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Applications, Challenges, and Opportunities of Blockchain Technology in Banking and Insurance

S. L. Gupta, Pooja Kansra, and Gagan Kukreja

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S. L. Gupta
Birla Institute of Technology, Noida, India

Pooja Kansra
Mittal School of Business, Lovely Professional University, India

Gagan Kukreja
College of Business Administration, University of Bahrain, Bahrain

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Table of Contents

Detailed Table of Contents

Blockchain has become the latest buzzword and hottest technology in academics and the IT industry. Blockchain is a decentralized model that maintains data growing at a rapid pace. In 2008, Satoshi Nakamoto has introduced the concept of blockchain. With the development of bitcoin, blockchain concept became popular and is now considered one of the most impactful inventions of the last decade. It has the potential applications in different areas of study such as banks, education, healthcare, internet of things, cryptography, transportation, and so on. It is considered the future of next digital transformation after mainframe computer, personal computer, smart mobiles, and social networking. The main purpose of this chapter is to introduce the concept of blockchain technology, its few important applications in banking industry, and how it can be used to transform financial institutions. Some of the most important applications of blockchain-based banking are payment systems, loans, KYC, and so on.

Blockchain technology is a core, underlying technology that stimulates possible applications in the banking sector. The study examines blockchain, the nascent technology that reinforces Bitcoin and other cryptocurrencies, to determine what it is and how it can disrupt and alter the banking services. It emphasizes the technology's

In this chapter, the authors holistically study different barriers in the path of implementation of blockchain technology in the growth of the banking sector. Over the last decade, blockchain technology has received a lot of attention. This disruptive force of digital technology is becoming an imperative factor around the world by changing the business models. This chapter includes three different research phases. In the first stage, barriers were identified from the literature followed by interviews with experts of the industry. Finally, the authors design an ISM impact matrix cross-reference multiplication model. For the mass application of blockchain technology, policymakers tend to remove the barriers that have been shown in this chapter. On the basis of their importance, the blockchain technology application tends to ease by eliminating the highlighted barriers. This study is one of the preliminary attempts at the implementation of blockchain by identifying barriers and ranking them according to their importance.

The chapter focuses on robustness of blockchain technology for recording a chain of transactions and maintenance of data. The initial sections of the chapter explain basic concepts like cryptography, double-entry ledger, cryptographic hashing, etc. that have been used in the development of blockchain technology. The authors explain the functioning of blockchain and its advantages in terms of time- stamped, immutable records. Blockchain represents a chain of transactions in the form of blocks that are connected through a hash unique to each block. Blockchain offers solutions to many real-world problems like recording the transactions and maintaining the records in a decentralized manner making the system efficient and yet ensuring transparency and safety. In subsequent sections, the authors discuss several use cases of blockchain in insurance and banking. The important applications include fraud detection and risk prevention, decentralized insurance and cheaper premiums, reinsurance, cross-border payments, trade finance, and compliance.

theoretical perspective, and literature search strategy was performed for all working and published research articles and book chapters indexed under different databanks (e.g., CEI, Google Scholar, IEEE, Research Gate, Web of Science, etc.). Only articles accessible in English and published between 2010 to 2021 are included in the study. Blockchain is gaining ever-increasing attention from various industries and research domains. A quantum leap in skills and technical know-how influences all segments of industries, and this revolution is absolutely necessary in the field of insurance. Thus, the implementation of blockchain in the insurance sector has turned out to be a default platform.

Blockchain technology has received much attention from academicians and industry practitioners because they perceive that it can contribute to the bottom line of corporations. Current literature shows a significant need for adopting blockchain technology in the finance and banking sector to bring digital disruption. The main objective of this chapter will be to identify the principles of blockchain technology and how it impacts the performance of the financial and banking sector. The secondary aims of this chapter will be to examine the challenges faced by the banking and insurance sector and analyse the characteristics of blockchain technology to suggest a model that collaborates with the other ecosystems to overcome those challenges. The chapter identifies models that have been suggested by other researchers and finally proposes a framework for the adoption of blockchain technology in the finance and banking sector.

Bancassurance was initiated as a supplementary medium for dispensing insurance-related products and services. The proposal was to make certain auxiliary profits for banks exclusive of the necessity to inculcate extra funds in a period when restrictions were under force and credit off take was unresponsive. Insurance firms thus had the time to amplify the market penetration for them. On the other hand, online and cybernetic intrusion in the banking sector and the inception of Bancassurance were nearly associated. The chapter will emphasize the need for a customer-centric approach

Cryptocurrencies started gaining popularity in 2017 because of the exponential returns despite their introduction in the year 2009. Cryptocurrency is now also seen as an investment opportunity by many especially after various cryptocurrencies have given unimaginable returns. Favourite investment avenues for investors were mutual funds, stock market, bonds, fixed deposits, etc., but cryptocurrencies have made their presence felt in recent times as an investment option and have seen a lot of inflow. Various start-ups are facilitating the investment in cryptocurrencies, making it feasible and reachable for every household to invest in in the hope of high returns. This chapter tries to analyse the returns that various cryptocurrencies have given since inception and compare the same with global benchmarks like NASDAQ, Nikkei, Sensex, etc. It is observed that despite very high volatility, cryptocurrencies were able to achieve very high returns as compared to stocks. The study also found a high positive correlation between the returns given by global indices and cryptocurrencies.

Retirement planning is a crucial step in any individual's life, yet many complain of dissatisfaction with the plan they made before retirement. Many variables, the uncertainty of life, and socio-economic shocks make this planning difficult. At times, an action plan needs some adjustments, which can be made through financial institutions. Any loan or scheme offered to an individual involves risk calculation. Transparency in records and the complete history of an individual's financial transactions can help institutions access risk correctly. Linking transactions and other details with blockchain technology can improve transparency and can make retirement saving plans viable for individuals. This chapter explains the relevance of blockchain technology in context to retirement planning investment. This chapter also suggests a blockchain model that can be implemented by financial institutions to make their products favorable.

Foreword

Today's financial world, dominated by banks and insurance companies, uses centralised database technologies primarily.

In India and in most parts of the world, all bank accounts have been digitalised in centralised databases. Many financial services, including payments, are being delivered using these centralised database technology platforms, as most visibly witnessed in the superfast progress made by UPI created by NPCI. Likewise, dematerialised equities, bonds and most other financial assets are also organised in centralised databases.

Financial transactions take place efficiently, seamlessly and at very low costs in this world of centralised databases. There is, however, a major systemic discomfort. These databases are invariably owned by some central authority which controls all these assets and transactions. The central authorities also control access of the participants to the databases and platforms as well. The real asset owners are not in real control and have to trust the central authorities to keep their money, assets and access safe and to permit transactions.

There is an alternative emerging. The cosy system of centralised databases based financial world of banks and insurance companies is in for a jolt by the new technology of blockchain and cryptography, more commonly described as cryptocurrencies. The blockchain-cryptography technologies is also known as decentralised databases and decentralised ledger technologies.

The principal business of banks and insurance companies is to intermediate funds between savers and borrowers and protection seekers and unfortunate sufferers of covered insurable events. The blockchain-cryptography technologies threaten to replace the intermediator (banker and insurer) and establish direct relationship between the savers/borrowers and protection seekers/sufferers of insurable events. In the process of using decentralised ledger/database systems, the blockchain-cryptography technologies also solve the problem of trusting the central authority.

The book in your hands, *Applications, Challenges, and Opportunities of Blockchain Technology in Banking and Insurance*, edited by Dr. Gagan Kukreja, Professor S L Gupta, and Professor Pooja Kansra, unfolds this phenomenal transformation initiated in and taking roots in the financial world.

In the sixteen chapters contributed by twenty-five researchers, academicians, and practitioners of blockchain-cryptography technology hailing from Turkey, Italy, Sultanate of Oman, and India, most dimensions of introduction and inroads being made by blockchain-cryptography technology have been dealt with quite credibly. The book also brings out implications of and challenges faced by this evolving phenomenon as well.

The authors deal with various dimensions of the opportunity, status, and challenges of blockchain-cryptography technology introduction in the banking and insurance industries in the chapters contributed by them.

The chapters are quite well-researched, and the contents organised in a reasonably free flowing way. The book brings out global perspective on blockchains and its increasing use in the financial industry. Authors credit and mention the authorities for the accessed contents and arrange the same seamlessly.

Dr. Gagan Kukreja, Professor S L Gupta and Professor Pooja Kansra have painstakingly allocated distinct subject themes to the authors. Yet, as almost all the chapters are dedicated to banking and insurance industries, there is some overlap. Perhaps this was unavoidable.

I am sure the researchers, academicians, practitioners, policy makers and other readers would find the Book quite informative on the subject to emerging subject of blockchains in financial world.

Subhash Chandra Garg

Author of *The $10 Trillion Dream: The State of Indian Economy and the Policy Reform Agenda*, India & Ex-Finance Secretary and Secretary Economic Affairs, Government of India, India

Preface

Blockchain technology as the name suggests is the chain of blocks that contain the relevant data regarding transactions of cryptocurrency, which firstly confide and verify the records which cannot be removed or changed. (Makridakis & Christodoulou, 2019). Blockchain Technology is one of the dispersed forms of technology that is used to form an appropriate ledger of the transactions which take place regarding cryptocurrency.

Blockchain is a fiction that is inclusive of a classified summary regarding prior concerns with a block being the original document of day-to-day transactions. (Chiu & Koeppl, 2018). It is the register that is used to record encoded as well as an encrypted records of digital affairs which is known as a block. This provides protection from the intervention of a third party because it results in direct transmission regarding the block of data which is approved and sequentially structured with the use of cryptography.

Cryptography is one of the mechanisms which are used to transfigure the data into a tangled form which provides protection against third parties. Blockchains are generally confined to cryptography to safeguard the surveillance of data that is reserved. It is quite important to store the data with evident accuracy and irreversibility.

Blockchain technology regulates the inter-change process between the parties who regulate to protect their interest on a secured basis as well as the transactions are to be signed by the parties without any intermediary through digital mode (Makridakis & Christodoulou, 2019).

This book represents a compilation of various research papers and articles covering the in-depth application of Blockchain technology across various sectors ranging from banking, insurance, bancassurance, real estate, and SMEs to name a few. It emphasises how the evolution of Blockchain technology has revolutionised the financial sector. It also addresses the current issues and challenges being faced in Blockchain technology across various sectors in detail. In addition to that, it also touches base upon new emerging areas like cryptocurrency.

This book can be used by the researchers, students of the banking and financial services. This book will also facilitate the practitioners, and policymakers in their work profile.

A summary of the contents of each chapter is presented below:

Chapter 1 is authored by Dr. Fasel Qadir Shusha, Mr. Gulnawaz Gani, and Dr. Zubair Jeelani who elaborate on Blockchain-based banking theory and applications. This chapter showcases that blockchain technology has the capability to eliminate the inefficiencies caused by traditional digital systems, like the traditional banking system. This chapter discusses four important applications of Blockchain Technology which are payment system, CIBIL score system, KYC system and smart contract system. Finally, major challenges in blockchain-based banking applications are presented.

Chapter 2 is authored by Sugandh Arora and Dr. Tawheed Nabi who deliberate whether the adoption of Blockchain technology in Banking systems is a boon or bane. This chapter examines the financial industry's perception of the Blockchain. It further explores the current impediments to blockchain technology's widespread adoption in banking and the perceived benefits of blockchain technology in banking. This chapter discusses the theoretical underpinnings for examining the potential benefits and drawbacks of implementing blockchain technology in banking.

Chapter 3 is authored by Mrs. Derya Üçoğlu where she discusses the opportunities and challenges of Blockchain Technology that would emerge in the banking sector through a thorough analysis of the current literature prevailing on the subject.

Chapter 4 is authored by Nicola Del Sarto and Prof. Lorenzo Gai who discuss the threats, opportunities and future research trajectories of Blockchain technology for SMEs. This chapter analyses the various aspects of Blockchain and elaborates on how blockchain integrates into the broader industrial processes and digital business platforms. It also elaborates the actions that SMEs need to take to benefit from these new solutions.

Chapter 5 is authored by Dr Gargi Pant Shukla and Dr. Nitin Balwani who present an analysis of key barriers to Blockchain in the banking sector through an ISM Ranking approach. This chapter presents a blend of the theoretical framework and practical application. It uses interpretive structural modelling (ISM) analysis to draw the linkage and impact of distinctive barriers being applied via blockchain technology in the Banking Sector.

Chapter 6 is authored by Dr. Priti Sharma and Mr. Ritesh Chandra who highlight the significance of Blockchain in the Banking and Insurance sector. This chapter explains how Blockchain can be used to reduce transaction costs and improve the efficiency of banking processes. It also elucidates that Blockchain can help banks to tap into the unbanked customer population and create new revenue streams.

Chapter 7 is authored by Dr. Vandana Mehrotra and Dr. Meena Bhatia who explore the innovation of Blockchain concepts prevailing in the Financial Market. This chapter states that the global financial markets and, more specifically, the financial services industry is experimenting with blockchain in many of its functions. The authors believe that Blockchain technology can transform the financial products and services available in the financial market.

Chapter 8 is authored by Tanveer Kajla, Dr. Vishal Sarin, and Dr. Sahil Raj who investigate Blockchain in the banking sector as a revolution or digital disruption. This chapter explains that though the Blockchain itself provides a secure and trustable architecture to the financial markets and however, collaborative governance is required to bring trust in the banking and finance sector. The absence of a regulatory framework for this new technology acts as a disruptive force. Therefore, to get the societal benefits of the blockchain, there needs to be stringent governance and regulatory framework to handle the blockchain technology.

Chapter 9 is authored by Mr. Sumit Oberoi and Dr. Pooja Kansra who elaborate on the use of Blockchain Technology in the Insurance Industry. This chapter highlights that Blockchain technology possesses the capacity to develop and enable the insurance industry with new tools to redesign products and business models This chapter also enlists the challenges and opportunities of blockchain technology in Insurance sector.

Chapter 10 is authored by Hesham Magd, Dr. Ravi Thirumalaisamy and Mr. Benson Ruzive who deliberate on Blockchain Technology as a way forward toward transformation for the banking and insurance sector. This chapter identifies the principles of Blockchain technology and how it impacts the performance of the financial and banking sector. It also examines the challenges faced by the banking and insurance sector and analyzes the characteristics of Blockchain technology to suggest a model that collaborates with the other ecosystems to overcome those challenges.

Chapter 11 is authored by Ms. Diksha Verma who presents a theoretical perspective of prospects and confronts of BlockChain Technology in Digitizing Bancassurance in India. The paper emphasizes the need for a customer-centric approach and recognizes the tactic desired for giving a boost to the Bancassurance business model through innovations and intensification of the digital infrastructure of banks.

Chapter 12 is authored by Dr. Satveer Kaur, Miss Neeru Jaswal, and Dr. Harvinder Singh who elaborate on the principles, applications, and advantages of Blockchain Technology in the Digital Era.

Chapter 13 is authored by Mr. Basit Ali Bhat and Prof. Nitin Gupta who talk about the integration of Blockchain tokenisation in Real Estate. This chapter highlights that virtual reality and automated homes have made significant impacts in the real estate sector, and Blockchain technology, or real-estate Tokenisation, has a bright future, and many industries benefit from Blockchain technology.

Chapter 14 is authored by Mr. Pitresh Kaushik and Miss Neha Kukrety who investigate Cryptocurrency as a new investment avenue in India. This chapter emphasise that in more recent years, cryptocurrencies have become a popular choice of alternative investment. However, much higher volatility is seen in the cryptocurrencies as compared to stock market indices, and Sensex and nifty and the lack of any regulatory framework are the issues which need attention.

