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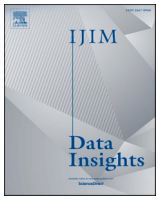

Blockchain adoption for sustainable development in developing countries: Challenges and opportunities in the banking sector

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ABSTRACT

Blockchain technology has been gaining relevance in every walk of life. Keeping this relevance in the banking sector, the current study aims to synthesize the body of knowledge on blockchain adoption for sustainability in developing countries while encapsulating challenges and opportunities using a systematic literature review. It offers a review of scholarly published articles published between 2010 and 2022 in EBSCO, Web of Science, Scopus, and Google Scholar databases. The findings of the study revealed that scalability, the lack of operability among the blockchain service providers, and the absence of favorable regulatory laws and generally accepted rules were the major hurdles in the way of blockchain adoption in developing countries. Implantation of smart contracts, risk management, risk mitigation and faster payment are the opportunities for the banking sectors of developing countries to increase trust and transparency in their financial systems as well as formalization of their economy. However, the studies concluded that upon the adoption of blockchain technologies, there will be ease in financial transactions and transfers of money for financial institutions. Other challenges highlighted by the studies included threats of cybercrimes and privacy breaches.

1. Introduction

Pursuing sustainable development is essential to ensuring the well-being of future generations (Jiang et al., 2022; Alsmairat & AL-Shboul,2023). It is widely acknowledged that information and communication technologies (ICT) act as catalysts for all three pillars of sustainable development, namely economic growth, social progress, and environmental preservation. Over the past several years, substantial changes and developments in telecommunications and information technology have been brought about in the banking business (Alsmairat, 2023). Blockchain Technology (BCT) is one example of innovation in the global banking sector leading to sustainable development (Jena, 2022). Implementing blockchain technology into existing banking systems by financial service providers will transform the banking industry, making most fundamental procedures more open, secure, and productive (Omran et al., 2017).

The distributed ledger technology known as Blockchain has been called a game-changing breakthrough of the Internet age (Shrivastava & Sharma, 2022). Blockchain technologies have shown promise for institutionalizing remittances and expanding financial services (Mhlanga, 2023; Rella, 2019) to gain a competitive edge. Authorities and practitioners may have investigated blockchain technology's potential to streamline and replace correspondent banking and other international payment infrastructure. Blockchain technology verifies and records transactions in a dispersed record book. Digital banking links, frequently identified, as "Nostro-Vostro accounts," stand as agreements linking authorities that accept banks operating in countries anywhere, they do not require a substantial authority.

Correspondent banking describes networks (Bai et al., 2022). Moreover, blockchain technology helps in the formalization of remittance processes through the consideration of existing infrastructure, plans, and regulatory framework. Prior researchers have noted that blockchain technologies are gaining increasing interest from governments, and non-governmental organizations as potential instruments for the "financial inclusion" of the unbanked and "underserved" (Abdulhakeem & Hu, 2021).

Digital fiscal inclusion, as reported by the World Bank, signifies those individuals take admittance to a range of proper financial facilities as per their needs and are supplied dependably at a price that is affordable for customers and sustainable for providers. Abdulhakeem and Hu

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(2021) suggested that blockchain technology assists in disseminating information through the Internet and possible for easy money transactions. A prerequisite for the sustainable development of India's rural areas is the connectivity of remote villages to regional and international supply chains, which can be facilitated by blockchain technology (Schuetz & Venkatesh, 2020). Financial inclusion in India's sustainable development programs is successful just because of the adoption of blockchain technologies, which is also helpful in understanding the anthropogenic factors and blockchain technology adoption (Schuetz & Venkatesh, 2020).

Over the years, the development of new services in the banking and financial sector has been driven by telebanking, online/mobile banking, and other forms of fintech (Hasan et al., 2020). These advancements have enabled the sector to overcome universal challenges associated with facilitating transactions across various industries, thanks to improvements in accessibility, speed, efficiency, effectiveness, and transparency (Peters & Panayi, 2016). However, the introduction of blockchain technology is being heralded as the next evolutionary step, poised to transform not only the banking and finance industry but also the nature and execution of corporate transactions (Cermeño, 2016; Osmani et al., 2021). According to van Engelenburg et al. (2018), the primary objective of blockchain technology is to establish an open, decentralized ledger that offers visibility to all participants, eliminating the need for intermediaries to establish trust in an environment where it would otherwise be challenging. The ledger contains an immutable record of past transactions, serving as the basis for consensus among all users regarding the current state of the blockchain.

Additionally, it can be combined with other technologies, like identity management, business rules, and encryption, to customize the technology to the particular challenges that are now being faced (Mills et al., 2016; Zachariadis et al., 2019). Peters and Panayi (2016) added in one book that the application of blockchain mechanisms with a variety of monetary services carries the possibility of causing widespread disruption in the banking industry. As a result, it encompasses activities such as the facilitation of international money transfers, intelligent contracts, automated banking ledgers, and digital assets. It has the potential to revolutionize a significant number of the conventional banking services that are now available by enhancing the safety of transactions, accelerating transfer times, and doing so at a cheaper cost (Lee & Shin, 2018). Blockchain technology has promising banking applications (Guo & Liang, 2016). The shrinking interest-rate differential and interest rate liberalization are hurting China's banking business. However, economic change, Internet growth, and financial innovations affect it. Thus, the banking sector needs urgent transformation and fresh development prospects (Guo & Liang, 2016).

Blockchains could upgrade and transform bank payment clearing and credit information systems by revolutionizing their underlying technology (Guo & Liang, 2016; Saidat et al., 2022). As a result, it provides relevant stakeholders with the opportunity to contribute to improving issues related to openness, trust, and privacy. However, even though blockchain technology has made several opportunities available to businesses, it is essential to be aware that there will be several difficulties and complexity in the areas of adoption as well as in the areas of technology and regulation (Attaran & Gunasekaran, 2019). The recent loss of digital money and breaches in cybersecurity are examples of recent incidents that have revealed the high level of risks associated with the usage of blockchain technologies in banking and finance (Demirkan et al., 2020). Dandapani (2017) propagated that Blockchain technology in banking and finance is risky due to recent digital currency theft and cybersecurity incidents. Blockchain technology is DLT with a decentralized ledger (Chandrasekar et al., 2021). The "chain of blocks" contains digital data with a time stamp and a hash identifying each block. Blockchain technology has been perfect for financial services since its introduction in multiple industries (Rahim et al., 2020). Bitcoin's 2009 creation garnered attention for the technology. Blockchain technology's unique traits could improve finance.

