the current and prospects of blockchain technology across multiple domains beyond crypto-currency. The blockchain is a distributed ledger system in which financial and nonfinancial information can be stored and shared between multiple computers and users across the globe. There are three types of blockchains namely public (client-server), private (peer-to-peer), and consortium/federated blockchains. Also, there are multiple blockchain ecosystems and cryptocurrency (Bitcoin, Ethereum, Litecoin, Ripple, and Dash) is just one of the blockchain technology applications.

The public blockchain is an open database or network where the participants can create, read, and amend the cryptocurrency ledger (Gatteschi *et al.*, 2017). On the contrary, private blockchains are regulated such that all the participants ought to subscribe to similar rules in dispute settlement (Yoo, 2017). Consortium blockchain is a hybrid of private and public blockchain where the rules governing the conduct of participants are set by the association rather than individuals (Oh & Shong, 2017). Overall, there are technical and business rules governing the conduct of the participants in all three types of blockchains.

In the public blockchain, access, creation, or amendment to the cryptocurrency ledger is subjected to an authentication process known as mining. Authentication or integrity checks and security of data are dependent upon the trust among the participants, though trust may not be guaranteed at all times. Unlike the Society for Worldwide International Funds Transfer (SWIFT) used in banking and financial institutions, in a public blockchain, the participants can join and opt-out anytime without seeking or obtaining permission from anyone.

II. Blockchain Technology Analysis

The blockchain operates in a multifaceted ecosystem that affords all users the ability to write to the ledger without disclosing their identity. Important elements of blockchain include; decentralized operations, data storage in the blockchain network, and anonymity though some users may disclose their identities to the participants they know and trust.

The user's ability to authenticate previous blockchain transactions using cryptography, digital signatures, and reference numbers for each block offers an authentic audit trail and unparalleled data security. Despite the stringent

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authentication, malicious actors may still invade the blockchain and unilaterally operate parallel verification processes unnoticed. Blockchain technology offers users the ability to verify data integrity at the source, hence, minimizing fraud. Despite the stringent network security protocols of the blockchain, Interpol through ethical hacking has demonstrated to the blockchain operators the possibility of a cyber-attack using malware and the ensuing catastrophic effects on the database.

Innovation in the financial services industry is partly technological, and customer needs driven. Consequently, banks in advanced economies have embarked on studying how they can use blockchain technology to transform banking and financial services. However, cyber security concerns on the safety of customer's money and information are still a major concern and a threat to the existence of banks and financial services providers.

Blockchain technology can facilitate the exchange and storage of value by providing a secure and timely settlement of claims that is expected to replace third-party confirmation in brokerage, custodianship, and trade finance. Real-time updating of blockchain can afford banks accurate data and timely reporting capabilities. Banks can use blockchain technology to simplify budget and capital planning, financial and regulatory reporting including liquidity management through a single version of the general and subsidiary ledger system, thereby eliminating time-consuming and costly reconciliation. However, blockchain technology is still at a nascent stage, and some financial institutions including banks regard the technology as a risky and disruptive innovation.

III. Blockchain Technology in Banking and Financial Services

Scott *et al.,* (2017), conducted a study on the rise of blockchain technology for distributed collaborative organizations. They sought to understand the importance of cryptocurrency and blockchain technology in building accessible and sustainable financial services in society. Findings show that blockchain technology plays a significant role in promoting trust, enhancing social cohesion, facilitating funds transfer, and global commerce, and eliminating intermediaries. They view blockchain technology as the latest disruptor traversing beyond the financial services industry. However, while the authors expounded the positive effects of the blockchain technology they did not discuss the adverse economic and social effects on the would-be displaced intermediaries in the society.

A study on the effects of blockchain technology on modern business models by Nowinski and Kozma (2017) shows that blockchain technology could support transaction authentication of traded goods, facilitate disintermediation by eliminating third parties, and improve operational efficiency due to a short transactional processing cycle. To comprehend the connection between blockchain and business models of financial institutions, Oh and Shong (2017) found that blockchain is an important financial services intermediation institution that can help in the introduction of an efficient database system, modification or replacement of business models and the underlying financial services including a change in financial transaction patterns of consumers.

In their quest for more knowledge on the suitability of blockchain and smart contracts for the insurance business, Gatteschi *et al.*, (2017) found that there are many use cases and prototype solutions for private blockchain technology and smart contracts for the insurance sector. The researchers concluded that the maturity and, hence, adoption of blockchain technology in the insurance sector is not expected shortly and still needs several improvements.