Chapter 15 is authored by Mr. Anup Sharma and Prof. Nitin Gupta who present comprehensive coverage of Blockchain Application in Retirement Planning Investment while improving transparency and viability of the blockchain technology. This chapter elucidates Blockchains as digital ledgers that are considered to be tamper-evident and tamper-resistant. It further states that this concept of blockchain is applied in many areas and improvement in transparency and security is reported. Hence, the authors insist, that the use of Blockchain technology could help in making the retirement planning industry more lucrative.

Chapter 16 is authored by Ms. Tanya Kumar and Dr. Satveer Kaur who examine the present and future perspectives of Blockchain Technology by studying the companies which are using Blockchain technology. The author also tries to estimate the future requirements of Blockchain technology.

S. L. Gupta
Birla Institute of Technology, Noida, India

Pooja Kansra
Mittal School of Business, Lovely Professional University, India

Gagan Kukreja
College of Business Administration, University of Bahrain, Bahrain

REFERENCES

Chiu, J., & Koeppl, T. (2019). Incentive compatibility on the blockchain. In *Social design* (pp. 323–335). Springer. doi:10.1007/978-3-319-93809-7_20

Makridakis, S., & Christodoulou, K. (2019). Blockchain: Current challenges and prospects/applications. *Future Internet*, *11*(12), 258. doi:10.3390/fi11120258

Chapter 1
Blockchain-Based Banking: Theory and Applications

Fasel Qadir
University of Kashmir, Srinagar, India

Gulnawaz Gani
University of Kashmir, Srinagar, India

Zubair Jeelani
https://orcid.org/0000-0003-4600-2899
Islamic University of Science and Technology, India

ABSTRACT

Blockchain has become the latest buzzword and hottest technology in academics and the IT industry. Blockchain is a decentralized model that maintains data growing at a rapid pace. In 2008, Satoshi Nakamoto has introduced the concept of blockchain. With the development of bitcoin, blockchain concept became popular and is now considered one of the most impactful inventions of the last decade. It has the potential applications in different areas of study such as banks, education, healthcare, internet of things, cryptography, transportation, and so on. It is considered the future of next digital transformation after mainframe computer, personal computer, smart mobiles, and social networking. The main purpose of this chapter is to introduce the concept of blockchain technology, its few important applications in banking industry, and how it can be used to transform financial institutions. Some of the most important applications of blockchain-based banking are payment systems, loans, KYC, and so on.

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INTRODUCTION TO BLOCKCHAIN TECHNOLOGY

Making transactions in conventional systems is controlled and managed through third parties rather than directly between two principal activities. To address this issue, the idea and framework of blockchain technology was introduced and has been applied successfully in different application areas such as banking, education, healthcare, and so on. The objective of blockchain technology is to develop decentralized systems where there is no involvement of third party. Its main strengths, such as low-cost, less-time, transparency, security, traceability, data-sharing, data-integrity, etc. makes blockchain an important technology for developing efficient systems. Any attempt to change any block is immutable as the blockchain technology doesn't permit for it because that can be seen by the other members of the technology. So, it makes frauds impossible and at the same time creates trust among the users which further makes the system transparent. These are the reasons that a wide range of applications have been developed underlying blockchain technology (Nakamoto, 2008; Yli-Huumo et al, 2016; Alammary et al, 2019; Ben & Lahami, 2020).

The idea of blockchain is not new. In 1991, two researchers Stuart Haber and W. Scott Stornetta gave the conceptual framework of chain of blocks (Haber & Stornetta, 1990; Haber & Stornetta,1991, Shrimali & Patel, 2021). The idea was to develop a secured system of chain of blocks for timestamping digital documents, so that their forgeries could be stopped. To achieve this target, cryptographic-hash functions and Merkle trees were used to record verified digital documents in blocks. However, the technology became popular only after its use in cryptocurrencies. Bitcoin is one of the most famous examples of cryptocurrencies emerged under blockchain technology and is the first electronic payment system executed without the intervention of intermediators (Nakamoto, 2008).

One of the main reasons that blockchain technology is so successful today is due to Merkle Trees, also known as hash trees. Merkle Trees are named after Ralph Merkle, who patented them in 1979. In 1992, the concept of Merkle trees were used with chain of blocks for making it more secure. In simple terms, a Merkle Tree or a binary hash-tree is a data structure that is used in blockchain to encode data more efficiently. It consists hashes of other blocks and provides the history of block transactions. Depending upon the block size, it allows each block to hold more than one record. The popular cryptocurrencies such as Bitcoin and Ethereum uses Merkle Trees.

A Proof of Work (PoW) is a consensus algorithm that ensures the transaction success and is responsible for connecting new blocks to the existing chain. However, the computing process takes much time to verify the status of the process but can be checked quickly. Further, tokens of PoW can't be reused because of double-spend problem. So, Hal Finney explored the concept further and solved the double spending problem by putting registered tokens on a trusted server. Later, Finney in 2004, proposed a system of Reusable Proof of Work (RPoW) that provides PoW tokens which can be reused, particularly used for digital cash. RPoW is considered as the primary and significant step towards cryptocurrencies.

In 2008, Satoshi Nakamoto, after understanding the framework and potential applications of blockchain, published a paper on blockchain-based bitcoin. Blockchain technology became popular after its use in cryptocurrency such as Bitcoin. Nakamoto modified the design of blockchain by allowing blocks to be added to the existing chain without signing them by the trusted parties. It uses a distributed peer to peer network for timestamping digital documents that can be executed without third party. With such improvements, blockchain is considered as the fundamental technology in the world of cryptocurrencies (Nakamoto, 2008). In 2009, Nakamoto released bitcoin software. The first successful bitcoin transaction that occurred between two computer scientists were Hal Fenny and Satoshi Nakamoto. At present, the underlying technology of blockchain serves as a public ledger for wide range of applications.

The reminder of this chapter is as follows. Section (1) will present an introduction to blockchain technology. Section (2) presents key concepts of blockchain. Section (3) will explain a few important applications of blockchain in banking systems. Section (4) will present characteristics and limitations of blockchain-based banking. And, finally section (5) will present conclusions and future challenges of block-based banking.

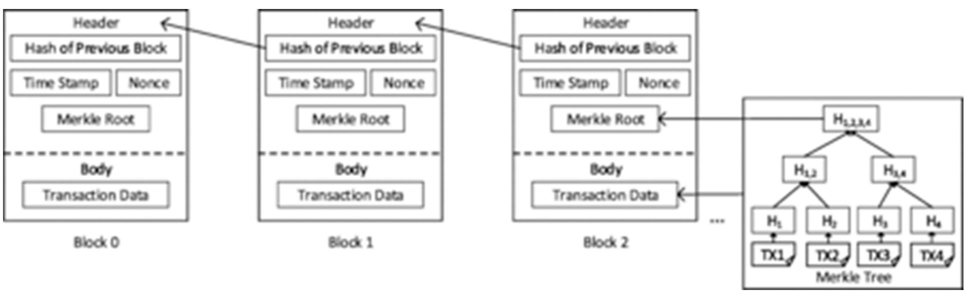
KEY CONCEPTS OF BLOCKCHAIN TECHNOLOGY

This section presents some important concepts of blockchain technology.

Blockchain: Blockchain is a peer-to-peer distributed digital ledger used to store information related to transactions without any central authority. It consists a chain-of-blocks, each containing some information, distributed over the network. Its decentralization property provides security, integrity and transparency in making transactions. While making a transaction, users of this technology holds a copy of data. Later, data is stored in blocks, if both the parties agreed with each other, that gets connected to a chain of cryptographic blocks. Finally, data is distributed on the blockchain technology and every user then holds a copy of the same. That is, each computer maintains security of the information by keeping its replicas on different computers along with past transaction records. Information in cryptographically connected blocks is immutable. That is, any attempt to manipulate any block (even a single bit of information from any block) will break the chain of connected blocks. It uses asymmetric cryptographic methods for validation of transactions. An asymmetric-key based digital signature is used in systems where there is no trust between two activities.

As shown in the figure 1, every block consists of two sections one is block-header and the second is block-body (Zeheng et al, 2018; Liang, 2019). A block-header contains a unique header which is used to find the individual blocks on the blockchain network. It consists the following. A *Hash of previous block,* which is an 8-byte long hash that points immediate previous blocks. A t*imestamp,* which is a 4-byte long field that represents timestamp of a block. A *Nonce,* which is a 4-byte long field used by the miners. It usually starts with index 0 and then increases for next blocks. And, a *Merkle root,* which is a 32-byte long root hash of a Merkle tree. The block-body stores transaction data that consists all transactions and their counter. A block can contain more than one transaction. Size of blocks and transactions determines the limit on the number of transactions that a block can store or hold.

Figure 1. Example of block and blockchain (Liang, 2019)



Further, as shown in the figure 1, blockchain consists a sequence of connected blocks. Every block holds a complete list of transactions like traditional public ledger. A hash reference is used to point the immediate previous block known as the parent block. Blockchains first block is known as the genesis block and it has no parent block. The users participating in the blockchain network are known as miners. They are responsible for creating new blocks in the network. They are the first parties to validate transactions using digital signatures. The new blocks are broadcasted over the whole network, so that all the users hold a copy of the same.

Blockchain technology stores information in such a way that it becomes impossible or probably difficult to temper it. Therefore, the biggest drawback of blockchain technology is that it cannot be used in applications where data is needed to be deleted. Blockchain network is something different from traditional supply-chain network and therefore requiring a new type of network infrastructure for connecting devices over world wide web. All users on blockchain network maintains distributed techniques and consensus algorithms (Chen et al, 2018).

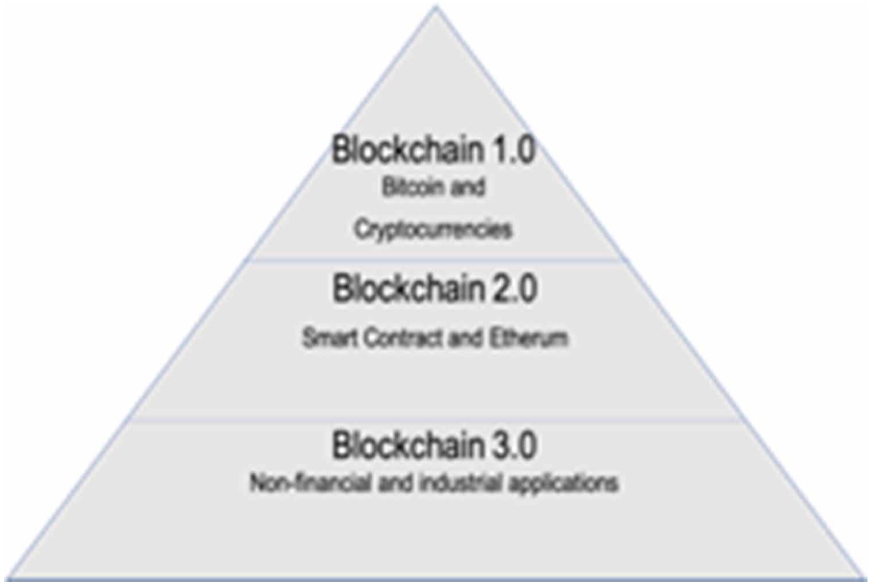
Digital Signature: The fundamental building blocks in blockchain is digital signatures. In simple terms, a digital signature is a cryptographic proof system required to establish a trust in the blockchain network. Primarily, a digital signature is used to ascertain transaction authentication. In blockchain, each user holds two keys private and public (Chen et al, 2018). A user uses a private key for signing a transaction on the blockchain network. The digitally signed transaction is then distributed over the blockchain network where each user holds a copy of it. The same transaction is also visible to every user of the network and can be accessed by the public keys.

Blockchain Generations: Blockchain technology has been evolved with time since its development and is classified into three different generations or versions, as shown in the figure 2. The three generations of blockchain are 1.0, 2.0 and 3.0 which are named as first, second and third blockchain generations, respectively (Alammary, 2019; Ben & Lahami, 2020). Blockchain 1.0 is designed to replace existing financial systems by efficient decentralized systems where two parties can make transactions directly. Bitcoin cryptocurrency is the first practical and real application of blockchain that emerged under 1.0. Blockchain 2.0 is designed to incorporate terms and conditions between parties while making transactions for agreeing smart contract terms. It is used to eliminate dependency on intermediators. That is, the concepts of smart contract, ethereum, solidity, and so on have been emerged under 2.0. They are a piece of computer code that is to be defined, executed and recorded on the blockchain network. Blockchain 3.0 is designed to address non-financial applications such as education, healthcare, energy, internet of things, cryptography, government, supply chain, etc. Further study of blockchain generations leads us to the development of new technologies under each generation.

BLOCKCHAIN APPLICATIONS IN BANKING INDUSTRY

Blockchain technology has found potential applications in different areas of study such as banking, business, management, healthcare, computer science, education and so on. Although banking sector is expanding at a rapid pace but still facing major challenges. Some of the major challenges that exist in conventional banking systems are transaction lag, inefficient models, limited and poor data, operation risks, money laundering, inefficiencies in validating credits, and so on. Such problems can easily be overcome by developing efficient systems using blockchain technology. The blockchain technology is believed to transform the banking industry by providing

Figure 2. Evolution of blockchain generations (from top to bottom) (Shrimali & Patel, 2021)



tangible solutions to all these issues. Some of the most important blockchain applications in banking industry are discussed below.

Payment System

Payment system is treated as the backbone of banking institutions. Intra-bank and inter-bank are the two types of banking payment transfer modes. In intra-bank, payment is transferred between accounts of the same bank. While as in inter-bank, payment is transferred between accounts of different banks. In inter-bank payments, third-party banks such as intermediary or correspondent banks are used to facilitate the international electronic fund transfers and settlement of transactions between banks. Before a payment is credited to the beneficiary's bank account, it first goes to the third-party bank. The third party-bank processes the request, debits the payment from the paying bank and then credits the payment to the beneficiary's bank account. This process takes few-hours to few-days (known as remittance period) depending upon the location of two banks, amount to be transferred, and guidelines of the two banks. Therefore, the process involved, especially at third-party banks end, is too long. Further, remittance service providers charge a transaction fee for making such transactions.

To address such issues, the idea of blockchain technology has been adopted, used successfully and is believed to transform the payment systems (Guo & Liang, 2016). It eliminated third-party banks that enables efficient and fast payment transfers at lower transaction costs than banks. It also helps banks to smoothly settle payment systems of commercial activities between cross-boarders. A recent poll, held among the members of European Payments Council, reveal that 90% of them believe that blockchain technology will change and revolutionize the banking industry by 2025. Similarly, an estimation made by Mckinsey reveal that the cost of transactions in international business transactions can be reduced considerably using blockchain.

Therefore, a large number of banking institutions have used the framework of blockchain technology to test inter-bank transactions. RippleNet is one of the most important blockchain based platform to process such transactions. It provides a global payment solution for transferring money easily, instantly and efficiently. More than 300 financial institutions so far have joined RippleNet for real-time transactions. Some of the leading financial institutions that joined RipppleNet are American Express, MoneyGram, NIUM, SBI Remit, Standard Chartered Bank, Interbank, etc. For instance, Standard Chartered Bank using RipleNet takes only 10 seconds to complete a transaction instead of 2 days taken on a standard banking platform. Similarly, National Bank of Australia also takes 10 seconds to complete a transaction initiated from this bank to Canadian Imperial Bank of Commerce.