People participate together in their everyday lives under the umbrella of the Industrial Revolution i.e., Industry 4.0 which is an essential adjustment (Mhlanga & Denhere, 2020). Comparable to the first, second, and third industrial innovations, astonishing technological advances significantly contributed to human history. Ghobakhloo (2020) claimed that technological improvements, the natural, biological, and digital worlds are enhancing and linked, and this can produce equally immense assurance and elevated hazard. Because of the speed, scope, and depth of this transition, human is compelled to rethink about country's prosperity and also answers how organizations earn revenues by also assisting mankind.

The primary objective of this paper is to summarize the findings of the studies into two central inquiries;

RQ1: What are the challenges encountered in developing countries in integrating blockchain technology in the banking or financial sector?

RQ2: What are the opportunities for sustainable development in developing countries in integrating blockchain technology in the banking or financial sector?

This paper attempts a pioneering endeavor to explore the significant aspects i.e., challenges and opportunities for the banking sector of developing countries. The study conducts a systematic literature review of the relevant literature by incorporating published works from the research databases. The current study has been structured as follows: Section 2 covers sustainable aspect of Blockchain has been dissected; Section 3 encompasses research methodology; Section 4 contains results; Section 5 encapsulates discussion and Section 6 summarizes the conclusion of the study.

2. Dissecting the sustainable aspect of blockchain

2.1. Sustainable development

The term "sustainable development" implies growth that meets the conditions of the present deprived of jeopardizing the capability of future age groups to support wants and needs. The definition is what is meant by the phrase "sustainable development." This is what is meant when we talk about "sustainable development." This all-encompassing concept of sustainable development incorporates a wide range of distinct characteristics. The goal of economic expansion has unintended consequences, the most notable of which are the degradation of the natural environment and the increasing social disparities. The concepts behind sustainable development call for an expansion strategy that is more all-encompassing. This plan ought to make strides toward achieving all three of the fundamental goals of advancing social inclusion, environmental sustainability, and economic prosperity.

In addition to a monumental increase in economic activity, the beginning of the Industrial Revolution was also the impetus for a great number of strides forward in technological development, one of which was the invention of electricity. An alternative energy source does not have any negative consequences on either the health of humans or the health of the environment. All such initiatives in which financial transactions at the business level and equally from the governmental level require blockchain technology through banks and help deprived ones living in the community. One report published in 1987 revealed the idea of sustainable development by one of the United Nations Agencies working on Environment and Development. Sustainable development regarding blockchain technology initiatives makes organizations and governments realize how much significance blockchain technology carries to working with diverse stakeholders residing in the community.

2.2. Background of blockchain technology

Blockchain applications encourage "multi-center, weakly intermediated" scenarios, which improve banking efficiency. Blockchains are permissionless and self-governing; however, decentralization regulation and implementation are still issues. Thus, a "regulatory sandbox" and

industry standards are needed immediately (Guo & Liang, 2016).

According to Qi-Guo (2016), the focus of FinTech has been on blockchain, which utilizes distributed data storage, point-to-point transmission, consensus processes, and encryption. This technology represents a disruptive innovation of the Internet era. Qi-Guo also asserts that the breakthrough in data storage and transmission achieved by blockchain has the potential to fundamentally transform finance and the economy, sparking a new wave of technological innovations and industrial transformation within the FinTech industry (Qi-Guo, 2016). The development of blockchain has garnered significant attention not only from international organizations such as the UN and IMF (The First Digital Currency Report of the International Monetary Fund [EB/OL]), but also from industrialized countries like the US, UK, and Japan. These nations have effectively implemented blockchain applications across various disciplines. Moreover, countries like Russia, China, South Africa, and India have also commenced blockchain research. Zhou Sichuan, the governor of the People's Bank of China (PBOC), introduced blockchain technology during a digital currency meeting held in February 2016 (Guo & Liang, 2016).

Technology advancements make decision-makers in organizations and at the government level think about applying secure, easy-to-manage technology to keep accountability in practice. The improvement of international logistics is a continuous process that is being carried out both by private companies and by national governments. Nevertheless, there is room for improvement in the global economy. The global GDP increased by around 2.2% over the current year (Gani, 2017). Organizations are bridging their daily modes of operations with artificial intelligence and the latest technology, such as blockchain (Fanning & Centers, 2016; Pal et al., 2021; Treleaven et al., 2017). This blockchain mechanism, applied to cut costs, wasted time, and risk while stimulating creative business options, could ease and lessen vague hurdles to international trade (Sarmah, 2018). Examples are service agreements, paperwork for customs, and payments sent internationally. Businesses are interested in blockchain technology for various reasons other than its financial benefits (Levis et al., 2021; Morabito, 2017).

Organizations are continuously grasping and applying blockchain technology leading to a positive return on their investment (ROI) (Agi & Jha, 2022). The new battleground is networked, not individual businesses; consequently, criteria other than financial health are gaining increasing importance due to blockchain technology (Peris-Ortiz et al., 2023). According to Peris-Ortiz et al. (2023), organizations compete with each other with the help of technological advancement, which is also backed by Raj (2021)

Blockchain technology has unique attributes as it gives a breakthrough in storing, verifying, and disseminating valuable information (Omidian et al, 2023). Financial and technology have a very close relationship, and technological advancements have significantly changed the fundamental architecture of the economic process (Guo & Liang, 2016). The introduction of money, which replaced the barter system, was the first step in the banking industry's adoption of digital technologies (Gupta & Gupta, 2018; Mishra & Kaushik, 2021). This was followed by the steady transition from wax seals to digital signatures. Blockchain Technology (BCT) is one example of this type of innovation that is disrupting the global banking sector (Gupta & Gupta, 2018).

In 2009, technology was considered unreliable and secure since blockchain inception in the Bitcoin cryptocurrency. Later in the next five years, the organizations made tremendous progress in securing it (Weichbroth et al., 2023). Organizations like bumblebee foods nestle baby foods, IBM (International Business Machines), and Proctor and Gamble are applying blockchain technology to manage their information ways (Gutmann et al., 2023; Rajput et al., 2023; Varmani, 2023). Based on this smart cutting-edge technology, i.e., blockchain, companies can simplify their processes and generate a competitive edge in the market (Sun et al., 2022).