A. Blockchain Technology in Accounting and Supply Chain Management

In a study on the emergent industry adoption and implications of blockchain for accounting, the authors analyzed blockchain technological features, its achievements, and ongoing initiatives in the Big Four accounting firms. The main objective of the study was to acquaint practitioners with technological advancements in the areas of blockchain. Findings show that blockchain may transform the processing of payments, bills, agreements, and documentation, thus has many implications for accounting and finance professionals and regulators (Kokina *et al.,* 2017). The authors pointed out that blockchain-based services may benefit different industries including supply chain management, accounting, government, and real estate as well as e-commerce and legal services. For example, specific block-chain-related initiatives in the Big 4 accounting firms include Deloitte Rubix, EY Ops Chain, and the PwC DeNovo platform. However, the researchers did not state how and in which areas of accounting where the most efficiencies are realized through the use of blockchain technology (Kokina *et al.,* 2017).

Coyne and McMickle (2017) sought to establish if blockchain can serve an accounting purpose. A case study of the Byzantine General's Problem was used to underpin a problem the blockchain technology is trying to resolve and to justify how the technology does not provide a proper solution in the context of financial reporting. The authors found that accounting ledgers require transaction verification, confidentiality, and security which may not be available in the blockchain technology, hence making blockchain untrustworthy in accounting. Moreover, financial reporting is quite different from other database management, hence creating a gap that may not be easily filled by the blockchain.

The authors also found that adopting blockchain could eliminate the behavior of manipulation of accounting ledgers by firms. However, the authors cautioned that their findings on the unsuitability of blockchain still require further research to untangle its inapplicability in financial reporting (Coyne & McMickle, 2017). Furthermore, according to Deloitte (2016), full adoption of blockchain technology in auditing may necessitate the emergence of a triple-entry accounting system to accommodate the verification process that is currently being performed outside the conventional accounting system.

A study was conducted on blockchain-based financial case analysis and its implications by Yoo (2017). Yoo examined the applicability of blockchain in the financial industry based on Korean domestic and foreign markets. Findings show that blockchain applicability is more apparent in smart contracts, payment clearance, securities, funds transfer, and customer verification. The authors also found that private blockchain is attracting attention in interbank payments, and financial institutions need a consortium to benefit from the application of blockchain technology. The author highlighted the need for further research on the cost of existing systems concurrently with the efficacy and security of blockchain technology.

Research on the distributed ledger for the supply chain physical distribution visibility was conducted to establish a proper solution for managing data flow from suppliers, manufacturers, distributors, and retailers to the customer. Wu *et al.,* (2017) analyzed the existing Enterprise Resource Planning system (ERP) in the supply chain management including private and public blockchain ledgers. The researchers developed a blockchain validation framework for online shipment monitoring for use by stakeholders in the supply chain. The framework integrated distributed databases, private-public blockchain architecture, and peer-to-peer networks, hence, striking a balance between the privacy and transparency requirements of the respective stakeholders.

A study on the potential of blockchain technology for building management was conducted by Klinc and Turk (2017). A review of the literature was used to evaluate the ability of blockchain technology to address the outstanding building management challenges around legal and security issues. The researchers found that blockchain may be used to address legal and security issues by providing a reliable groundwork for information management in all building life-cycle stages. Thus, blockchain may provide a reliable infrastructure for information management, a robust audit trail, integrity of records, and secure data storage such as reliability and trustworthiness of construction logbooks, works performed, and material quantities recorded (Klinc & Turk, 2017). Despite the immense benefits of blockchain technology in addressing the limitations of Building Information Management (BIM), researchers did not describe how data migration from BIM files to blockchain could be effected seamlessly.

B. Blockchain Technology in the Internet of Things (IoT)

Research on the applications of blockchain technology beyond cryptocurrency was conducted by Miraz and Ali (2018). The researchers reviewed the literature on blockchain implementation in varied sectors. Findings show that there is an exponential growth in the application of blockchain across other spheres such as healthcare data, Internet of Things (IoT), cloud computing, and smart contracts precipitated by the security, privacy, and decentralization of blockchain technology. It is estimated that the adoption of blockchain technology may mature in the next five instead of the earlier estimation of ten years (Miraz & Ali, 2018). However, researchers' contention that blockchain technology is incorruptible lacks substantive evidence (Conte *et al.,* 2017). Thus, further research is imperative to overcome the threat posed by additional processing power requirements from IoT.

A study on the Internet of Things, blockchain, and shared economy applications was conducted by Huckle *et al.,* (2016). The authors sought to understand how peer-to-peer (P2P) applications can benefit from blockchain and Internet of Things technologies in wealth creation. Findings show that the maximum benefit of P2P applications to consumers may be derived from the integration of blockchain technology and IoT. Blockchain technology applicability is apparent in the transportation and accommodation sectors and is challenging the existing business models such as Uber, Lyft, Taxify, and Airbnb. For instance, the recent introduction of Arcade City is a significant threat to Uber and Taxify's business models.