CIBIL Score System

Loans are the selling-product and life-blood of financial institutes. In simple terms, loan is defined as the process of lending money to individuals or corporations by some financial institute with the intention of receiving back the loan principal along with its interest. Broadly, loans are classified into two types such as secured and unsecured. In secured, a loan is protected by a collateral or security (such as, land, gold, etc), whereas in unsecured loan collateral doesn't require. The amount of loan to be sanctioned by banks depends on collateral capacity and CIBIL (Credit Information Bureau India Limited) score. CIBIL score, also known as Credit Information Report (CIR) or simply Credit score, is a 3-digit numeric value of one's credit history. Credit history, which consists of credit taken and its pattern of payment, is used to generate the CIBIL score. A high credit score indicates that an individual or a company can be considered suitable for loan approval while as a low credit score indicates less chances of getting loan approval. For instance, TransUnion, India's famous pioneer information and insights company, provides a comprehensive CIBIL score of indivisibles/companies that ranges between 300 to 900. Lower the score (lesser than 549) indicates lesser chances of getting a loan whereas a high score (greater than 549) indicates higher chances for sanctioning of loan. Therefore, the financial institutions check CIBIL score (the deciding factor) for determining the eligibility of loan or credit card application. But, the traditional way of maintaining record in SIBIL systems has many limitations (Guo & Liang, 2016). The availability of limited and inferior quality of customer data makes it difficult to ascertain the position of CIBIL score. The difficulties in data sharing between financial institutions yields poor CIBIL score. The uncertain proprietorship of data creates problems in its circulation, due to privacy issues. To address these issues, some mechanism is required to establish the cooperation between the financial institutes. Blockchain technology is one such mechanism.

Blockchains data encryption can help to develop efficient CIBIL score systems by controlling our own big data and labelling ownership to the data recorded on the blockchain. It gives the assurance that the information stored is genuine and reliable. These big data's can be considered as genuine credit centers for financial institutions to generate CIBIL scores for loan applications. As such, it enables credit organizations to collect data at low costs than traditional banks because the underlying technology of blockchain provides facilitation of automatic collection of big data. Therefore, blockchain technology can efficiently collect, store and share status of customers credit information with the financial institutions. In addition to that, the decentralization property eliminates intermediate broker payments that allows financial institutions to release loans with low interest rates.

KYC System

KYC is the most popular term in financial institutions used by US in late 1980's. It is acronym for Know Your Customer or Know Your Client. It is an essential step towards verifying the identity of customers for opening or updating bank account. It involves verification of ID card, face, address proof, and biometric. KYC process is considered as a crucial and regulator governed steps in banks for performing analysis of customers identity verification. Such steps help banks to prevent and identify money laundering, illegal use of funds, terrorism funding, and other illegal schemes.

Figure 3 shows the process of traditional KYC used in banking systems for the internal verification of new customers (Malhotra et al, 2021). Details required for KYC verification needs to be submitted in the bank at the time of opening a new account or updating the existing account. But the problem in existing systems is that, customers are required to submit separate KYC forms in case they need to open accounts in different banks. As shown in the figure, a new customer wants to open account in four banks Bank A, Bank B, Bank C, and Bank D. In all these banks, communication happens between customer and a particular bank, because centralized systems that could connect all these banks is missing in existing KYC systems. The submission of separate KYC forms costs each bank approximately

$60 million annually. That is, financial institutes spend huge amount of money to maintain KYC records. The financial institutions then verifies the records submitted by customers with the records provided by the government. Accordingly, banks then takes a decision whether to accept or reject the customers application for KYC. This implies, the existing process is not only expensive but time-consuming as well. The time-consuming KYC process delays the overall process from form submission to banks decision. Therefore, the traditional systems used to maintain KYC records are inefficient. To address such issues, it is believed that the underlying technology of blockchain can be an extremely useful step in developing efficient KYC systems.

Figure 4 shows the various steps involved in KYC process using blockchain (Hassani et al, 2018). It consists the following three steps. (1) Customer approaches bank; A customer approach's a bank with the request to open an account. (2) Bank verifies and saves KYC data; bank then verifies the details submitted by the customers. Based upon the verification process, decisions of acceptance or rejection are taken. Bank store the original KYC information in their own databases. (3) KYC data saved on shared blockchain; encryption algorithms are then implemented on the summary of the data that is needed to be uploaded on the shared KYC blockchain, where other banks can access the KYC information without asking customers to submit new KYC applications. As shown in the figure 4 only Bank A communicated with the new customer regarding KYC application. Remaining banks directly communicate with the shared blockchain for getting the information related to KYC on customers approval. Thus, there is no need of submitting separate KYC forms in different banks.

Moreover, it should be noted that immutability feature of blockchain technology help banks to share customer information between financial institutes securely. Its use makes the administrative process simple and efficient by reducing duplication customer data, because it allows independent verification of one client by one financial institute that can later be accessed by other financial institutes. Further, the sharing of KYC record between financial institutes using blockchain technology results in the formation of a standardized and efficient single non-editable KYC system. Such systems help to complete the individual, institutional and corporate KYC processes fast and accurately. In this connection, several financial institutions established KYC software applications and their effectiveness have been tested on R3 blockchain platform. More importantly, efficient KYC software applications are now required as cryptocurrencies opens new ways for money laundering and terrorism financing.

Smart Contract System

Involvement of intermediaries in financial transactions makes traditional banking contracts complicated and cumbersome tasks. Blockchain technology can be used

Figure 3. Traditional KYC process (Malhotra et al, 2021).

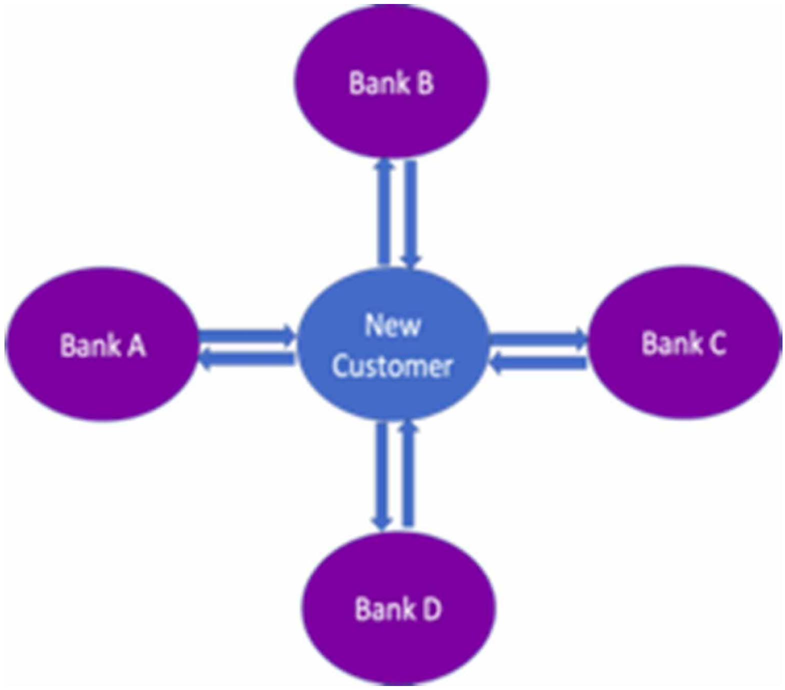
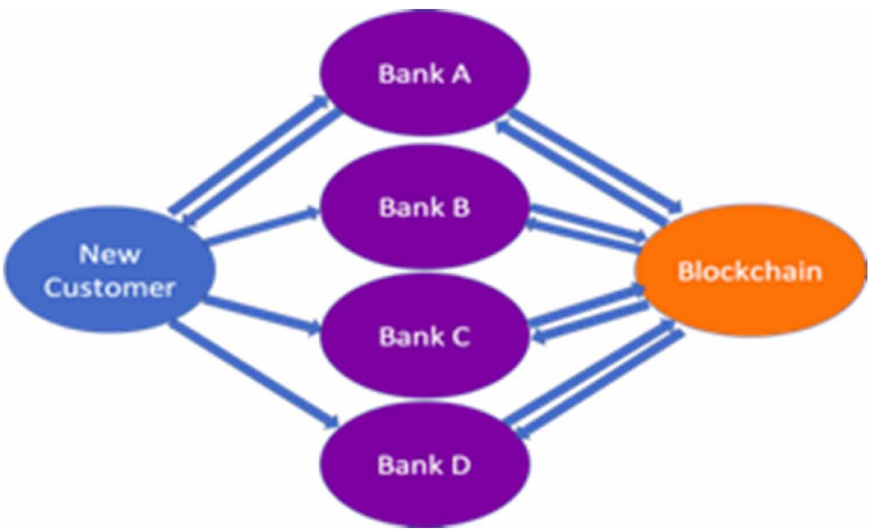


Figure 4. Blockchain-based KYC process (Malhotra et al, 2021)



to develop efficient banking contracts known as smart contracts. A smart contract is a computer program stored on top of the blockchain network. It holds contracts agreement terms and conditions to be written using any programming language. It can be executed to make financial transaction if conditions between untrusted parties meets. Unlike banking traditional contracts, smart contract doesn't require involvement of intermediaries. The agreement terms of a smart contract are executed in real-time and are based on a principle known as the principal of "if-when-then principle". To prevent contract tempering, copies of the smart contract are distributed across the blockchain network. Blockchain-based smart contracts has successfully been implemented in refunding, insurance and finance. Further, Australia's commonwealth bank used blockchain-based smart contracts to monitor the shipment of 17 tons of almonds (Hassani et al, 2018; Alharby et al, 2017; Khan et al, 2021).

There are two smart contracts types refereed as deterministic and non-deterministic. A deterministic smart contract does not need any information from external of blockchain network. Whereas, a non-deterministic smart contract needs some information from external of blockchain network. For instance, running a weather forecast smart contract on the blockchain network may require some information about current weather status (such as, wind direction), that may not be available on the blockchain network.

The automatic execution of contracts terms and conditions between two or more parties is the primary goal of smart contracts. Automatic process of smart contracts further reduces human errors to avoid contract disputes. So, they are fast with low-transaction fees as compared to conventional banking contracts. Further, the execution of smart contracts on blockchain network assures trust, transparency and security, as third parties are not involved in the process. Cryptographic digital signatures, used for the authentication of participants involved in the transaction, makes smart contracts a good choice for financial contracts. Thus, it is believed that use of smart contracts will revolutionize the banking industry. Despite many advantages, smart contracts face many challenges. For instance, in 2016, a smart contract namely decentralized autonomous organization was forged to steal around 2 million Ether 1 (approximately $15 million).

The four important blockchain platforms that are used for the development and deployment of smart contracts are Bitcoin, NXT, Ethereum and Hyperledger Fabric. Bitcoin is a public platform which is used to conduct and execute the transactions of cryptocurrencies with insufficient computing power. NXT (developed by BCnxt) is an open source and advanced platform used to conduct and execute cryptocurrency transactions with high computing power as compared to Bitcoin. Ethereum is the first platform used for developing modern, start-of-art and customized smart contracts using Turing complete virtual machine known as Ethereum Virtual Machine.

Hyperledger Fabric is a private platform that allows only selected individuals or organizations to participate through a membership service provider.

Digital Currency System

Financial institutions traditionally use SWIFT or SEPA networking systems for making secure money transfers along cross-borders. But, the main challenge facing these systems is processing time of transactions that takes normally a few days to complete a single transaction. On the hand, we have blockchain-based digital payment systems that process cross-border transactions securely and quickly (from few seconds to less than an hour) known as cryptocurrencies. Cryptocurrencies or cryptos, in short, are encrypted virtual currencies managed by blockchain systems. Cryptos, like any other currency, can be used for buying or selling of goods and for money transferring. In 2009, the first cryptocurrency known as Bitcoin developed by Satoshi Nakamoto, was introduced in the market and is the first electronic payment system executed without the intervention of intermediators (Nakamoto, 2008). Its popularity lays the base for the development of new cryptocurrencies for fulfilling different aspects and purposes in the market. As of March 2022, more than 18,000 cryptocurrencies exist in the world and the number is still growing rapidly since its adoption by many payment applications like PayPal. Some of the popular cryptocurrencies for investors are Bitcoin, Ethereum, Ripple, Bitcoin Cash, EOS, Stellar, Litecoin, Tether, Cardano, Monero, etc (Joo et al, 2020). A peer-to-peer networks, such as blockchain, can be used for conducting exchanges that is converting cryptocurrencies into cash by just selling them over the internet. Further, such type of systems has many strengths over conventional exchange systems such as lesser fees, faster processing, profitable exchanges and so on.

Nakamoto modified the design of blockchain by allowing blocks to be added to the existing chain without signing them by the trusted parties. It uses a distributed peer to peer network for timestamping digital documents that can be executed without third party. With such improvements, blockchain is considered as the fundamental technology in the world of cryptocurrencies (Nakamoto, 2008). In 2009, Nakamoto then released the bitcoin software. The first successful bitcoin transaction happened were Hal Fenny and Satoshi Nakamoto. At present, the underlying technology of blockchain serves as a public ledger for wide range of applications. RPoW is considered as the primary and significant step towards cryptocurrencies. Cryptocurrencies-based on blockchain technology have shown tremendous success in the area of financial sector. However, the area is still open for making efforts to make cryptocurrencies an all-time currency in all sectors. Further, the market is believing to get a best blockchain-based application for cryptocurrencies that will offer services like easy to use, less transaction fees, faster speed, highly efficient, and so on.

BLOCKCHAIN CHALLENGES

Despite limitless benefits and opportunities in financial sector, blockchain incurs the following limitations (Yli-Huumo et al, 2016; Zheng et al, 2018; Chen et al, 2018; Hassani et al, 2018; Lim et al, 2021; Casino et al, 2019; Malhotra et al, 2021).

Scalability

Scalability is used to measure the performance of system's ability on changing systems input and output. Or, it is the system's ability to accommodate greater number of users for processing growing amount of work and systems openness to augmentation. For instance, scalability checks how well a system performs by increasing the number of users/resources. Thus, for evaluating systems performance industries must pay great attention towards scalability component. Since the development of Bitcion, blockchains scalability remains an important and serious issues. The underlying technology of blockchain can't handle the load of transactions as the number of transactions are considerably increasing day by day. Therefore, scalability is one of the top blockchains area of study for researchers, scientists and industries to focus.

At present, blockchain-based Bitcion can handle only seven transactions per second while as VISA can handle four-thousand and five hundred transactions per second. The implementation of restrictions on the block size and the time required to create a new block are the reasons that allows blockchain to process only up to seven transactions per second. Therefore, blockchain technology can't handle/ process millions of transactions in real time. As such, considerable efforts are required to address blockchains scalability problem so that it can process a greater number of transactions. Moreover, due to limited capacity of blocks, miners will give preference to the transactions with high transaction fee over the transactions with low transaction fee. Thus, small transactions could be delayed. However, blocks with larger capacity will decrease the processing speed and are prone to threats. And that is the reason that various financial institutes are of the opinion that the current payment technology is not suitable. Thus, blockchains scalability problem is difficult to address.

Latency

In computing, latency refers time delay between input and its associated output. In blockchain, latency refers the amount of transaction time from submission to acceptance in the network. Using blockchain, approximately ten minutes are required to make one successful Bitcoin transaction while making Bitcoin-blocks highly secure. Means, blockchain transactions, specifically Bitcoin transactions, are time consuming. Thus, blackchin faces serious latency issues. It could become more dangerous, as the system is evolving rapidly, if appropriate steps at right time have not been taken. In fact, more time (in addition of 10 minutes) is required to avoid double spending problem. Double spending problem refers the risk of spending digital currencies more than twice.

Bitcoin is a decentralized digital currency. Transactions in Bitcoin are processed without any central authority. They are based on decentralized consensus mechanisms known as Proof-Of-Work. It allows activities to make payments by digitally signing their transactions. So, in Bitcoin, there is no involvement of trusted intermediators, who can authenticate whether a particular digital coin has previously been used or not. Third party's intervention could help to avoid spending the same money twice. In the world of digital payments, such attacks are known as double spending attacks. The most common double spending approach in blockchain is that when the hacker sends multiple packets and reversing them so that it seems that they have never been arise and processed. Thus, double spending problem needs to be addressed. Blockchain is the most suitable technique to combat the problem of double spending by keeping digital currencies as decentralized. Bitcoin technology is used to protect double spending problem by authenticating transactions before they added to the blockchain network. It ensures that transaction inputs have not been spent previously. This is done by combining blockchains security benefits and decentralization nature of miner's network (Pinzon & Rocha, 2016).