Despite its success, carefulness is a reasonable question to ask, as utilizing such technology will not be easy (Gligor et al, 2022). It was especially witnessed by the oil and gas industry organizations in Nigeria that implementation and configuration of such technology in terms of processes take time (Munim et al., 2022). Thus, the application of blockchain for business applications will not be simple. Its technical foundations and practical consequences are difficult to grasp (Taherdoost & Madanchian, 2023).

The technical details, such as the distribution mechanism of ledgers, hashing, and bitcoin mining, are difficult to understand by starters and require professionals in this regard (Sislian & Jaegler, 2022). Besides, its successes, challenges, and opportunities to adopt this technology to ensure sustainable advantages in financial services seem to require more understanding (Friedman & Ormiston, 2022). The answer is to comprehend what blockchain does and what it does not (Treiblmaier, 2023). Blockchain technology enables decentralized access to transactional records through ledgers. Blockchain is a distributed ledger technology (Abdennadher et al., 2022a).

The system assures that the transferred data cannot be altered in any manner, nor can it become corrupted (Abdennadher et al., 2022b). Several financial and securities systems have already used blockchain technology in their operations (Yang et al., 2022).

Investing in blockchain technology for businesses will almost certainly become vital due to competitiveness considerations and sustainability (Morabito, 2017). Many industry professionals believe blockchain technology will garner the same level of interest as previous game-changing innovations, such as the personal computer revolution of the 1970s and 1980s and the explosion of the World Wide Web in the middle of the 1990s. These are two examples of transformative advancements (Pinheiro et al., 2022). Businesses were aware then that their competitors were making the most of these industry developments (Taherdoost & Madanchian, 2023).

The biggest inspiration for adopting such blockchain technology is answering a fear of missing out due to its potential to reduce cost, expand business-to-business and business-to-computer networks, enable new products, and build wealth (Lahkani et al., 2020; Paul et al., 2022). Additionally, it is anticipated that the business value of Blockchain will increase as enterprise implementations of the technology become more widespread and refined (Lahkani et al., 2020). Enterprise-level blockchain comprises several processes, requires an equal number of stakeholders, and demands concrete information (Guo et al., 2023).

Thus, organizations spend a huge amount of time reconciling or figuring out information to share amongst the enterprise's stakeholders under the enterprise-level blockchain technology domain (Dewangan et al., 2023; Surati et al., 2023). The major reduction in time, cost, and effort is due to removing intermediaries and mostly automated processes. This blockchain will help to increase electronic commerce and financial activities and enable new avenues to work on businesses (Marikyan et al., 2022; Rosati & Ćuk, 2019).

Blockchain technology has evolved gradually. It helps an organization grow its customer sources, reach them more professionally, and improve the relations between suppliers and partners (Banerjee, 2018; Morkunas et al., 2019). Blockchain technology helps to raise trust among organization members and warrants the secrecy of combined data (Lopez & Alcaide, 2020). Moreover, blockchain technology also benefits in terms of tokenization, innovation, and decentralization (Esmat et al., 2021). At its first stage, blockchain 1.0 was introduced as a medium of transferring money to address the issue of double spending, aiming to avoid the role of intermediaries involved in the process of money transfer. Thus, blockchain was developed as a decentralized ledger for recording the transactions of the cryptocurrency. In its elementary stage, a total of 600 cryptocurrencies were made to be used as exchange tokens through Bitcoin applications. Moreover, blockchain 2.0 introduced smart contracts in the form of breaking information into codes. In the era of blockchain 3.0, its scope is wider and its applicability spans other public sectors such as governments, healthcare, and education. Governments around the world can now capitalize on this technology to improve transparency, data security access, and other

functions for the common good of the citizens. For instance, in countries, where there is a prevalent issue of censorship, citizens can enable such blockchain networks that are not accessible or erasable (Kar & Navin, 2021).

Fig. 1 demonstrates the functional blocks of blockchain with the technical architecture components wherein information about the previous hash is integral to process or encrypt information, presented or stored in the next blocks. Blockchain technology is made up of manifold functional blocks that are aligned and combined to work with its core capabilities. Below are the key functional blocks of blockchain and their integration with the technical components:

2.2.1. Data layer

In this segment, data is stored in the form of blocks that encompass transaction details and other information. These data layers are comprised of structures such as hash-linked lists where each block is encrypted through a cryptographic hash of the previous block, forming a chain of blocks (Sookhak et al., 2021) (Fig. 1).

2.2.2. Consensus mechanism

Consensus mechanisms are for ensuring agreement among the users or participants on the validity of transactions added to the blockchain. Components like Proof of Work (PoW), Proof of Stake (PoS), or Practical Byzantine Fault Tolerance (PBFT) are used to achieve consensus. These mechanisms determine how new blocks are added and validated (Sultana et al., 2020).

2.2.3. Smart contracts

They are self-executing contracts, following the terms of consensus which is present in the text. They automate the entire process and formulate rules. Virtual machines such as Ethereum Virtual Machine (EVM) are used to develop and execute them by interpreting and executing the code of contracts (Putra et al., 2019).

2.2.4. Cryptography and security

Cryptographic methods like digital signatures, hash functions, and encryption are used to secure transactions, control access, and provide data integrity (Putra et al., 2019). These features of a blockchain help ensure instant payment systems for consumers with the minimum cost of transaction with fast processing and the minimum number of required slots for coordination (Grover et al., 2018).

2.2.5. Network layer

A network layer is responsible for communicating and propagating data and transactions in the entire blockchain process. It is achieved through peer-to-peer networking protocols which ensure the process of communication among nodes, and verifying transactions. Gossip protocol or flooding algorithms are a few of the networking protocols used in bloc chain networking.

2.2.6. Access management

It is another fundamental aspect of a blockchain infrastructure that is used in managing the identities and permission of the participants and it acts for access control. Public or private key cryptography is involved in this process to create and ensure digital identities, sign the transactions, and control access to data and other functions concerned (Sundarakani et al., 2021).

2.2.7. Data storage and management

Distributed storage mechanisms have been designed for data storage and management in the system of blockchain. For instance, Distributed Hash Tables (DHTs), or IPFS, are two examples of such mechanisms for warranting the availability, protection, and redundancy of data (Kumar et al., 2021).