Research was conducted to find out how blockchain technology can be applied to the energy internet to ensure sustainability in energy systems (Wu & Tran, 2018). The researchers described the blockchain and energy internet from various literature reviews and later explained the applicability of blockchain technology in the energy internet. It was found that the energy internet and blockchain technology are compatible in that the latter provides a good opportunity for the development of the energy internet by addressing the issues that impair its development such as control and management of various distributed energy systems. The researchers based their study on developed economies such as Japan where blockchain technology has advanced to incorporate energy internet. However, they did not indicate when blockchain technology may integrate energy internet in Africa.

C. Blockchain Commercial and Technical Analysis

Yli-Huumo *et al.,* (2016) conducted a study on the topical research areas of the blockchain. The researchers explored blockchain technology from the technical and commercial perspectives on the already researched topics, shortcomings, and future outlook. The authors found that over 80% of prior research work on blockchain focused on Bitcoin, whereas around 20% is on other applications including licensing and smart contracts. The researchers describe blockchain technology challenges such as latency, size, bandwidth, and usability, and that future research on scalability and usability is important to ensure full adoption of the technology. The authors' exclusion of commercial viability, regulation, legal, and economic perspectives of blockchain implies limited applicability of the blockchain technology.

Conte De Leon *et al.,* (2017) studied the properties and misconceptions of blockchain technology. Researchers expounded on the ambiguity, challenges, and potential solutions to the trustworthiness of the Distributed Ledger System (DLS) and blockchain technologies. The findings show that there is a lack of concrete evidence on features such as immutability and exact copies of blocks in the DLS and blockchain system. Therefore, future research is inevitable to establish the trustworthiness of DLS before worldwide adoption.

IV. Findings and Discussions

The blockchain is a distributed ledger system in which financial and non-financial information can be shared between multiple computers and users across the globe. Data integrity may be impaired in instances where different participants can write on or create blockchains simultaneously, thereby, rendering it difficult to ascertain the lawful block. Blockchain may not be entirely immutable as nodes with superior computing power may do anything from changing the blocks to manipulating transactions (Conte De Leon *et al.*, 2017). For example, the South Korean cryptocurrency exchange Coinrail hack (Reuters, 2017).

The difficulty in reaching a consensus on the changes or revisions of the business rules or technical logic between the participants in the public blockchain may result in loss of data or financial value and impaired data privacy. Full adoption of blockchain technology may impose significant risks ranging from cyber-attacks to loss of investments for early adopters migrating from legacy systems. Banks and financial institutions are advised to plan migration to blockchain technology in a modular approach starting with the local blockchain ledger before connecting to the external networks or ecosystem (Oh & Shong, 2017).

Significant developments have been made in the financial sector involving cryptocurrencies specifically bitcoin towards the adoption of blockchain technology compared to other sectors. Maintenance of government records such as land ownership and healthcare in the blockchain could have big implications for the accounting profession. On the other hand, the adoption of blockchain technology in auditing may necessitate the emergence of a triple-entry accounting system to accommodate the verification process that is currently performed outside the conventional accounting system.

In developed economies such as Japan, blockchain technology has advanced to incorporate the energy internet. Japanese researchers have focused on the development of digital power grid systems and energy internet based on power routers and smart grids. Unfortunately, it is not clear when blockchain technology will integrate the energy internet in Africa and other continents.

Blockchain technology applicability is apparent in the transportation and accommodation sectors and is challenging the existing business models such as Uber, Lyft, Taxify, and Airbnb. For instance, the recent introduction of blockchain technology by Arcade City is a significant threat to Uber and Taxify's business models. It is predicted that the blockchain market for enterprise applications will grow from $2.5 billion in 2016 to $19.9 billion by 2025 (Tractica, 2016). It is estimated that by 2025, 10 percent of global GDP will be on the blockchain (World Economic Forum, 2017).

V. Conclusion

Blockchain technology is becoming more common in other data-based applications including supply chain management, energy internet, Building Information Management (BIM), and the Internet of Things (IoT). Blockchain is not only a disruptive technology but rather a foundational technology that enables progress or application in a variety of problem domains. With the increased adoption of blockchain technology in the provision of banking and financial services, banks and financial institutions are likely to experience a substantial reduction in transaction volume and profitability. Blockchain players are continually addressing challenges associated with blockchain technology ranging from data integrity, privacy, and vulnerability, to malware, and limited scalability including legal and regulatory limitations. Generally, blockchain is a relatively new and complex technology that very few potential users understand and embrace, hence, there is a need for more public education.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

Joseph O. Witts conducted the research; Catherine L. Soko, Elda K. Mushonela, and Natasha N. Ng'wanakilala collected data; Amadeus R. Shine, Musa L. Mwanga and Wilson T. Shayo analyzed the data; Joseph O. Witts wrote the research paper; all authors had approved the final version.

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