Expensive

The distributed architecture of blockchain technology leads to the development of expensive systems. Because the system requires to scatter all the nodes to be processed to all the participants. Further, to make blockchain based banking systems effective, it is needed to follow some standardized policies/schemes. For example, to share KYC information conveniently across financial institutes, some come policy for the verification of individuals or corporates must be followed.

The cost of storage is another major challenge in blockchain banking systems. For instance, the cost/gigabyte of a Bitcoin node for long-term storage is more than \$22 million.

Energy-Consuming

High energy-consumption is another major issue with miners in blockchain. Blockchain mining describes the process of adding transactions to Bitcoin network. Any device used to mine Bitcoin transactions is known as a node. Bitcoin miners (users) are supposed to run specialized Bitcoin software's for securely interacting with each other. Bitcoin systems reward miners who mine more number of Bitcoins. But the power consumed by Bitcoin mining is quite high. In fact, it is reported that mining consumes more electricity than consumed by 159 countries of the world in one year. Moreover, if cryptocurrencies would be increased only by 5%, it would require 10% of china's power. So, the challenge of high energy consumption raises two main questions. One, how to decrease energy-consumption. Second, whether to implement resources of energy to blockchain for processing data.

The reason that Bitcoin-mining (or, systems based on blockchain) consumes excessive power energy is the implementation of Proof-Of-Work (POW) consensus algorithms which is used for transaction validations in trading cryptocurrencies. Some efficient mechanism or consensus models are required to decrease the amount the computing power. Proof-of-Stake (POS) consensus model is one such mechanism. In case of POW, resource used for block-mining depends upon work-done carried out by the miner. While as in case of POS, resource used for block-mining depends on the amount of Bitcoin a miner holds. Thus, POS models, applied in several projects such as DASH cryptocurrencies, consumes less power as compared to POW. However, the mining problem needs to be addressed efficiently, so that process could consumes less computing power.

Stability

Token is the most important component in blockchain. It is used as a method or type of payment on blockchain network. For Bitcoin network, it is a cryptocurrency. Similarly, for other blockchain-based system, it may be used as a utility token for making transactions. In all cases, the conversion between different cryptocurrencies and cryptocurrencies & government-based currencies (such as, $, INR, etc) is important. But, cryptocurrencies are extremely volatile to be considered as the medium of exchange by financial institutions. Because, it goes up and down significantly as compared to other currencies or gold (Routledge & Zetlin-Jones, 2021). Therefore, stability of cryptocurrencies is another major issue in blockchain. Financial institutions usually hesitate to adopt cryptocurrencies as its market is too volatile, that is not stable. Stability ensures that neither seller nor buyer loses their cryptocurrencies due to price fluctuations.

Instead of using regular cryptocurrencies, it is suggested to use "stablecoin". A stablecoin is a pegged digital currency or token pegged that has low volatility relative to unpegged cryptocurrencies. Thus, stablecoin can be considered as stable digital payments for performing transactions on blockchain network. For instance, Stronghold USD is a stablecoin backed by USD deposits. Research, at IBM, is going on for making it a credible digital currency.

CONCLUSION

Blockchain is a peer-to-peer distributed digital ledger used to record all transactions that have ever occurred in the network without any central authority. It's important and unique characteristics such as low-cost, less-time, security, traceability, transparency, data-sharing, data-integrity, etc. has greatly attracted the attention of researchers, from divergent fields, towards blockchain technology. With the development of bitcoin, blockchain concept became popular and is now considered as one of the most impactful inventions of the last decade. It has the potential applications in different areas of study such as banks, education, healthcare, internet of things, cryptography, transportation, and so on. It is believed that the blockchain technology has the potential to eliminate the inefficiencies caused by the traditional digital systems, like traditional banking system. The goal of this chapter is to introduce the idea of blockchain technology and its important applications in banking industry. This chapter first discusses the key and general concepts of blockchain technology that lays the foundation for presenting the applications in banking industry. This chapter presents five important applications of blockchain in banking which are payment system, CIBIL score system, KYC system, smart contract system and digital currency system. Finally, this chapter presents five major challenges in blockchain-based banking applications. Moreover, it is evident from the presented work that there is lack of agreement within the industry regarding practicability of using blockchain technology in banking institutions. So, research gaps in connection to blockchain-based banking applications were also presented. These identified gaps are needed to address in future studies.

REFERENCES

Alammary, A., Alhazmi, S., Almasri, M., & Gillani, S. (2019). Blockchain-Based Applications in Education: A Systematic Review. *Applied Sciences (Basel, Switzerland)*, *9*(12), 2400. doi:10.3390/app9122400

Alharby, M., & van Moorsel, A. (2017). *Blockchain Based Smart Contracts : A Systematic Mapping Study. Computer Science & Information Technology*. doi:10.5121/csit.2017.71011

Ben Fekih, R., & Lahami, M. (2020). Application of Blockchain Technology in Healthcare: A Comprehensive Study. In M. Jmaiel, M. Mokhtari, B. Abdulrazak, H. Aloulou, & S. Kallel (Eds.), Lecture Notes in Computer Science: Vol. 12157. *The Impact of Digital Technologies on Public Health in Developed and Developing Countries. ICOST 2020*. Springer. doi:10.1007/978-3-030-51517-1_23

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*, *36*, 55–81. doi:10.1016/j.tele.2018.11.006

Chen, G., Xu, B., Lu, M., & Chen, N.-S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1. Advance online publication. doi:10.118640561-017-0050-x

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation*, *2*(1), 24. Advance online publication. doi:10.118640854-016-0034-9

Haber, S., & Stornetta, W. S. (1990). How to time-stamp a digital document. *Conference on the Theory and Application of Cryptography*, 437–455.

Hassani, H., Huang, X., & Silva, E. (2018). Banking with blockchain-ed big data. *Journal of Management Analytics*, *5*(4), 256–275. doi:10.1080/23270012.2018.1528900

Joo, M. H., Nishikawa, Y., & Dandapani, K. (2020). Cryptocurrency, a successful application of blockchain technology. *Managerial Finance*, *46*(6), 715–733. Advance online publication. doi:10.1108/MF-09-2018-0451

Khan, S. N., Loukil, F., Ghedira-Guegan, C., Benkhelifa, E., & Bani-Hani, A. (2021). Blockchain smart contracts: Applications, challenges, and future trends. *Peer-to-Peer Networking and Applications*, *14*(5), 2901–2925. doi:10.100712083-021-01127-0 PMID:33897937

Liang, Y.-C. (2019). Blockchain for Dynamic Spectrum Management. *Signals and Communication Technology*, 121–146. . doi:10.1007/978-981-15-0776-2_5

Lim, M. K., Li, Y., Wang, C., & Tseng, M.-L. (2021). A literature review of blockchain technology applications in supply chains: A comprehensive analysis of themes, methodologies and industries. *Computers & Industrial Engineering*, *154*, 107133. doi:10.1016/j.cie.2021.107133

Lizcano, D., Lara, J. A., White, B., & Aljawarneh, S. (2019). Blockchain-based approach to create a model of trust in open and ubiquitous higher education. *Journal of Computing in Higher Education*, *32*(1), 109–134. doi:10.100712528-019-09209-y

Malhotra, D., Saini, P., & Singh, A. K. (2021). How Blockchain Can Automate KYC: Systematic Review. *Wireless Personal Communications*, *122*(2), 1987–2021. doi:10.100711277-021-08977-0

Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*. Retrieved from https://bitcoin.org/bitcoin.pdf

Pinzón, C., & Rocha, C. (2016). Double-spend Attack Models with Time Advantange for Bitcoin. *Electronic Notes in Theoretical Computer Science*, *329*, 79–103. doi:10.1016/j.entcs.2016.12.006

Routledge, B., & Zetlin-Jones, A. (2021). Currency stability using blockchain technology. *Journal of Economic Dynamics & Control*, *104155*. Advance online publication. doi:10.1016/j.jedc.2021.104155

Shrimali, B., & Patel, H. B. (2021). Blockchain state-of-the-art: architecture, use cases, consensus, challenges and opportunities. *Journal of King Saud University - Computer and Information Sciences*. . doi:10.1016/j.jksuci.2021.08.005

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where Is Current Research on Blockchain Technology? A Systematic Review. *PLoS One*, *11*(10), e0163477. doi:10.1371/journal.pone.0163477 PMID:27695049

Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352. doi:10.1504/IJWGS.2018.095647

Chapter 2
Blockchain Adoption in Banking Systems:
A Boon or Bane?

Sugandh Arora
Lovely Professional University, India

Tawheed Nabi
Lovely Professional University, India

ABSTRACT

Blockchain technology is a core, underlying technology that stimulates possible applications in the banking sector. The study examines blockchain, the nascent technology that reinforces Bitcoin and other cryptocurrencies, to determine what it is and how it can disrupt and alter the banking services. It emphasizes the technology's properties and explains why they can significantly impact the banking industry, including reimbursements, payments, outflows, credentials facilities, and novel products based on smart contracts. The study also considered the work that needs to be done by the industry for blockchain applications to become a mainstream part of the financial landscape. It emphasizes that this is not a technology that a single company can perfect to obtain an advantage over competitors. Instead, it may assist the entire sector by speeding up and securing transactions. However, it can only reach its full potential if there is a wide-ranging alliance across the industry to explore practices and develop shared standards.

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INTRODUCTION

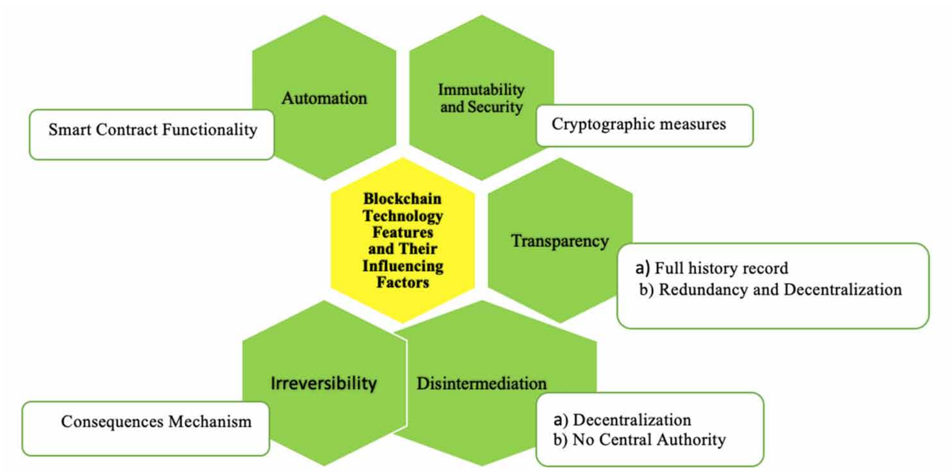
Internet of things, big data analytics, and cloud manufacturing impact the economic, social, and political forces driving global corporate operations (Rossit et al., 2019 and Frizzo et al., 2020). For data storage and management, nearly all industries and enterprises continue to rely on centralized information technology systems, most of which are not real-time capable and prone to various sorts of attacks. Blockchain technology, a decentralized, transparent, and observable technology, is one of the technologies that can disrupt operations management, manufacturing drastically, and supply chain management (Upadhyay, 2020; Tapscott and Tapscott, 2017 and Swan, 2015). Blockchain can be considered a trustless system because no entity relies on a specific counterpart's trustworthiness. Immutable transaction records and decentralized governance improve network confidence (Tapscott and Tapscott, 2017 and Swan, 2015). Blockchain technology is a critical component of today's banking industry, with numerous application scenarios. It can transform the banking industry by democratizing, transparently securing, and streamlining processes. A blockchain is a decentralized ledger that records transactions between two parties in real-time. Even though these parties have simultaneous access to the updated digital catalog, the system is virtually impregnable. Through bitcoin and other cryptocurrencies, blockchain technology will impact the end of money in the banking business. More than 90 central banks worldwide are experimenting with Blockchain technology, and 80 percent of institutions are projected to use distributed ledger technology shortly (Rossit et al., 2019). As a result, most banks are building blockchain use cases to start a global banking revolution by heralding the end of traditional banking.

The present study proposes the following research questions in light of blockchain technology: RQ1. What is the financial industry's perception on blockchain? RQ2. What are the current impediments to blockchain technology's widespread adoption in banking and the perceived benefits of blockchain technology in banking? This study discusses the theoretical underpinnings for examining the potential benefits and drawbacks of implementing blockchain technology in banking.

THE USE CASES OF BLOCKCHAIN TECHNOLOGY IN BANKING

Indian banks test blockchain technology for vendor financing, customer loyalty programs, and syndicated loans (Eyal, 2017). Banks like the Reserve Bank of India and State Bank of India are looking at blockchain technology (Ateniese et al., 2014; Universal Payments, 2017 and Upadhyay, 2020). The State Bank of India is the country's largest bank and the first to create a blockchain consortium with ten other banks. The bank completed its first blockchain project to share KYC, CFT, and AML data (Hassani et al., 2018). Outside India, other countries and businesses view blockchain differently. Blockchain as an ecosystem could benefit the banking and investment industries (Hassani et al., 2018; Beck et al., 2017 and Oberoi and Kansra, 2021). Banks use Bitcoin and Blockchain for financial and utility transactions (Ateniese et al. 2014; Taylor et al., 2019 and Zhang et al., 2018). As a distributed ledger, this technology is open to everybody. A blockchain's data cannot be easily modified or transformed, making it secure (Pratap, 2018; Iansiti, 2015). Blockchain technology may offer postal organizations decentralized platforms, safe data storage, and quick transactions (Jaag and Bach, 2017). Like in banking, blockchain technology is seen to improve efficiency. A variety of banks have tested and used this innovative technology. Some banks look at interbank choices initially, while others look internally first (Ateniese, et al., 2014). Many businesses can provide reliable and efficient solutions to global stakeholders (Dubey, et al., 2020; Upadhyay, 2020 and Manski, 2017). It creates an environment that fosters creativity to meet the needs and expectations of the project's stakeholders. This approach tracks several transactions and is transparent, secure, and decentralized (Ateniese, et al., 2014; Zhang et al., 2018). Blockchain aims to improve financial transaction transparency and efficiency (Kshetri et al., 2017; Guo and Liang, 2016). Using blockchain technology to improve payment clearing processes and credit information and management systems may trigger a new banking revolution (Cai et al., 2019; Guo and Liang, 2016). Remittances sent via blockchain entail a 2–3 percent fee, compared to 5–20 percent for traditional banking. Payments with cryptocurrencies may cause certain issues. Cryptocurrency payment systems may not work unless governments balance their interests and the currency's use regulations (Zhang et a., 2020). Furthermore, blockchain is a new institutional technology that affects transaction costs and redefines banking firm governance (Nofer et al., 2017), looked into the use of blockchain in banking to develop secure networks. According to Cai et al., (2019), claims that Blockchain technology eliminates financial intermediaries by enabling peer-to-peer internet payments and producing unregulated digital contracts. The most widely touted benefits of blockchain technology are cost efficiency, more earnings, better recordkeeping, smart digital contracts with universal online identification, a safe digital platform, and few legislative restrictions (Ateniese, et al., 2014; Puthal et al., 2018). Enhanced compliance, reduced risk, improved capacities, and automated trust are just a few of the advantages of industrial Blockchain [46]. The underlying technology also enhances the efficiency of clearing and post-transaction spending, resulting in cost savings (Hassani et al., 2018; Tapscott and Tapscott, 2017; Guo and Liang, 2016). According to Nelito (2018), Blockchain adoption could save the banking industry billions by decreasing handling and processing costs. Blockchain's timestamps on each transaction block can help banks reduce fraud (Harigunani, 2017). Instead of updating ledgers manually, blockchain technology immediately, automatically, and transparently (Kim and Laskowski, 2018 and Nelito, 2018). Banks can reduce transaction fees by reducing operating costs and eliminating intermediaries. Data is complete, accurate, and reliable since errors and duplication are eliminated (Thurner, 2018; New Age Banking Summit Europe, 2018). Blockchain technology can improve financial infrastructure and efficiency, notably in the banking sector (Mamoshina, 2018) Due to its low energy usage, it encourages global economic growth and green technology development. Kouzinopoulos et al., 2018 and Dale (2018) argues that rapid international payments would greatly reduce bank expenses and enhance proficiency and competency. Professional partners can trust blockchain because they can access technology and rely on reliable records and security mechanisms (Iskandar, 2017). Blockchain is a real-time, open-source technology that delivers value for the banking system's stakeholders (Accenture,2018; Umalkar et al., 2016). The blockchain-based financial system makes it easy to track authorized users, improving audit reliability and accuracy. Because banking is a service industry, intangibility and simultaneity are vital. Banking systems require service delivery, secrecy, innovation, and data integrity, which is provided by blockchain technology. In short, blockchain empowers a databank that is shared directly without a major owner. On the other hand, they highlighted improved data quality and durability, higher transaction speed, and lower transaction costs. The technology will enable banks to authenticate, consolidate, and trade-economic reports, verify contracts, keep track of reviews and audits, and deter money laundering. By enabling reduced fees on cash transfers and faster settlement systems via the distributed ledger, blockchain can disrupt the banking industry.