Trust was the factor underlying the genesis of blockchain within a distributed system as it was aimed to design a distributed storage of timestamped documents without leaving any possibility for tempering the content of the data or timestamped until detection which was designed through electronic/ digital signatures. The presence of a valid digital signature verifies the signature and ensures that this document has not been modified by any external party through a timestamp. This verification, based on time, plays an important role in the matters of smart contracts and financial transactions where these matters are audited and authenticated independently. In a blockchain, the hash is an actual string of data or information encrypted given the fact that the original string is not approachable and guarantees the authenticity and security of the entire chain of operations (Di Pierro, 2017).

2.3. Key attributes of blockchain technology

Four major characteristics highlighted by Chang et al. (2020) are (1) Decentralization, (2) End User's Anonymity, (3) Consensus System, and (4) Implementation. The explanation of these attributes was mentioned for the readers.

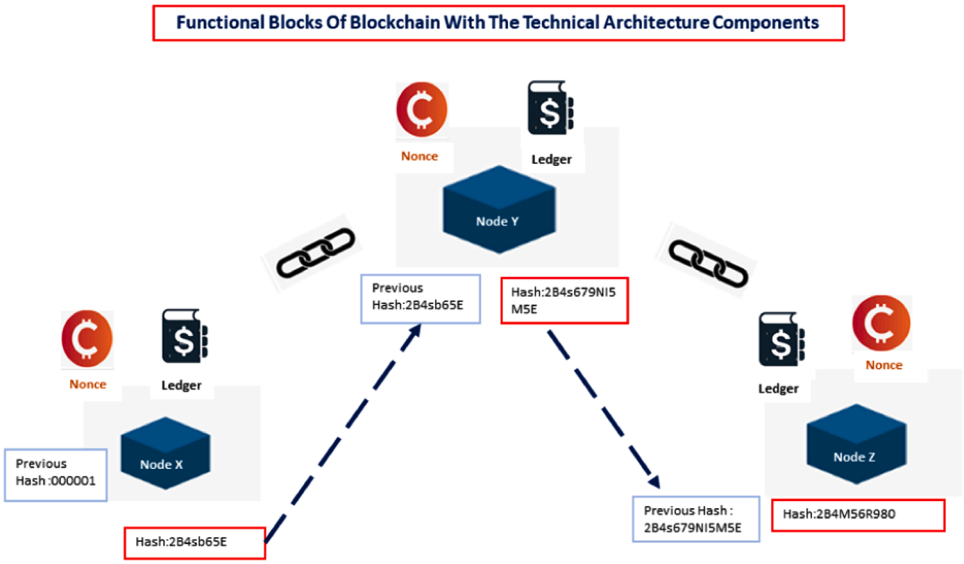

Fig. 1. Functional architecture of Blockchain.

2.3.1. Decentralization

In a conventional centralized transaction system, each transaction is subject to counter-examination by a single individual at the central bank. Every customer who is on blockchain technology can verify their transactions and amount without the intervention of a third party through blockchain (Chang et al., 2020). Propagation of data and its distribution via other networks creates a major input in terms of benefits thus helping organizations and other entities share information which helps in crime reduction. Thus, real-time recording of data through a distributed ledger mechanism will help banking sector organizations in the reduction of deception transactions and misinterpretations (Chang et al., 2020; Pereira et al., 2019; Zhang et al., 2018).

2.3.2. End user anonymity

There is no longer a need for a centralized entity to maintain users' private information, as they can just use the created keywords to connect with other nodes through blockchain technology (Pereira et al., 2019). This method helps keep personal information secure. However, blockchain has constraints that prevent it from providing foolproof privacy.

2.3.3. Mutual consensus mechanism

A mutual consensus mechanism is used since there is no single reliable node in the network. The end goal is for all records to be accepted as valid by all parties. If more than 51% of the network's accounting nodes are compromised, a fake record can be created. This makes it easy to spot any distortion (Huang et al., 2019).

2.3.4. Blockchain technology implementation

Transactions between various nodes can be regulated according to the algorithms used by various users (Tapscott & Tapscott, 2017). Blockchain is also capable of executing programs under certain conditions. A smart contract is another name for this type of agreement. It is not only one or two qualities of blockchain that make it new and catch people's interest, as one managing director of a blockchain business has stated. According to Tapscott and Tapscott (2017), the value of this new technology can be increased by incorporating aspects of blockchain technology such as decentralization, anonymity, and immutability (Sampat et al., 2023).

2.4. Study gap

Blockchain has been gaining traction among scholars as a plethora of published literature is available in this domain. The study by Attaran (2022) conducted a review study to explore the important roles played by blockchain technology to highlight the most pressing challenges and opportunities in the domain of healthcare. Gorkhali et al. (2020) reviewed the relevant publications of 76 journals on blockchain (2016–2018) and recommended to integration of new technologies such as Internet of Things (IoTs) cloud computing to further invent new ventures into technology and make efficient systems. More interestingly, Xu et al. (2019) conducted a cluster analysis and figured out the themes such as economic benefit, initial coin offerings, and the fintech revolution. In the field of Islamic Finance, Rabbani et al. (2020) attempted a review study and pinpointed challenges and opportunities for Islamic Financial institutions due to the integration of blockchain technology in the financial system with a special emphasis on transparency, transparency, and efficiency. Another review study was conducted to figure out the benefits, costs, risks, and opportunities for the banking and financial sectors Osmani et al. (2021). Maher et al. (2023) took Healthcare 4.0 as an emerging concept in the healthcare sector with a focus on empowering patients in the capacity of active stakeholders. Considering the Airbnb economy model while linking with a blockchain, Maher et al. (2023), proposed a digital health data marketplace (DHDM). This system was designed to enable the patients as data producers to sell health data to potential buyers such as policymakers, researchers, and machine learning algorithm developers in a secure environment. Kar and Varsha (2023) conducted a literature review to explore the impact of novel technologies in constructing functional blocks of metaverse while analyzing the results of 70 published articles. This study explored the way Artificial intelligence (AI) along with blockchain has given a boost to the usage of a metaverse in the domain of marketing to accelerate return on investments and customer satisfaction. The analysis of the study shows that despite the availability of numerous researches published in this domain, there is a need to explore the full potential of using metaverse and bloc chain for businesses and marketing. Another study by Jain et al. (2021) has taken the approach of exploring the vitality and usefulness of blockchain in the domain of marketing by reviewing 75 research articles., published in international databases such as SCOPUS. The study encapsulated some recommendations for future studies referring to the creation of interdisciplinary linkages among five domains which are blockchain and electronic commerce, blockchain and marketing, blockchain and data, blockchain and data analytics, and blockchain privacy and security. Arjun et al. (2021) have figured out a need for future research to explore volatility in the loyalties of customers in the banking sector or other financial institutions. It is imperative to investigate the way banks or any other financial institution process their information through blockchain-enabled knowledge management systems and practices which may improve their decision-making abilities at every level in a real-time environment which is beneficial for all the stakeholders in this domain concerned. Prakash et al. (2022) asserted that blockchain-enabled currencies have the potential to gain trust as a more verified and secure system of payment in comparison with the contemporary systems of payment or making transactions. As an attempt to explore this potential, Prakash et al. (2022) conducted a literature analysis of the published studies while adopting techniques such as topic modeling, and key phrase extraction. The study concluded that blockchain-enabled currencies, despite a huge potential, are vulnerable to cyber security. Thus, future studies are needed to figure out the solutions to such challenges impeding the integration of blockchain to make trusted encrypted currencies.

The studies cited above, although have presented a comprehensive review of technology but not made an explicit focus on developing countries with an emphasis on the banking or financial sector. However, the present study attempts to conduct a review study to explore the challenges and opportunities for the banking sectors in the context of developing countries.

3. Research methodology

3.1. Screening of relevant papers

The research conducted a systematic literature review. In this study, the search paradigm was limited between 2010-2022. EBSCO, Web of Science, Scopus, and Google Scholar databases were accessed to search for the relevant studies. After selecting the studies from the above-stated database, the next step involves screening the required studies for further selection and inclusion. Initially, the studies were selected based on the titles that were aligned with the keywords, given in Table, during the title search associated with the criteria of keywords, those studies did not match the title and the required keywords were discarded and excluded from this systematic review. Notably, where it was not certain to determine the criteria of the study to be included or excluded from the study, the study was included and proceeded to the next level of scrutiny. Further, the researchers analyzed the abstracts of the selected studies and screened out the studies that passed the criterion of the first stage. For the exclusion of the study, it was a meritorious strategy to review the introduction and conclusion sections of those studies to discover whether these studies matched the exclusion criteria of the present study or not. The exclusion criterion, followed by the present research included: (1) papers that were passed through the peer-reviewed i.e., press announcements and interviews (2) papers with no

availability of full text; (3) duplicate research; (4) papers published in languages other than English; (5) retracted papers.

3.2. Keywording and filtering criteria

Table 1 shows the search terms used for retrieving the data. The search results were limited to English articles only which yielded 1857 items. 1203 articles were left after eliminating duplicates (n = 654). After reading the titles and abstracts of the study the researcher considered 205 articles for the review. However, based on the study objectives, only 17 articles were included that were themed on the challenges and opportunities of the adoption of blockchain in developing countries as illustrated in Fig. 2.

3.3. Data extraction process

It was the last stage in which data was extracted from the selected study based on the criteria stated above, aimed at answering the research questions. Table 2 presents a description of the studies which included the metadata (the title and the authors of the studies), the objectives, methods, approach, study settings, and the findings of each study selected in detail. Each of the studies was labeled with an identifier from 1 to 21. The data extracted from the studies were recorded into an Excel sheet for convenience of organization and analysis.

4. Results

Table 2 presents the summary of the findings which describe the challenges in the way of adopting blockchain into the banking sector of the developing countries.

4.1. Challenges in the way of adopting blockchain technology in the banking sector of developing countries

4.1.1. Technical challenges

The findings of the present study have revealed that scalability was the most frequently encountered technical challenge in adopting blockchain into the banking industry of developing countries (Zhang et al., 2018; Harwood-Jones, 2016). As reported by Zhang et al. (2020), despite blockchain being a cutting-edge technology, it is impeded by its higher development cost and other challenges on technical grounds. For example, 19 min are required to create a single block to the blockchain. There is a limited capacity of each block which is only 1 MB. Owing to this storage, merely eight transactions per second can be processed. Moreover, despite its capacity to play its role as a trusted intermediary via a developed algorithm, the information presented in the system is not reversible which makes it difficult to the information lost. Thus, privacy breaches if occur in any of the blockchains can cause irreparable damage to the information, data, or assets of the customers or the data owner. In developing countries, due to the higher cost of developing blockchain infrastructure, it is barely possible for the financial or banking sector to completely operationalize blockchain into their systems. It is a common observation in developing countries that they do not prioritize such ventures due to unstable or uncertain economic growth (Cong & He, 2019; Zhang et al., 2018; Hassani et al., 2018). An example is the African region where the economy is less formalized and there is no will or practical use of blockchain due to inadequate economic activities (Mavilia & Pisani, 2020). The issue of excessive centralization has been remarked as one of the challenges to the adoption of blockchain as reported by the various studies (Zhang et al., 2018). As a counter solution to this challenge, creating and adopting a decentralized system is deemed promising amid higher concerns about data protection, cyber security, privacy, and better operability. Decentralized blockchain systems are given preferences in comparison with transferring ownership of blockchain or the data concerned confined to a limited entity(s) concerned.

Table 1
Key search terms.

Database	Key search terms
Google Scholar, Scopus, EBSCO, and Web of Science	Blockchain, adoption, banking sector, challenges, opportunities, sustainability, developing countries

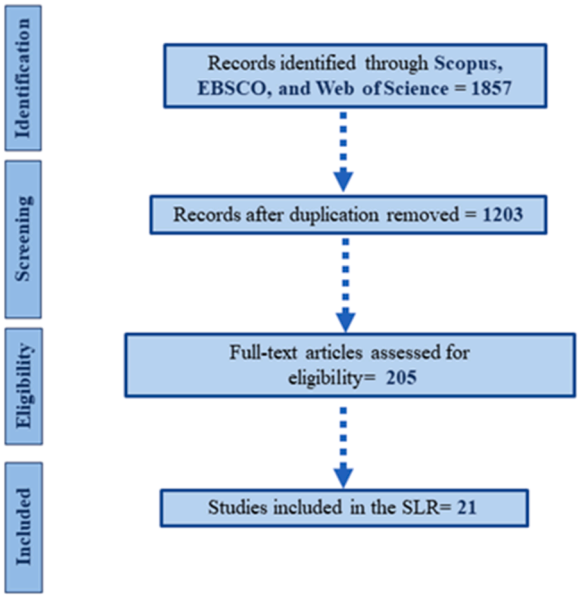

Fig. 2. Search and Selection Criteria of the Study.