Figure 1. Blockchain features and their influencing factors



Our community frequently raises finances for unexpected catastrophes like disasters or pandemics, like Covid-19. Compared to traditional fund-raising methods, blockchain may offer a new financial access. Nowadays, most people need loans for houses, vehicles, and other personal needs. Blockchain can help remove barriers to securing a low-interest loan faster and more quickly Blockchain may thereby revolutionize the way people and societies interact. Blockchain can help boost transparency, reduce expenses, and increase production while reducing risk.

Current Trends in the Application of Blockchain Technology

In recent years, the financial sector has experienced an increase in blockchain-based applications (Hughes,2019; Zheng et al., 2018). Implementing these changes will improve data security, system capabilities, and interoperability with other systems. Because of these reasons, the financial and insurance sectors are investing in blockchain technology. Blockchain technology is being used to manage financial assets and business activities. Ledgers are distributed systematically, making transactions decentralized and immutable. Blockchain is seen as a tool for global sustainable development because it gives customers the benefits of the current financial system. Blockchain technology's promise to address trust and security, and control over data issues, is driving the use of smart contracts in financial services predicts a paradigm shift in capital markets and operational security through digital payments (Wall, 2018; McCallig, 2019). The use of blockchain technology in financial services, such as loan administration, governance, service delivery, and auditing, is also beneficial. According to financial services firms, they are already taking steps in that direction. Contracts and distributed ledgers emphasize JP Morgan Chase's Quorum division's blockchain solution. Blockchain technology has recently been licensed and trademarked by Bank of America. Goldman Sachs is spearheading a new effort to reduce volatility. By cutting expenses, boosting customer service, and enhancing creativity, businesses will reap the benefits of blockchain-based technologies. Soon, blockchain technology will be accepted as a viable component by financial organizations.

Transformation of Banking Services through the Use of Blockchain

Blockchain technology has the potential to alleviate difficulties in the financial sector. Applications based on Blockchain technology have their benefits and drawbacks.

1. **Payments**: The most common use of a financial or banking system is to move money between accounts. Commercial and central banks will use blockchain

technology to process payments in the near term. These are required for cross-border transactions to speed expenses. To make things more complicated, if the value of your local currency is volatile, it may be challenging to convert your bitcoin.

2. **Digital Funding**: All traditional methods of verifying identification, such as photo IDs and facial recognition software, may be rendered obsolete by Blockchain-based digital verification. Each time a user needs a banking service, they don't have to go through the tedious process of registering again. Using the shared ledger technology, anyone can access information without permission. Private information should not be stored on the blockchain as a result.
3. **Lending**: Traditional banks have a wide range of lending possibilities. Aside from the fact that the process takes a while, this lending system can use Blockchain technology for faster and more secure transactions. For KYC (Know Your Client) and BSA (Bank Secrecy Act) purposes, banks offer loans, which are linked to a single customer block. This technique helps to save money and time by eliminating the need to wait for the usual lengthy process.
4. **Bookkeeping, Accounting, and Auditing**: Most traditional banks still rely on paperwork such as double-entry transactions, gradually digitalizing after a lengthy process. In the shared ledger system, banks can directly enter transaction information. When using blockchain, all records are transparent and irrevocable. Smart contracts are a feature of this system that allows it to pay invoices automatically. Working in a bank requires prior knowledge of blockchain, which is a significant limitation.
5. **Crowdfunding**: This is a method of raising funds online by enlisting the help of many people who each have a modest amount of money. Initial Coin Offerings (ICOs) can offer their tokens over the internet, with the added benefit of decentralization provided by blockchain technology. Because of the legal concerns surrounding ICOs, this poses a risk.
6. **Smart contracts**: A smart contract is a collection of code recorded on the blockchain. When certain conditions are satisfied, these apps run automatically. Because blockchain is a decentralized ledger, it can perform cryptographic transactions and provide transparency without the involvement of intermediaries.
7. **Know Your Customer**: Traditional KYC (Know Your Customer) processes in banks and other financial institutions take a long time to complete, one at a time, making it difficult for new customers to get started. Blockchain can be used to provide other banks with independent verification of each of their customers. In addition to reducing waste, this strategy also saves time and reduces administrative burdens.

Opportunities for Blockchain Technology

To improve the capabilities of their employees, organizations should encourage them to engage and attend internal Blockchain knowledge sessions and conferences. Cross-functional teams must be encouraged to build a thorough plan for incorporating blockchain in the company's operations. An alternative technique must be devised so that no one can get their hands on the data (Wall, 2018). Regulators can investigate, contextualize or even regulate digital platforms in this virtual world. Peer-to-peer payment and present processes of storing and processing consumer requests can be transformed by blockchain technology. Smart contracts on the blockchain can assist insurance companies in processing claims (Wang et al., 2019d; Sharma, 2018). Using this technique, any claim can be traced back to its source with perfect transparency. Settlement agents, custodians, brokers, and intermediaries all play a role in the trade lifecycle. Allows for inefficiencies and errors due to a lack of modern technology. Thus, the trade lifecycle will become more efficient due to blockchain technology. Blockchain technology is intriguing potential in trade finance and the digital supply chain. This technology can minimize paperwork, such as "letters of credit," and costs by cutting out middlemen and creating a reliable network of stakeholders (Guo and Liang, 2016). Regulators in different countries have different requirements for financial institutions around the world. Without automated customer identification, "knowing your customer" can be a time-consuming process. The blockchain can provide a single platform for customer identification and document exchange among financial institutions. Privacy is a legal obligation, and this method will help ensure it. Institutional indicators highlight benefits coming from governance, cultural, and regulatory domains among multiple stakeholders. A culture of reducing fraudulent transactions and boosting trust can be fostered through blockchain technology. Auditability is achieved by identifying the source for various accounts and documents. A solid governance platform is made more accessible by using blockchain technology. The blockchain provides several market-based advantages under the headings of performance and procedures. To improve the performance of financial services, cost reduction and minimization are essential (Karamchandani, 2020). Various costs, including transaction, processing, and administrative expenses, must be analyzed to improve financial-market efficiency and reduce operational risk. As a result of real-time information and the elimination of intermediaries, business processes have also become more efficient and effective. Blockchain has solutions to assist drive perceived benefits in terms of technical metrics. In the first place, it ensures the integrity of data by ensuring that information is protected, accurate and controlled. For one thing, it provides better security and an automated recordkeeping system in addition to a speedier disbursement and settlement time frame. The architecture of any system must be able to withstand any disturbances. A financial system's infrastructure has a significant impact on the long-term viability of a company's business model. Resilience, sturdiness, and environmental friendliness are all features of blockchain technology (Kouzinopoulos et al., 2018). Information interchange and transactions can also be seen as sources of perceived benefits in speedy transactions, integrated systems and fewer errors, and speedier reconciliation. Using these criteria, we were able to identify which areas of banking could benefit from the use of blockchain. Banking relies significantly on outside companies to monitor and control huge transactions (Guo and Liang et al., 2016). The banking industry is tasked with regularly verifying the authenticity of data and ensuring that it complies. Blockchain can improve this by reducing the overlap between KYC and AML activities. AML can benefit from blockchain's artificial intelligence (AI) and machine learning (ML) capabilities. Any illicit conduct can be detected using blockchain-based AI and machine learning.

Blockchain can better monitor transactions using these technologies, and suspect transactions can be halted until additional research is complete. Traditional banking systems have been criticized for their slow transaction processing speed and reliance on decades-old procedures. Depending on the type of transaction, bank exchange charges can be pretty significant. Customer service in banking is increasingly dependent on the speed and efficiency of money transfers. Furthermore, integrating trade finance with blockchain technology helps speed up economic processes, where security and speedy settlements are critical.

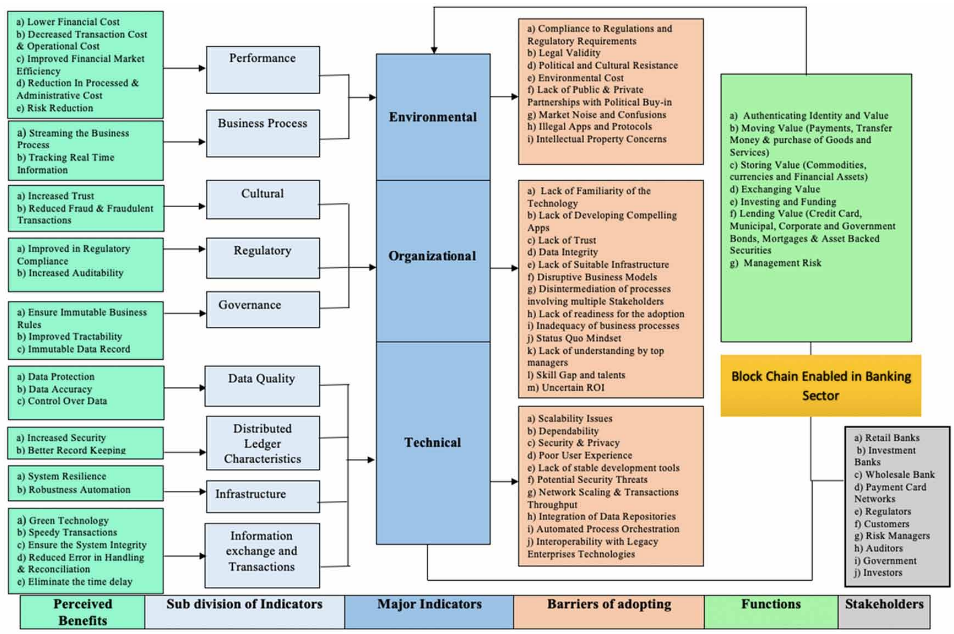
The Challenges of Using Blockchain in the Banking Sector

In some cases, the adoption of Blockchain technology has proved difficult. It's crucial to think about these difficulties in the context of e-governance as an example (Chang, 2016a). The absence of regulatory and legitimate support for blockchain in the public sector is also a problem. Blockchain technology applications face major three types of barriers:

Technological Indicators

Scalability and throughput constraints prevent blockchain technology from being adopted in most corporate applications (Chauhan et al., 2018, Naser, 2018 and Oh and Shong, 2017). All organizations want to be fast, scalable, and able to manage many transactions per second. There is a trade-off between the amount of computational power available and the number of transactions processed in blockchain applications. In most IoT applications, the cost of keeping transactions on the blockchain is prohibitive (Naser, 2018). Another challenge in device computational capabilities is the scalability of processing capacity, restricted by limits such as "sharding." As

Figure 2. Major indicators implementing blockchain technology in banking sector
Source: *Author's Compilation*



part of sharding, data storage for computational and workload duties is partitioned into smaller pieces (Sharma et al., 2018).

Technically, the algorithms employed for many blockchains are too slow and use too much energy (Janssen et al., 2020; Upadhyay, 2020). Blockchain has yet to significantly impact peer-to-peer energy trade, electric vehicle charging, and transportation (Ateniese et al., 2014). Several sectors have made significant investments in legacy systems that work well in most situations, making it challenging to integrate blockchain with already existing systems (Schuetz and Venkatesh, 2020).

Fault tolerance and performance might be negatively impacted by the distributed network reliability of blockchain applications (Cinque and Esposito, 2018). When a contract function can't handle fluctuations of more than 30 seconds and can't maintain its integrity, it's known as a timestamp dependency issue (Mense and Flatscher, 2018). Security and privacy are critical in blockchain networks (Harthy et al., 2019; Kwok and Koh, 2019; MacDonald et al., 2016; Mamoshina et al., 2018; Wang et al., 2019). Some other issues to be concerned about are data loss or network attacks when there are only a small number of participants in a blockchain, cyber threats, and vulnerabilities of blockchain systems because it is challenging to predict threats and existing systems are unable to deploy countermeasures (Liang et al.,

2018) and hacker vulnerabilities in intelligent contracts (Hughes, L., et al., 2019; Abdellatif and Brousmiche, 2018; Mense and Flatscher, 2018). Blockchain adoption in e-commerce can be bolstered by using certified bitcoins, such as the prevention of identity theft, because of privacy concerns (Ateniese, et al.; 2014). Because of the nature of distributed ledger technology, it is projected that blockchain technology will take the industry by storm. The most severe DLT flaws are found at the endpoints, where people and corporations use blockchain-based services (Lu, 2019; Deloitte, 2017). Both public and private keys are required to access data, and the ownership of both is linked. As long as the keys are accessible, there is a significant possibility that hackers will exploit the system's most vulnerable places (Zamani and Giaglis, 2018). If a vendor's security systems (flawed code) are insufficient, third-party partners may reveal their blockchain credentials (Hughes et al., 2019). If the code is not adequately vetted, a Decentralized Autonomous Organization (DAO) may launch an attack on numerous blockchains, including bitcoin.

One of the most difficult aspects of putting blockchain into practice. Although blockchain technology offers numerous advantages, it still has several technological shortcomings. One of the key elements in this is a coding defect or loophole. Although Bitcoin was the first to do so, the entire system smacks of wasteful design. Sure, Ethereum attempted to compensate for Bitcoin's flaws, but it was insufficient. Take, for example, decentralized application development. Ethereum allows developers to create decentralized applications (dapps) based on its platform. There have been numerous daps based on these to date. The majority of them, however, appear to be a result of incorrect code and loopholes. These flaws can be exploited by users to swiftly gain access to the system. So, all of that security rhetoric isn't working well here. Things will undoubtedly improve if solve the blockchain adoption problem.

Organizational Indicators: Organizational challenges include a lack of understanding of new technologies and a lack of human resources and competent specialists (Hughes, et al., 2019a; Liang et al., 2018a; Thakur, et al., 2020). In part because of a lack of familiarity with blockchain technology, many businesses cannot adapt (Kwok and Koh, 2019; Mamoshina et al., 2018; Mougayar, 2016). Weaknesses in humans' abilities to deal with vast amounts of data are significant roadblocks to adopting new technologies (Kharlamov and Parry, 2018).

For blockchain integration with older systems, data scalability, interoperability, and access to data are critical factors (Liang et al., 2018). There must be a constant flow of information, cash, and decisions for information technology to be successfully integrated. Businesses that need to process real-time data, for example, may face difficulties utilizing blockchain. If there aren't any fascinating apps or a "killer app," the adoption process will be hindered (Hughes et al., 2019a). Experts in computer security and information technology are skeptical of Blockchain technology (Harthy et al., 2019; Queiroz and Fosso, 2019). According to some academics, increasing the number of participants in a blockchain application will improve its trust and security, as more transactions are made between users, trust issues will diminish (Huges et al., 2019a). More research shows that supply chain players must have faith in each other to keep using blockchain-based supply chain solutions (Fosso, 2019).