4.1.2. Legal challenges

The adoption of blockchain has been hampered by some of the key legal issues. More importantly, in most developing countries, no legal provisions related to the implementation of blockchain and the related practices are in place in their systems, there are a plethora of regulatory constraints which caused the proliferation of independent miners where it is difficult to ascertain the legal status of such covert transactions in the developing countries (Cong & He, 2019; Zhang et al., 2018; Chang et al., 2020; Till et al., 2017; Lewis et al., 2017; Guo & Liang, 2016; Osmani et al., 2021). Studies have also reported that at the global level, there is no set of legal procedures generally accepted by all the countries likewise generally-accepted rules of trade and commerce (Patki & Sople, 2020; Garg et al., 2021). However, concerns such the cyber security, the lack of legal procedure, ambiguities about jurisdictions in cross-border transactions, hurdles in interoperability between different system, the higher operational cost of infrastructure, and the limited financial inclusion makes it less attractive for the policymakers around the world to formulate any such international legal regime for block chain.

4.1.3. Organizational challenges

Energy consumption by blockchain systems is a serious challenge for organizations, operating in developing countries (Al Barghuthi et al., 2019; Gyimah et al., 2023). Along with it, higher privacy risks to the databases, the absence of legal regimes, ineffective risk assessment and management mechanisms, less regulatory compliance within the organizations and consensus, and the lack of interoperability are the organization challenges faced by the banking sectors of the developing countries. Altogether, these factors increase operational risks for the financial entities and constrain the developing conducive environment for the adoption and implementation of blockchain in the banking or financial sectors (Khalil et al., 2021; Hassani et al., 2018; Lewis et al., 2017; Guo & Liang, 2016). Business model challenges and failure to

Table 2
Challenges of blockchain in the banking sector of developing countries.

Identifier	Author	Challenges
1	Al Barghuthi et al. (2019)	privacy breaches, scalability, and energy consumption
2	Cong and He (2019)	Long-term financial goals and a rise in economic activity
3	Zheng et al. (2018)	Scalability, higher privacy risks, the lack of technical infrastructure, and the prevalence of selfish mining
4	Chang et al. (2020)	existing regulations and financial legal regimes, and ineffective risk management mechanisms.
5	Till et al. (2017)	Hurdles in enforcing appropriate regulatory guidelines, and the fair usage of medical information and records
6	Lewis et al. (2017)	Creating consensus among blockchain networks, poor standardization, making of the generally accepted practices and standards, the lack of interoperability
7	Guo and Liang (2016)	Existence of desired and appropriate infrastructure, platforms, and channels, increasing customer awareness
8	Harwood-Jones (2016)	Scalability and privacy, greater operational risks, cyber security issues, and the absence of operability among the blockchain providers
9	Osmani et al. (2021)	Absence of regulatory frameworks and standards and trust, scandals, business model challenges, and privacy of data
10	Zhang and Chen (2020)	Scalability, storage capacity, excessive centralization, and the tradeoff between block size and security
11	Clohessy and Acton (2019)	The lack of support from leadership, inadequate readiness of the organization, and the size of the organization
12	Mishra and Kaushik (2021)	Higher costs, the lack of trust, and the fin-tech disruptions
13	Patki and Sople (2020)	Legal and standardization issues, ambiguities about jurisdictions in cross-border transactions, and hurdles in interoperability between different systems.
14	Hassani et al. (2018)	Higher cost, scalability, and interoperability
15	Garg et al. (2021)	The lack of security, governance, regulations, and scalability.
16	Zhang et al. (2020)	The complex global legal financial regimes, and the limits of blockchain technology in terms of storage and cost
17	Gyimah et al. (2023)	The absence of internationally or generally accepted rules, energy consumption, rampant corruption and poverty, and the lack of technical expertise
18	Khalil et al. (2021)	The study specified the mediating role of information technology for the adoption of blockchain technology to bring about sustainability and innovation in the financial sector of the country.
19	Mavilia and Pisani (2020)	Lower financial inclusion in Africa

create synergies between the existing systems and the new systems, the lack of customer;' awareness, and scandals are other factors that do not support the adoption of blockchain into the banking systems in developing states (Osmani et al. (2021).

4.2. Opportunities in the way of adopting blockchain technology in the banking sector of the developing countries

Fig. 3 presents the opportunities for the banking sector of developing countries through implementing blockchain technology.

Opportunities are promising, as reported by the studies, in terms of work efficiencies, and reduced time delays with greater integration (Al Barghuthi et al., 2019). The banking system can revolutionize its operations by implementing smart contract systems to ensure the privacy of the customers. Also, this sector can help developing countries ensure sustainability in their operations and sustain the market equilibrium (Cong & He, 2019). Integration of blockchain is also promising for risk mitigation, risk management, and reduction in the operations' and transfers' costs (Chang et al., 2020; Garg et al. 2021; Mishra & Kaushik, 2021; Gyimah et al., 2023). Till et al. (2017) have concluded that the penetration of blockchain-based universal health coverage will help efficient and sustainable financial systems in healthcare. Examination and verification of digital and physical assets, digital record-keeping, reduction in settlement period, and faster payments are the other potential opportunities for the banking sector (Lewis et al., 2017). Blockchain is also an enabling factor for organizations to maintain their competitive advantages and sustainability (Osmani et al., 2021; Mishra & Kaushik, 2021; Cong & He, 2019) (Table 3).

5. Discussion

Scientists have argued on the significance, adoption, and challenges of blockchain technology in the context of UAE in both private and government sector organizations (Al Barghuthi et al., 2019). Various issues are emerging to adopt blockchain technology which are technology privacy leakage, scalability, and energy consumption (Heires, 2016). Some of the highlighted ones are ethical and non-ethical ones. Although there is a lot of unrealized potential in blockchain technology, there are also many challenges that could hinder its widespread implementation. Anyone connecting to the network has access to the transaction records and can also submit new data to the Blockchain, a distributed ledger system. This is because blockchain is a peer-to-peer technology spread across numerous computers. The system is founded on openness and a lack of central coordination, which serve as its pillars but also exacerbate its flaws and limit its use. Although they are the system's pillars, they also contribute to its flaws and limit its use. The blockchain can generate multiple addresses instead of a user's actual identity to prevent data outflow, which is imagined to be reasonably assured. However, the blockchain cannot avoid the leakage of business accounting information, and balance data is made public. The issue of information being shared without permission is fairly significant, and it poses a threat to the privacy of users. Even though numerous solutions have been suggested, the issue of improving the anonymity of blockchain transactions has not yet been adequately resolved (Cong & He, 2019). Zheng et al. (2018) proposed that the volume of the blockchain increases as the number of transactions rises. Due to their complexity, encryption, and distributed nature, scientists have noted that blockchain transactions require some time to implement (Marr, 2018).

According to Chang et al. (2020) while Visa handles 24,000 transactions per second, PayPal handles 193 transactions per second, whereas Ethereum and Bitcoin can only handle 20 transactions per second. It indicates that the requirement to conduct millions of transactions quickly cannot be met. The reason is due to the limited capacity of blocks, which causes miners to frequently delay minor transactions over those with relatively high fees. The amount of computing power required to operate blockchain is rapidly expanding. The infrastructure supporting Bitcoin uses a significant amount of electricity. The amount of power that is needed for a single Bitcoin transaction is equal to one terawatt-hour. There is a comparison made between Bitcoin and VISA, as well as statistics regarding the amount of energy used by Bitcoin transactions in various nations (Chang et al., 2020). Ethical issues highlighted by Chang et al. (2020) as privacy, cybercrime, laws, and their implementation. Privacy. blockchain technology poses an increased risk to the privacy of certain entities despite its ability to produce records for participants that are permanent and unchangeable (Till et al., 2017). The consequences of the current regulatory ambiguity are substantial. No matter how well-developed blockchain technology becomes, the fact remains that it cannot guarantee the authenticity of data stored offline. Data stored on the blockchain cannot be altered after it has been recorded, even if the originating database fails. Some

Fig. 3. Opportunities of blockchain for the banking sector of developing countries.

Table 3
Opportunities of blockchain in the banking sector of developing countries

Identifier	Author	Opportunities
1	Al Barghuthi et al. (2019)	Work efficiency and reduced time delays with greater integration
2		significance of smart contract systems to ensure the privacy of the users in a financial system of blockchain technology
3	Cong and He (2019)	smart contracts, the privacy of the customers, sustainability in the market equilibrium
4	Zheng et al. (2022)	-
5	Chang et al. (2020)	risks mitigation, risk management, reduction in the operations' and transfers' costs
6	Till et al. (2017)	For universal health coverage via block, chain-enabled efficient and sustainable financial systems in healthcare
7	Lewis et al. (2017)	Examination and verification of digital and physical assets, Digital record-keeping, Digital currencies, Smart contracts, Reduction in settlement period, Faster payments
8	Guo and Liang (2016)	Revolutionization in the e-payment clearing and credit information systems
9	Harwood-Jones (2016)	-
10	Osmani et al. (2021)	Competitive advantages, and new services formation,
11	Zhang et al. (2018)	decentralization, persistency, anonymity, and audibility.
12	Clohessy and Acton (2019)	-
13	Mishra and Kaushik (2021)	Significant reduction in the cost of transfers and operations for financial institutions, sustainability
14	Patki and Sople (2020)	-
15	Hassani et al. (2018)	-
16	Garg et al. (2021)	Reduction in overhead costs, regulatory compliance, smart contracts
17	Zhang et al. (2020)	Creating ease in the transactional complexities and protection and management of the data
18	Gyimah et al. (2023)	A smart contract, transparency, cost reduction
19	Khalil et al. (2021)	Process innovation
20	Mavilia and Pisani (2020)	The adoption of blockchain by industrial enterprises for expediting financial inclusion in African society

problems will arise because blockchain is decentralized; that is, it is not governed by any central authority, and it is difficult to alter information already recorded on the chain. A few nations' governments have begun treating cryptocurrencies like illicit currency in their nations. Only roughly 110 countries do not place any restrictions on Bitcoin, despite its widespread use (Chang et al., 2020).

Cybercriminals, whose activities are sometimes known as computer-oriented crimes, engage in illicit acts involving the network, which can have negative consequences for their victims. Criminals use cryptocurrency as their preferred means of payment. Scientists indicate that blockchain is applied to Anti-Money Laundering (AML) and Know Your Customer (KYC) requirements for financial applications. For transactions conducted on public, blockchain is open and pseudonymous to all users, whereas private systems have constraints on the participants who can use them (Lewis et al., 2017).

Scientists have identified various challenges when organizations in the banking sector adopt blockchain technologies such as Regulatory challenges, lack of corporate governance for ensuring trust in financial markets, and technical and scalability challenges (Guo & Liang, 2016; Osmani et al., 2021). In light of the above commentary on the topic, studies have highlighted numerous challenges when new disruptive technologies have been adopted in banking sector organizations i.e., mobile banking and cryptocurrency. Apart from the usage of online banking, challenges in adopting digital banking can be reduced. This shift from the old traditional mechanism to a new way of blockchain technology is innovative in banking sector organizations. The financial industry to a larger extent experiencing a tremendous amount of rise with the induction or adoption of this new technology. Traditional banking is now replaced to a larger extent with the help of new ways introduced under the umbrella of blockchain helping governments, and customers to invoke (Pazaitis et al., 2017). In extra, blockchain possibly will make currencies global instead of country-based (Lipton, 2018). The current research was written based on past research literature focusing on the linkage between blockchain technology in banking sector organizations and their long-term sustainability in developing countries.

Ether is produced by the Ethereum platform, which is a well-known open-source, public, blockchain-based computing platform (Marr, 2018). Scientists reported that more than one million smart contracts are active on Ethereum (Chen et al., 2018). On the Etherlane platform, thousands of entrepreneurs and developers are currently creating new initiatives and startups. Financial institutions are beginning to realize the potential benefits that may be derived from cryptocurrencies and the technology underlying blockchains, even though the banking business is subject to a significant number of restrictions. This is even though the banking industry is subject to a huge number of restrictions. Researchers are expecting that blockchain-based solutions for transparent, open, and

dependable financial transactions will become more commonplace as important players in these industries conduct trials to uncover new use cases and opportunities.