Data integrity ensures that historical data is not tampered with and that previously given evidence is not tampered with during the process (Caro et al., 2018; Naser, 2018; Sharma and Park, 2018). Data integrity is critical to the success of management information systems (Branco et al., 2019). Lack of infrastructure is a significant problem for businesses. Storage, processing, and communication are the three main building blocks of the blockchain. Companies must set up the appropriate infrastructure to support the network's computational capabilities (Mukkamala et al., 2018). Disruptive business models hinder blockchain adoption (Hans et al., 2017; Rodrigues et al., 2018; Yoo, 2017) and the emergence of disruptive and dispersed autonomous organizations (Yoo, 2017). Disintermediation of processes involving numerous stakeholders [90], lack of readiness for adoption (Li et al., 2017), and inadequate business procedures (Liang et al., 2018) are the other two significant obstacles (Benbunan-Fich and Castellanos, 2018).

In many cases, business is concerned about the blockchain's cost and performance (Casino et al., 2019; Zheng et al., 2018). However, even though blockchain technology can reduce expenses, it still restricts more traditional methods. The initial investment in blockchain infrastructure and development is expensive. It may not be worth it for smaller financial institutions and banks to invest in this new technology. The expensive costs of maintaining blockchain technology are another obstacle to its widespread use (Cao et al., 2019). There are several barriers to clear when it comes to using this technology. Human-related issues with the early implementation of blockchain technology include knowledge-hiding, which was used to hinder institutions or management from prospering (Chang et al., 2020). Companies, therefore, need to keep a close eye on the development of the blockchain and prepare for its adoption.

Environmental Indicators: Regulators and technology advancements can conflict with one other (Hughes et al., 2019a). According to Castellanos and Benbunan-Fich (2018), and Gilcrest & Carvalho (2018), regulators and laws pose a barrier to widespread adoption of this technology (Hughes et al., 2019b, Hans et al., 2017; Moro et al., 2015; Thakur et al., 2020; Hughes et al., 2019a). As a result of the widespread adoption of blockchain, there are still numerous challenges. A lack of knowledge and understanding of technology in the workplace is a significant issue (Saberi et al., 2019). Developing blockchain prototypes is hindered by a lack of applicable platforms, providers, and collaborators (Clohessy and Acton, 2019; Hughes et al., 2019b). It has gotten increasingly difficult to protect customer data from hackers as their abilities have increased. There is no documentation of a financial institution using blockchain to manage its internal network and external information exchange for payments and transactions (Casino et al., 2019). Blockchain technology's decentralized nature restricts many financial businesses (Karamchandani et al., 2020; Khan and Salah, 218). There is a problem when the goals and intentions of multiple parties do not align in a decentralized system (McCallig et al., 2019). Blockchain adoption is also hindered by legal validity, conflict settlement, and integration of various laws (Hans et al., 2017; Hughes et al., 219b; Hye et al., 2017; Kwok and Koh, 2019). Lack of trust in blockchain technologies is an essential impediment to their widespread adoption (Hye et al., 2017). User resistance and changes in behavior may make it challenging to implement (Hans et al., 2017). The lack of public-private partnerships backed by the government impacts adoption rates (Benbunan-Fich and Castellanos, 2018). As a result, the environmental impact of blockchain networks and computing is tremendous, as encryption and cryptocurrency mining need a large amount of computer power and a large quantity of energy utilization (Hughes et al., 2019a; Kwok and Koh, 2019)

SUGGESTIONS AND WAY FORWARD

The use of blockchain technology boosts investor and stakeholder confidence. India urgently needs a legislative framework to maximize the potential of blockchain technology. The authors propose establishing a Council of Blockchain Technology to govern and promote Blockchain and Distributed Ledger Technology to establish trust between people and intermediaries and recognize and regulate Smart Contracts, Cryptography, and Distributed Ledger. Amend the Information Technology Act, 2000 to include blockchain-based electronic recordkeeping. To eliminate legislative overlaps, the author advocated merely modifying the Information Technology Act, 2000. The paper calls for creating a Council of Blockchain Technology in line with various state legislation in the USA. Because present regulations rely on centralized actors, such as licensed organizations and regulators, implementing a decentralized system or a hybrid of both would necessitate legal modifications. Decentralization of land records and registry was not deemed a practical step when the Government of Andhra Pradesh and Telangana shifted to it. Regulators must be thoroughly educated about the technology, its benefits, and drawbacks to get a balanced policy result. These findings, along with education and awareness campaigns, would help India accept technology and restructure its banking industry.

CONCLUSION

Blockchain has the potential to revolutionize finance. This includes payments, settlements, smart contracts, and e-identity. Blockchain technology forces us to rethink how organizations, processes, and markets work as banks and industries. It may forever alter our perceptions of ownership, money, and risk management. It's not just about 'putting a blockchain on it' to make things more efficient. Because blockchain technology is not a cure, the current focus is on finding real economic value. Technology can help many layers of the financial business if participants collaborate and properly build solutions. This takes time, effort, and focus. Short-term targeted solutions will gradually evolve into more integrated and complex use cases, proving the technology's usefulness. One thing is sure: a single player cannot develop this technology to acquire a competitive advantage. So long as everyone works together, it will help the entire industry. Blockchain is a decentralized digital ledger that stops hackers. Finale Abroad, the benefits of Blockchain technology have sparked global interest. Corporate governance as a concept revolves around three components: openness, auditability, and stakeholder trust. Because corporate governance is a behavioral science that affects businesses from the core, it has many theories and practical obstacles in execution. While blockchain is a unique technology, it lacks the behavioral aspect.

Absence of central authority and human touch in governance make a fully decentralized organization ineffective. Blockchain technology has the potential to provide real-time accounting, increase transparency, and reduce balance sheet fraud. By validating accounts in real time, the technology can save auditors money. The function of smart contracts can also be a blessing or a disaster for those that use this technology, like in the case of DAO, where smart contracts were created to only oblige in letter and not spirit. However, firms or banks will save litigation costs because arrangements are self-enforcing and cannot be breached. This helps the financial industry's efficiency. With Blockchain technology, you have unparalleled alternatives. This unique technique to encrypt transactions simplifies the world's money. Banking behemoths are looking for new Blockchain use cases to enhance their products. This technology transforms digital verification, auditing, crowdsourcing, and banking KYC. The banking industry is anticipated to use this technology soon. Using blockchain has its drawbacks. As such, experts should make steps to mitigate the upfront expenses associated with integrating blockchain in banking. The system that is being used is really advanced. As a result, designers must simplify and educate their audiences. The study revealed that organizational and environmental restrictions outweigh technological barriers to blockchain adoption in the banking industry. According to the study, blockchain technology can help banks increase their operational transparency, traceability, and trustworthiness. This study will contribute to our theoretical knowledge of the business benefits of blockchain. It will assist managers in implementing blockchain more effectively and reaping its benefits.

REFERENCES

Abdellatif, T., & Brousmiche, K. L. (2018). *Formal verification of smart contracts based on users and blockchain behaviors models. In 2018 9th IFIP International Conference on New Technologies, Mobility and Security (NTMS)*. IEEE. Available at https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8328737

Abreu, P. W., Aparicio, M., & Costa, C. J. (2018). Blockchain technology in the auditing environment. In *2018 13th Iberian conference on information Systems and technologies (CISTI)*. IEEE. Available at: 10.23919/CISTI.2018.8399460

Accenture. (2018). *Building the future-ready bank*. www.accenture.com/gb-en/_acnmedia/PDF-78/Accenture-Banking-Technology-Vision-2018.pdf

Al Harthy, K., Al Shuhaimi, F., & Juma Al Ismaily, K. K. (2019). The upcoming blockchain adoption in Higher-education: requirements and process. In 2*019 4th MEC international conference on big data and smart city (ICBDSC)*. IEEE. 10.1109/ICBDSC.2019.8645599

Ateniese, G. (2014). *Certified Bitcoins*. Springer. doi:10.1007/978-3-319-07536-5_6

Beck, R., Avital, M., Rossi, M., & Thatcher, J. B. (2017). Blockchain technology in business and information systems research. *Business & Information Systems Engineering*, *59*(6), 381–384. doi:10.100712599-017-0505-1

Benbunan-Fich, R., & Castellanos, A. (2018). Digitization of land records: From paper to blockchain. ICIS 2018 Proceedings.

Bogucharskov, A. V., Pokamestov, I. E., Adamova, K. R., & Tropina, Z. N. (2018). Adoption of blockchain technology in trade finance process. *Journal of Reviews on Global Economics*, *7*, 510–515. doi:10.6000/1929-7092.2018.07.47

Branco, F., Moreira, F., Martins, J., Au-Yong-Oliveira, M., & Gonçalves, R. (2019). Conceptual approach for an extension to a mushroom farm distributed process control system: IoT and blockchain. In *World Conference on Information Systems and Technologies* (738-747). Springer. 10.1007/978-3-030-16181-1_69

Büchi, G., Cugno, M., & Castagnoli, R. (2020). Smart factory performance and Industry 4.0. *Technological Forecasting and Social Change*, *150*, 119790. Advance online publication. doi:10.1016/j.techfore.2019.119790

Cai, T., Cai, H. J., Wang, H., Cheng, X., & Wang, L. (2019). Analysis of Blockchain System with Token-Based Bookkeeping Method. *IEEE Access: Practical Innovations, Open Solutions*, *7*, 50823–50832. doi:10.1109/ACCESS.2019.2911124

Cao, B., Li, Y., Zhang, L., Zhang, L., Mumtaz, S., Zhou, Z., & Peng, M. (2019). When Internet of Things meets blockchain: Challenges in distributed consensus. *IEEE Network*, *33*(6), 133–139. doi:10.1109/MNET.2019.1900002

Caro, M. P. (2018). *Blockchain-based traceability in agri-food supply chain management: A practical implementation. In 2018 IoT vertical and topical summit on agriculture*. IEEE. doi:10.1109/IOT-TUSCANY.2018.8373021

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*, *36*, 55–81. doi:10.1016/j.tele.2018.11.006

Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How Blockchain can impact financial services–The overview, challenges and recommendations from expert interviewees. *Technological Forecasting and Social Change*, *158*, 120166. doi:10.1016/j.techfore.2020.120166 PMID:32834134

Chang, V., Valverde, R., Ramachandran, M., & Li, C. S. (2020a). Toward Business Integrity Modeling and Analysis Framework for Risk Measurement and Analysis. *Applied Sciences (Basel, Switzerland)*, *10*(9), 3145. doi:10.3390/app10093145

Chang, V., Wang, Y., & Wills, G. (2020). Research investigations on the use or non-use of hearing aids in the smart cities. *Technological Forecasting and Social Change*, *153*, 119231. doi:10.1016/j.techfore.2018.03.002

Chang, Y., Iakovou, E., & Shi, W. (2020). Blockchain in global supply chains and cross border trade: A critical synthesis of the state-of-the-art, challenges and opportunities. *International Journal of Production Research*, *58*(7), 2082–2099. do i:10.1080/00207543.2019.1651946

Chauhan, A. (2018). *Blockchain and scalability. In 2018 IEEE international conference on software quality, reliability and security companion (QRS-C)*. IEEE. doi:10.1109/QRS-C.2018.00034

Cinque, M., & Esposito, C. (2018). How to assess the dependability of applications on top of the blockchain: Novel research challenges. In *2018 14th European dependable computing conference (EDCC)*. IEEE. 10.1109/EDCC.2018.00037

Clohessy, T., & Acton, T. (2019). Investigating the influence of organizational factors on blockchain adoption. *Industrial Management & Data Systems*, *119*(7), 1457–1491. doi:10.1108/IMDS-08-2018-0365

Cole, R., Stevenson, M., & Aitken, J. (2019). Blockchain technology: Implications for operations and supply chain management. *Supply Chain Management*, *24*(4), 469–483. doi:10.1108/SCM-09-2018-0309

Dale, O. (2018). *Benefits of Blockchain Technology for the Financial Services Industry*. Academic Press.

Deloitte. (2017). *Blockchain in Banking*. https://www2. deloitte.com/content/dam/Deloitte/in/Documents/strategy/in-strategy-innovation- blockchain-in-banking-noexp.pdf

Dong, Y., Hamilton, R., & Tippett, M. (2014). Cost efficiency of the Chinese banking sector: A comparison of stochastic frontier analysis and data envelopment analysis. *Economic Modelling*, *36*, 298–308. doi:10.1016/j.econmod.2013.09.042

Dubey, R., Gunasekaran, A., Bryde, D. J., Dwivedi, Y. K., & Papadopoulos, T. (2020). Blockchain technology for enhancing swift-trust, collaboration and resilience within a humanitarian supply chain setting. *International Journal of Production Research*, *58*(11), 3381–3398. doi:10.1080/00207543.2020.1722860

Eyal, I. (2017). Blockchain technology: Transforming libertarian cryptocurrency dreams to finance and banking realities. *Computer*, *50*(9), 38–49. doi:10.1109/MC.2017.3571042

Ferdows, K. (2018). Keeping up with growing complexity of managing global operations. *International Journal of Operations & Production Management*, *38*(2), 390–402. doi:10.1108/IJOPM-01-2017-0019

Fosso Wamba, S. (2019). Continuance intention in Blockchain-enabled supply chain applications: Modelling the moderating effect of supply chain stakeholders trust. Cham: Springer. doi:10.1007/978-3-030-11395-7_4

Frank, A. G., Mendes, G. H., Ayala, N. F., & Ghezzi, A. (2019). Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective. *Technological Forecasting and Social Change*, *141*, 341–351. doi:10.1016/j.techfore.2019.01.014

Frizzo-Barker, J., Chow-White, P. A., Adams, P. R., Mentanko, J., Ha, D., & Green, S. (2020). Blockchain as a disruptive technology for business: A systematic review. *International Journal of Information Management*, *51*, 102029. doi:10.1016/j.ijinfomgt.2019.10.014

Gai, K., Qiu, M., Zhao, H., & Sun, X. (2017). Resource management in sustainable cyber-physical systems using heterogeneous cloud computing. *IEEE Transactions on Sustainable Computing*, *3*(2), 60–72. doi:10.1109/TSUSC.2017.2723954

Gilcrest, J., & Carvalho, A. (2018). Smart contracts: Legal considerations. *IEEE International conference on big data (Big Data)*, 3277–3281.

Gordon, W. J., & Catalini, C. (2018). Blockchain technology for healthcare: Facilitating the transition to patient-driven interoperability. *Computational and Structural Biotechnology Journal*, *16*, 224–230. doi:10.1016/j.csbj.2018.06.003 PMID:30069284

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation, 2*(1), 1-12.

Gupta, A., & Gupta, S. (2018). Blockchain technology application in Indian Banking Sector. *Delhi Business Review*, *19*(2), 75–84. doi:10.51768/dbr.v19i2.192201807

Hans, R. (2017). Blockchain and smart contracts: Disruptive technologies for the insurance market. AMCIS 2017 Proceedings.

Harigunani, P. (2017). Blockchain for Banks: Benefits and Implications. *Journal of Management Analytics*, *5*(4), 256–275.