The fields of healthcare and finance present the most significant opportunities for the application of blockchain technology. For instance, higher will be the public trust when a digital currency is backed or supported by blockchain in a more digitized environment where the focus is on non-cash payments and settlements. This will originate a new era of electronic transaction accounting management with greater control over the flow of money and other monetary execution inside and outside the organizations (Zadorozhnyi et al. 2018). Another potential area of development in this domain will come out in the form of venturing into entrepreneurial finance via token sales or initial coin offerings with blockchain technology (Xu et al., 2019). Gandhi et al (2023) while realizing the crucial role of the approval process within an organization, have proposed to implement blockchain for the execution of specific administrative tasks which can be one of the applications of blockchain in the banking or financial sector. The proposed approach capitalized on data analytics to eliminate the hurdles in the approval process by developing a flat network where different communication authorities are involved to establish consensus and confidence among the various parties concerned. Typically, the most important advantage brought by this technology is an increase in safety. There is little question that blockchain technology will dramatically transform Asian economies. Those changes are likely to occur sooner rather than later. The efforts of the government to strengthen fundamental services and remove long-standing impediments would benefit significantly from this development.

5.1. Theoretical implications

This review study adds to the literature on the blockchain, addressing the challenges and prospects of this new technology in the context of developing countries where already there is a greater need to formalize their financial/banking sectors. It is pertinent to summarize the key challenges faced by these countries to provide insights to the policymakers, researchers, and stakeholders concerned to formulate the policies required aiming to create a conducive environment for the favorable transition of new technologies and the system of blockchain. This review provides novel findings about the adoption of blockchain and highlights the need to formulate some generally accepted legal regimes to regularize the penetration and adoption of blockchain systems in developing countries. In addition, for the countries, that where a higher inclination for formalizing their financial or banking systems, these findings will help to portray the promising aspects of blockchain-enabled systems to expedite this process. Fig. 4 presents a schematic of the present study's implications.

5.2. Managerial implications

The current study extends the blockchain literature while addressing the challenges and opportunities for developing states. The study highlights important implications for all the stakeholders. For example, it pinpointed that in developing countries there is a lack of required financial regime. Also, there is a need to devise generally and universally applicable standards when it comes to the adoption of blockchain in the financial sector so that a divide between developed and developing nations can be bridged. Further, it is pertinent to expedite financial inclusion in developing countries to swiftly adopt blockchain technology in every sector. Future studies can be conducted to examine the role of big data in expediting financial inclusion in the case of developing countries to obtain meaningful progress in blockchain adoption in the financial sector.

5.3. Recommendations for future research

The future directions for blockchain research are not nuance but limitless (Pimentel & Boulianne, 2020). A rise in the concerns about cyber security and data protection are two potential urges appealing for future research where blockchain is reckoned as one of the best and most effective solution strategies (Maroufi et al, 2019). In particular, prospects are higher for blockchain 3.0 where it will be acquiring the attention of key stakeholders such as the governments and the data regimes around the world. Thus, based on the findings of the study, future research can be conducted to draw a parallel between the prospects of decentralized versus centralized blockchain systems aiming to protect the data and improve and expedite the usage of the available data for more real-time decision-making and policy formulation (Nawari & Ravindran, 2019). So that all the systems in the future could make a smart assessment that which type of blockchain will stay relevant in different sectors in particular in the financial or banking sector.

6. Conclusion

The possibilities for future applications of solutions based on blockchain technology are practically limitless. As the blockchain revolution gains momentum, companies operating in the financial services and fintech sectors will face new challenges. Among these is the

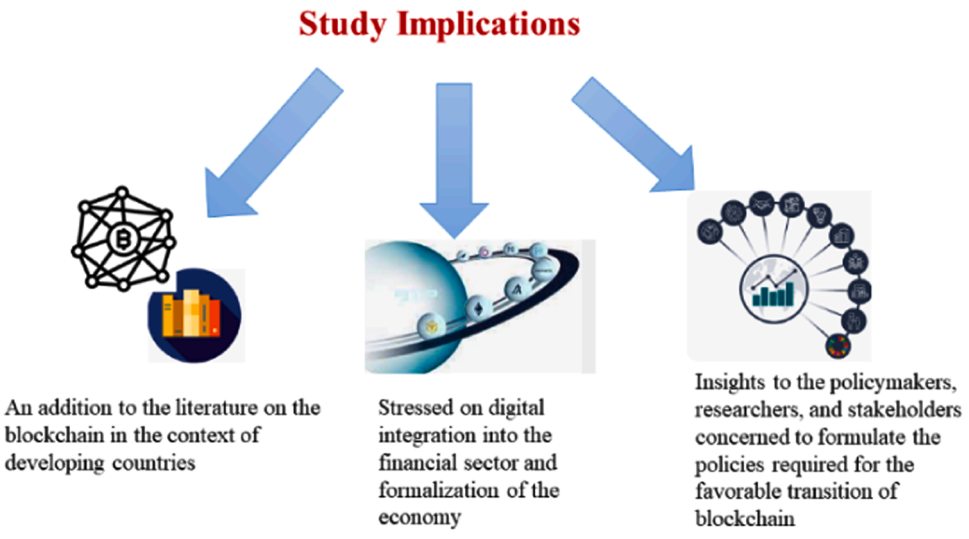

Fig. 4. Study implications.

identification of problems that call for inventive approaches to their resolution, as opposed to merely the formulation of solutions to problems that already exist. Businesses that invest in blockchain technology and other forms of fintech will have an advantage over their competitors. Blockchain technology has already been proven successful in a variety of industries, such as retail, healthcare, and real estate. amongst others, investing in the development of blockchain software has the potential to generate a high return on investment. The Internet of Things (IoT), which is revolutionizing a wide variety of industrial sectors, will serve as a driving force behind the development of blockchain technology. The implementation of blockchain technology in the banking and financial business will result in the creation of a safe environment, the elimination of paperwork, and a reduction in the amount of time required for the completion of transactions by fifty percent. It has the potential to increase overall consumer satisfaction while also making data transfers safer.

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