Hassani, H., Huang, X., & Silva, E. (2018). Banking with blockchain-ed big data. *Journal of Management Analytics*, *5*(4), 256–275. doi:10.1080/23270012.2018.1528900

Hou, J., Wang, C., & Luo, S. (2020). How to improve the competiveness of distributed energy resources in China with blockchain technology. *Technological Forecasting and Social Change*, *151*, 119744. doi:10.1016/j.techfore.2019.119744

Hughes, A., Park, A., Kietzmann, J., & Archer-Brown, C. (2019a). Beyond Bitcoin: What blockchain and distributed ledger technologies mean for firms. *Business Horizons*, *62*(3), 273–281. doi:10.1016/j.bushor.2019.01.002

Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management*, *49*, 114–129. doi:10.1016/j.ijinfomgt.2019.02.005

Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., & Akella, V. (2019b). Blockchain research, practice and policy: Applications, benefits, limitations, emerging research themes and research agenda. *International Journal of Information Management*, *49*, 114–129. doi:10.1016/j.ijinfomgt.2019.02.005

Hye, K., Min, K., & Hong, S. (2017). A study on ways to apply the blockchain-based online voting system. *International Journal of Control Autonomy*, *10*(12), 121–130. doi:10.14257/ijca.2017.10.12.11

Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*, *95*(1), 118–127.

IBM. (2016). *Leading the pack in blockchain banking*. www.hyperledger.org/wp-content/uploads/2016/10/Leading-the-packa.-in-blockchain-banking-1.pdf

Iqbal, B. A., & Sami, S. (2017). Role of banks in financial inclusion in India. *Contaduría y Administración*, *62*(2), 644–656. doi:10.1016/j.cya.2017.01.007

Iskandar, K. (2017). *What will blockchain mean for banks?* https://www.bookingbug.com/blog/what-blockchain-will-mean-for-banks/

Jaag, C., & Bach, C. (2017). Blockchain technology and cryptocurrencies: Opportunities for postal financial services. In *The changing postal and delivery sector* (pp. 205–221). Springer. doi:10.1007/978-3-319-46046-8_13

Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analysing blockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, *50*, 302–309. doi:10.1016/j.ijinfomgt.2019.08.012

Jayadev, M., Singh, H., & Kumar, P. (2017). Small finance banks: Challenges. *IIMB Management Review*, *29*(4), 311–325. doi:10.1016/j.iimb.2017.10.001

Karamchandani, A., Srivastava, S. K., & Srivastava, R. K. (2020). Perception-based model for analyzing the impact of enterprise blockchain adoption on SCM in the Indian service industry. *International Journal of Information Management*, *52*, 102019. doi:10.1016/j.ijinfomgt.2019.10.004

Khan, M. A., & Salah, K. (2018). IoT security: Review, blockchain solutions, and open challenges. *Future Generation Computer Systems*, *82*, 395–411. doi:10.1016/j.future.2017.11.022

Kharlamov, A., & Parry, G. (2018). Advanced supply chains: Visibility, blockchain and human behaviour. In *Innovation and Supply Chain Management* (pp. 321–343). Springer. doi:10.1007/978-3-319-74304-2_15

Kim, H. M., & Laskowski, M. (2018). Toward an ontology-driven blockchain design for supply-chain provenance. *Intelligent Systems in Accounting, Finance & Management*, *25*(1), 18–27. doi:10.1002/isaf.1424

Kohtamäki, M., Parida, V., Patel, P. C., & Gebauer, H. (2020). The relationship between digitalization and servitization: The role of servitization in capturing the financial potential of digitalization. *Technological Forecasting and Social Change*, *151*, 119804. doi:10.1016/j.techfore.2019.119804

Kouzinopoulos, C. S., Spathoulas, G., Giannoutakis, K. M., Votis, K., Pandey, P., Tzovaras, D., ... Nijdam, N. A. (2018, February). Using blockchains to strengthen the security of internet of things. In *International ISCIS Security Workshop*. Springer. 10.1007/978-3-319-95189-8_9

Kshetri, N. (2017). Blockchain's roles in strengthening cybersecurity and protecting privacy. *Telecommunications Policy*, *41*(10), 1027–1038. doi:10.1016/j.telpol.2017.09.003

Kumar, K., & Prakash, A. (2019). Developing a framework for assessing sustainable banking performance of the Indian banking sector. *Social Responsibility Journal*, *15*(5), 689–709. doi:10.1108/SRJ-07-2018-0162

Kwok, A. O., & Koh, S. G. (2019). Is blockchain technology a watershed for tourism development? *Current Issues in Tourism*, *22*(20), 2447–2452. doi:10.1080/13683500.2018.1513460

Larios-Hern´andez, G. J. (2017). Blockchain entrepreneurship opportunity in the practices of the unbanked. *Business Horizons*, *60*(6), 865–874. doi:10.1016/j.bushor.2017.07.012

Larson, D., & Chang, V. (2016). A review and future direction of agile, business intelligence, analytics and data science. *International Journal of Information Management*, *36*(5), 700–710. doi:10.1016/j.ijinfomgt.2016.04.013

Lemieux, V. L. (2016). Trusting records: Is Blockchain technology the answer? *Records Management Journal*, *26*(2), 110–139. doi:10.1108/RMJ-12-2015-0042

Li, J., Greenwood, D., & Kassem, M. (2019). Blockchain in the built environment and construction industry: A systematic review, conceptual models and practical use cases. *Automation in Construction*, *102*, 288–307. doi:10.1016/j.autcon.2019.02.005

Li, X. (2017). A survey on the security of blockchain systems. *Future Generation Computer Systems*. Advance online publication. doi:10.1016/j.future.2017.08.020

Liang, J. (2018a). Correlation-based dynamics and systemic risk measures in the cryptocurrency market. In *2018 IEEE international conference on intelligence and security informatics (ISI)*. IEEE. . doi:10.1109/ISI.2018.8587395

Liang, X., Shetty, S., Tosh, D., Ji, Y., & Li, D. (2018). Towards a reliable and accountable cyber supply chain in energy delivery system using blockchain. In *International Conference on Security and Privacy in Communication Systems* (pp. 43–62). Springer. doi:10.1007/978-3-030-01704-0_3

Lu, H., Huang, K., Azimi, M., & Guo, L. (2019). Blockchain technology in the oil and gas industry: A review of applications, opportunities, challenges, and risks. *IEEE Access: Practical Innovations, Open Solutions*, *7*, 41426–41444. doi:10.1109/ACCESS.2019.2907695

Lu, Y. (2019). The blockchain: State-of-the-art and research challenges. *Journal of Industrial Information Integration*, *15*, 80–90. doi:10.1016/j.jii.2019.04.002

MacDonald, T. J., Allen, D. W., & Potts, J. (2016). *Blockchains and the boundaries of self- organized economies: predictions for the future of banking*. *Banking Beyond Banks and Money*. Springer.

Mamoshina, P., Ojomoko, L., Yanovich, Y., Ostrovski, A., Botezatu, A., Prikhodko, P., Izumchenko, E., Aliper, A., Romantsov, K., Zhebrak, A., Ogu, I. O., & Zhavoronkov, A. (2018). Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. *Oncotarget*, *9*(5), 5665–5690. doi:10.18632/oncotarget.22345 PMID:29464026

Mani, Z., & Chouk, I. (2018). Consumer resistance to innovation in services: Challenges and barriers in the Internet of Things era. *Journal of Product Innovation Management*, *35*(5), 780–807. doi:10.1111/jpim.12463

Manski, S. (2017). Building the blockchain world: Technological commonwealth or just more of the same. *Strategic Change*, *26*(5), 511–522. doi:10.1002/jsc.2151

Mariani, M., & Borghi, M. (2019). Industry 4.0: A bibliometric review of its managerial intellectual structure and potential evolution in the service industries. *Technological Forecasting and Social Change*, *149*, 119752. doi:10.1016/j.techfore.2019.119752

McCallig, J., Robb, A., & Rohde, F. (2019). Establishing the representational faithfulness of financial accounting information using multiparty security, network analysis and a blockchain. *International Journal of Accounting Information Systems*, *33*, 47–58. doi:10.1016/j.accinf.2019.03.004

Mense, A., & Flatscher, M. (2018). Security vulnerabilities in ethereum smart contracts. In *Proceedings of the 20th international conference on information integration and web-based applications & services - iiWAS201*. ACM Press. 10.1145/3282373.3282419

Moro, S., Cortez, P., & Rita, P. (2015). Business intelligence in banking: A literature analysis from 2002 to 2013 using text mining and latent Dirichlet allocation. Expert Syst. *Appl.*, *42*(3), 1314–1324. doi:10.1016/j.eswa.2014.09.024

Mougayar, W. (2016). *The business blockchain: promise, practice, and application of the next Internet technology.* John Wiley & Sons.

Mukkamala, R. R. (2018). Converging blockchain and social business for socio-economic development. In *2018 IEEE international conference on big data (big data).* IEEE. doi:10.1109/BigData.2018.8622238

Naser, F. (2018). *Review: The potential use of blockchain technology in railway applications: An introduction of a mobility and speech recognition prototype. In 2018 IEEE international conference on big data (Big Data)*. IEEE. doi:10.1109/BigData.2018.8622234

Nelito. (2018). *Blockchain technology in banking and finance*. https://www.nelito.com/blog/blockchain-technology-in-banking-and-finan ce.html

New Age Banking Summit Europe. (2018). *4 key advantages of using blockchain in banking*. http://newagebankingsummit.com/europe/ 4-key-advantages-of-using-blockchain-in-banking/

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering, 59*(3), 183–187..doi:10.1007/s12599-017-0467-3

Oberoi, S., & Kansra, P. (2021). Motivating Antecedents and Consequences of Blockchain Technology in the Insurance Industry. In *Blockchain Technology and Applications for Digital Marketing* (pp. 276–285). IGI Global. doi:10.4018/978-1-7998-8081-3.ch017

Oh, J., & Shong, I. (2017). A case study on business model innovations using Blockchain: Focusing on financial institutions. *Asia Pacific Journal of Innovation and Entrepreneurship*, *11*(3), 335–344. doi:10.1108/APJIE-12-2017-038

Palihapitiya, T. (2020). *Blockchain Revolution in Banking Industry*. University of Moratuwa.

Pratap, M. (2018). *Blockchain Technology Explained: introduction, Meaning, and Applications*. https://hackernoon.com/blockchain-technology-explained-introduction-meaning-and-applications-edbd6759a2b2

Puthal, D., Malik, N., Mohanty, S. P., Kougianos, E., & Yang, C. (2018). The blockchain as a decentralized security framework. *IEEE Consumer Electronics Magazine*, *7*(2), 18–21. doi:10.1109/MCE.2017.2776459

Queiroz, M. M., & Fosso Wamba, S. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management*, *46*, 70–82. doi:10.1016/j.ijinfomgt.2018.11.021

Rodrigues, B., Bocek, T., & Stiller, B. (2018). The use of blockchains: Application-driven analysis of applicability. *Advances in Computers*, *111*, 163–198. doi:10.1016/bs.adcom.2018.03.011

Rossit, D. A., Tohmé, F., & Frutos, M. (2019). Industry 4.0: Smart scheduling. *International Journal of Production Research*, *57*(12), 3802–3813. doi:10.1080/00207543.2018.1504248

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. doi:10.1080/00207543.2018.1533261

Schuetz, S., & Venkatesh, V. (2020). Blockchain, adoption, and financial inclusion in India: research opportunities. *International Journal of Information Management,* 52, 101936. 10.1016/j.ijinfomgt.2019.04.009

Sharma, P. K., Kumar, N., & Park, J. H. (2018). Blockchain-based distributed framework for automotive industry in a smart city. *IEEE Transactions on Industrial Informatics*, *15*(7), 4197–4205. doi:10.1109/TII.2018.2887101

Skilton, M., & Hovsepian, F. (2017). *The 4th industrial revolution: Responding to the impact of artificial intelligence on business*. Springer International Publishing, AG.

Swan, M. (2015). *Blockchain: Blueprint for a new economy*. O'Reilly Media, Inc.

Tapscott, D., & Tapscott, A. (2017). How blockchain will change organizations. *MIT Sloan Management Review*, *58*(2), 10–13. doi:10.7551/mitpress

Taylor, P. J., Dargahi, T., Dehghantanha, A., Parizi, R. M., & Choo, K. K. R. (2019). *A systematic literature review of blockchain cyber security*. Digital Communications and Networks. doi:10.1016/j.dcan.2019.01.005

Thakur, V., Doja, M. N., Dwivedi, Y. K., Ahmad, T., & Khadanga, G. (2020). Land records on blockchain for implementation of land titling in India. *International Journal of Information Management*, *52*, 101940. Advance online publication. doi:10.1016/j.ijinfomgt.2019.04.013

Thurner, T. (2018). Supply chain finance and blockchain technology–the case of reverse securitisation. *Foresight*, *20*(4), 447–448. doi:10.1108/FS-08-2018-099

Umalkar, M., Macneil, A., & Light, D. (2016). *What every CEO should know about blockchain.* Academic Press.

Universal Payments. (2017). *Unlocking the real benefits of blockchain through its "Sweet Spot"*. https://www.aciworldwide.com/-/media/file s/collateral/trends/unlocking-benefits-of-blockchain-tl-us.pdf

Upadhyay, N. (2020). Demystifying blockchain: a critical analysis of challenges, applications and opportunities. *Int. J. Inf. Manage.* Available at: 10.1016/j.ijinfomgt.2020.102120

Wall, L. D. (2018). Some financial regulatory implications of artificial intelligence. *Journal of Economics*.

Wang, L., Shen, X., Li, J., Shao, J., & Yang, Y. (2019b). Cryptographic primitives in blockchains. *Journal of Network and Computer Applications*, *127*, 43–58. doi:10.1016/j.jnca.2018.11.003

Wang, R., Lin, Z., & Luo, H. (2019d). Blockchain, bank credit and SME financing. *Quality & Quantity*, *53*(3), 1127–1140. doi:10.100711135-018-0806-6

Wang, S., Ouyang, L., Yuan, Y., Ni, X., Han, X., & Wang, F. Y. (2019a). Blockchain-enabled smart contracts: Architecture, applications, and future trends. *IEEE Transactions on Systems, Man, and Cybernetics. Systems*, *49*(11), 2266–2277. doi:10.1109/TSMC.2019.2895123

Wang, Y., Han, J. H., & Beynon-Davies, P. (2019). Understanding blockchain technology for future supply chains: A systematic literature review and research agenda. *Supply Chain Management*, *24*(1), 62–84. doi:10.1108/SCM-03-2018-0148

Wanitcharakkhakul, L., & Rotchanakitumnuai, S. (2017). Blockchain technology acceptance in electronic medical record system. *ICEB 2017 Proceedings*. Available at: https://aisel.aisnet.org/iceb2017/7

Yoo, S. (2017). Blockchain based financial case analysis and its implications. *Asia Pacific Journal of Innovation and Entrepreneurship*, *11*(3), 312–321. doi:10.1108/APJIE-12-2017-036

Zamani, E. D., & Giaglis, G. M. (2018). With a little help from the miners: Distributed ledger technology and market disintermediation. *Industrial Management & Data Systems*, *118*(3), 637–652. doi:10.1108/IMDS-05-2017-0231

Zhang, L., Xie, Y., Zheng, Y., Xue, W., Zheng, X., & Xu, X. (2020). The challenges and countermeasures of blockchain in finance and economics. *Systems Research and Behavioral Science*, *37*(4), 691–698. doi:10.1002res.2710

Zhang, P., White, J., Schmidt, D. C., Lenz, G., & Rosenbloom, S. T. (2018). FHIRChain: Applying blockchain to securely and scalably share clinical data. *Computational and Structural Biotechnology Journal*, *16*, 267–278. doi:10.1016/j.csbj.2018.07.004 PMID:30108685

Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2017). *An overview of blockchain technology: architecture, consensus, and future trends. In IEEE international congress on big data (BigData congress)*. IEEE.

Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352–375. doi:10.1504/IJWGS.2018.095647

Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352–375. doi:10.1504/IJWGS.2018.095647

Zhu, L., Wu, Y., Gai, K., & Choo, K. K. R. (2019). Controllable and trustworthy blockchain- based cloud data management. *Future Generation Computer Systems*, *91*, 527–535. doi:10.1016/j.future.2018.09.019

Chapter 3
Blockchain Technology and Future Banking:
Opportunities and Challenges

Derya Üçoğlu
https://orcid.org/0000-0001-5510-3574
Istanbul Bilgi University, Turkey

ABSTRACT

In recent years, the blockchain emerged as a trending technology, and the innovations introduced by blockchain technology have influenced financial services as well as other sectors. The banks are currently using several blockchain applications, but they are not mature and still not widely adopted. Despite the numerous benefits, blockchain has many challenges to be solved, such as lack of regulation and governance; energy and other costs of development and implementation; interoperability, technical, security, and privacy problems; and user-related challenges. Therefore, this chapter aims to overview blockchain technology and discuss the opportunities and challenges for the future banking sector concerning the extant literature.

INTRODUCTION

The concept of blockchain emerged in the 1980s, and in 1991, a contractual chain of information was used as an electronic record enabling documents to be digitally signed (Mishra & Kaushik, 2021). Since then, blockchain technology has captured the attention of academics, governments, and industries to provide decentralization and high security (Wan, Liu & Xiao, 2020).

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Although digitally wrapped, the traditional financial system has paper-based, centralized processes vulnerable to failures and attacks. The current inefficient system is also exclusionary as many people cannot access even basic financial tools (Tapscott & Tapscott, 2017). Traditionally, societies trust third-party intermediaries to accurately protect their assets or transfer funds. But, blockchain technology replaces the intermediaries by redirecting the trust to decentralized systems, which are less costly and more secure (Macrinici et al., 2018).

Therefore, based on a careful review of current literature, this chapter discusses the opportunities and challenges of blockchain technology in banking and how it will reshape future banking.

BLOCKCHAIN TECHNOLOGY

According to World Economic Forum, blockchain is the heartbeat of financing sectors. Financial institutions have been implementing blockchain technologies in different areas, such as domestic banking and payment services (Mishra & Kaushik, 2021). Blockchain is an emerging and promising technology central to the Fintech movement and has affected the functioning of financial institutions. Although many people associate this technology mainly with cryptocurrencies, it can produce solutions to challenges faced by the financial industry (Pal et al., 2021).

Blockchain technology, which is "a peer-to-peer system that operates in a decentralized manner", has four key features: secure, shared, ledger, and distributed (Mishra & Kaushik, 2021). So, this technology focuses on having a universally accessible and open decentralized ledger that contains the shared and agreed-upon state of the blockchain for establishing trust in an unsecured environment without relying on a third party. Blockchain can also be utilized with identity management and encryption, providing stakeholders privacy, transparency, and trust (Osmani et al., 2021). Blockchain can be perceived as a transparent and secure system as users can control their information and transactions, and any change to the public blockchain can be accessed by all users (Zhong et al., 2021).

Blockchain has three layers; protocol, extension, and application. The protocol layer has network and storage layers that provide network programming, encryption signatures, distributed algorithms, and data-storage technology. The extension layer is the heart of the blockchain, where product development of applications such as cryptocurrencies and smart contracts occurs. In addition to the intelligence technology that makes transactions possible, data forms such as pictures, documents, or videos are processed in this layer (Luo & Yan, 2021). The application layer has programs for communicating with end-users. This user interface masks the technical aspects and facilitates the real-world applicability of blockchains (Cointelegraph).

As blockchain combines different computer technologies regarding data storage, information transmission, and encryption, it is expected to transform existing models of economy and finance. Therefore, some companies in the financial sector have already established their blockchain laboratories and are formulating their plans, working closely with blockchain platforms (Guo & Liang, 2016). These financial institutions have invested millions in researching the best implementation (Marr, 2017).

At first, the blockchain was considered a threat to the banking industry and a strong competitor for banks due to disintermediating financial institutions (Martino, 2021). Because blockchain-based startups can provide some banking services at lower fees due to incurring fewer costs, they can take market share from the banks (Stulz, 2019). For instance, in the Dec. 31, 2020, dated annual 10-K filing with the SEC, the bank of America Corporation, one of the largest banks in the US, addressed certain risk factors that could affect the business, results of operations, and financial condition. Two of these factors were related to increased competition in the financial services industry and the inability to adapt products and services. The bank disclosed that some customers might choose to work with other businesses providing services in risky and speculative areas, such as cryptocurrencies. As these non-traditional financial service providers offer low or no commissions and fees, the bank may face the pressure of lowering its prices and fees, which might unfavorably affect earnings. Moreover, new technologies such as blockchain may force the bank to incur expenses for modifying or adapting the current services, and these attempts undertaken may not be completed successfully or timely.

However, fintech companies' success and competition with financial institutions also have certain limits. Financial institutions have a wide range of product offerings and sizeable established consumer bases, are experienced in complying with regulations, and are experienced in dealing with the regulatory bodies (Stulz, 2019).

BLOCKCHAIN TECHNOLOGY AND FINANCIAL SERVICES

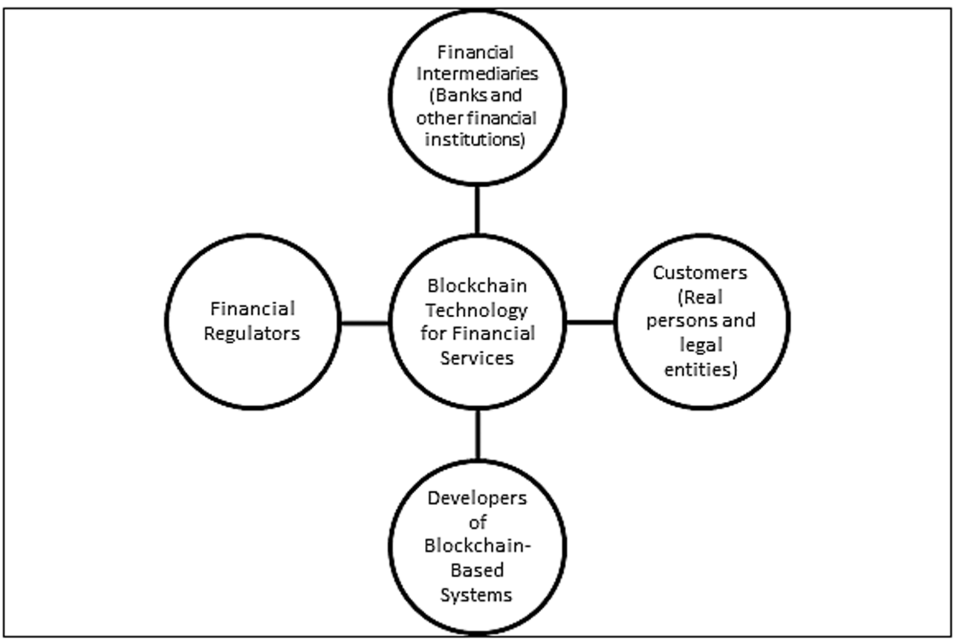
Blockchain is a network software protocol that provides a tamper-resistant database where the transactions are validated, carried out, and recorded in chronological order. By blockchain, the transfer of assets, money, and information can be executed securely without the intermediation of any party. Digital money systems, such as Bitcoin and Ethereum, are the most common applications of blockchain, where real-time money transfers and payments can be made in a few seconds at very low costs. In addition to digital currency systems, blockchain technology enables the development of applications concerning property registries, contractual agreements, and identity confirmation (Swan, 2017). Blockchain technology can also be used in customer identification regarding Know Your Customer (KYC) regulations, smart contracts for collateral transfer when a default occurs or issuing margin calls, and data collection and sharing concerning related rules and regulations (Broome, 2019).

Public blockchains, such as digital currency systems, can be used by anyone whose identity is unknown. On the other hand, private blockchains can be accessed by credentialled corporate intranet users (Swan, 2017). The allowed users have specific permissions for performing operations (Casino et al., 2019). Consortium (federated) blockchains are private networks where a group of entities controls authorization and access to the system. Industry consortia are primarily valuable for bringing efforts, ideas and funds together for testing the technology in real-time (Maslova, 2018).

Blockchain technology has a vast potential for banking as it offers simplified processes, increased transparency, and lower costs (Lang, 2017). In addition to lower costs, as transactions are processed significantly faster, blockchain technology is expected to revolutionize the banking industry (Mason, 2017).

The participants of a blockchain system established for financial services are the developers of the system, regulatory and authoritative bodies, financial intermediaries such as banks and other financial institutions, and the existing and potential customers of financial institutions.

Figure 1. Major participants of a blockchain system for the financial sector
Source: Diemers et al., 2015; Lee & Shin, 2018



Blockchain technology has a vital role in transforming conventional financial products and services (Ramchandra, 2021). With blockchain-enabled applications, digital payments, cryptocurrency payments and exchanges via e-wallets, loan management schemes, securities and derivatives transactions, and financial auditing can be performed more efficiently. Therefore, the financial system participants are exploring new ways to incorporate these applications into the banking system (Casino et al., 2019).

OPPORTUNITIES AND CHALLENGES OF BLOCKCHAIN TECHNOLOGY IN BANKING

Opportunities

Cost Reduction, Increased Efficiency, and Timesaving

Currently, financial institutions make international payments through the SWIFT system, which is quite costly and sometimes takes significant processing time (Zuberi, 2017). Blockchain allows the removal of intermediaries, resulting in higher efficiency and lower costs (Sanka et al., 2021) for financial institutions and their customers.

KYC is another crucial cost for financial institutions. When a potential customer applies to a financial institution, the customer needs to submit basic identity information. The financial institutions analyze the documents to avoid working with customers that pursue illegal activities such as terrorism funding or money laundering. In addition to the minimum KYC verification obliged by regulations, each financial institution may have additional KYC verification processes. When a single customer intends to work with four different banks, the total cost incurred by that single person can be burdensome for the financial system. The process also includes monitoring the transactions of existing customers and risk management of new customers (Demarco, 2019). The KYC process can be introduced to the blockchain's distributed ledger technology, where each bank customer may create a digital identity. The identity serving as a digital passport may store the necessary information such as account details, addresses, and credit ratings. The identities used by all financial institutions may result in reduced total costs for the financial system and may help reduce fraud (Demarco, 2019). Although each blockchain ledger uses a different protocol for verification, hybrid consensus may enable faster verification (V. Garcia, 2018). Besides, by blockchain, one organization can make an independent verification for a client that others can access so that the customer verification process would not start over again (Marr, 2017). In this way, blockchain technology can enable banks to decrease their compliance and regulatory costs while more transparency regarding financial transactions is achieved (Rust, 2019).

In addition to regulatory and compliance costs, the financial sector has many operating costs such as electricity, gas, and water consumed by employees and waste produced. Although the blockchain system incurs other expenses, it provides substantial savings compared to the traditional financial system (Cocco et al., 2017). Moreover, a higher computing speed of blockchain technology will decrease data handling time (Maiti et al., 2021). Besides settlement times being just minutes, the possibility of banking transactions being carried out 24/7 does not seem far (Ho, 2016). For instance, stock trades are settled in two business days (T+2), whereas blockchain can reduce settlement time significantly (Maslova, 2018). The efficiency related to speed depends on the blockchain category, such as private, public, and consortium. Consortium blockchains are more appropriate for the financial sector, and due to lower decentralization, the speed of such systems is high compared to more decentralized structures such as Bitcoin (Guo & Liang, 2016).

Similarly, back-office handling consumes too much time and is burdensome when a financial institution sells a syndicated loan. It may take about 20 days to settle the loan trade, and the financial institution has regulatory requirements regarding transparency and reporting. Blockchain can change the back-office handling of transactions by creating savings in the regulatory, settlement, and cross-border payment costs (Fanning & Centers, 2016).

The blockchain may also affect the payment processes. For example, when customers make payment with a credit card, the settlement is generally completed with a delay of several days. If the payment is made by a blockchain-based system, it can be completed in real-time by only adjusting the ledger (Nofer et al., 2017). In addition, the blockchain removes the burden of proof as all aspects of the transactions and processes can be traced (Demir et al., 2019). Also, real-time verification of accounts on the blockchain can decrease auditor costs (Kashyap & Saurav, 2021).

To sum up, blockchain technology can enable financial institutions to reduce their direct and indirect costs, such as institutional exit costs, operating costs (traditional processing and transactions costs, administrative costs for compliance), and infrastructure costs (Hassani, Huang & Silva, 2018).

Financial Inclusion

The World Bank's survey conducted in 2014 identified that approximately 18% of citizens are not able to access financial services because either they do not have digital identities or cannot provide any proof of identity (Alam et al., 2021). In the last decade, although 1.2 billion previously unbanked individuals were able to reach financial services via mobile money accounts by creating a 35% decrease in the unbanked population, still 1.7 billion individuals do not have access to financial services (Appaya, 2021).

Potential customers who do not have a credit score can create a digital identity and access financial services through blockchain technology. Without a centralized authority, the identity can be verified, and the customers can choose the parties they want to share their information. In this way, especially women in the third world can be empowered by having access to the banking system, and gender equality may be improved (V. Garcia, 2018). Moreover, financial inclusion may accelerate countries' economic development and growth (Appaya, 2021). Financial inclusion can be increased with blockchain as it provides an authentic and secure identity at low costs. Also, the ID cards used in most countries are paper-based, making them suitable for forgery and fraudulent activities. On the other hand, it is not easy to falsify information when the account of users are linked to their iris (Kshetri, 2020).

Transparency, Financial Trust, and Enhanced Security

Most banking systems have centralized databases and are exposed to economic crime (Marr, 2017). For instance, in recent years, three cyberattacks on the SWIFT network caused a total loss of $100 million to the banking industry (Hillsberg, 2018). Therefore, cybersecurity can be an essential issue for motivating the use of blockchain technology. Hackers generally target centralized databases as the records in decentralized databases are protected by cryptographic signatures (Swan, 2017). But blockchain technology helps eliminate centralized vulnerability points, such as cybercriminal attacks, and mainly prevents data manipulation (Osmani et al., 2021).

By the ledger system of blockchain, once a transaction is recorded, it cannot be changed or undone. Moreover, the system avoids duplication and communicates the information related to transactions to all participants in real-time (Zuberi, 2017). The immutability of blockchain makes it suitable for banks and financial institutions, as the transactions can be operated under the same blockchain from which each bank can push the related transactions. In addition to transparency, the system facilitates the audit of transactions (Casino et al., 2019). Moreover, blockchain assures that the same data has not been duplicated (V. Garcia, 2018). Enhanced security is due to this technology's digital signatures and tamper-resistant characteristics. Hackers cannot destroy or change any data stored in the blockchain because it is impossible to corrupt data and attack from one point (Demir et al., 2019).

As all transactions are recorded on a public ledger, the transparency increases with real-time information communication. Increased transparency may lower risks regarding fraud and increase financial trust throughout the capital markets (Zuberi, 2017). When the node address is known, it is possible to trace all transactions and activities performed by that node. This transparency and traceability of the blockchain can be helpful in auditing and fraud detection (Sanka et al., 2021) of financial services. Moreover, as many different nodes store the same blockchain data, even if a node loses its data, the network will still have access to the copy of the blockchain and can recopy it from other unaffected nodes. In this way, data losses are entirely prevented (Sanka et al., 2021). So, blockchain may provide enhanced security for the future digital banking model as historical information cannot be changed, and data alterations can be monitored (A. Garcia, 2018; Harsono, 2018; Patel, 2018).

Long-Tail Personalized Financial Services and Other New Services

With blockchain technologies, it is possible to develop personalized financial services that might better respond to the needs and expectations of different customers. For instance, a borrower might wish to get a 23-year mortgage rather than the standard 30-year mortgage, considering the planned home downsizing when children are grown up. Furthermore, potential buyers and providers of personalized and specific financial services who do not know each other may meet in a secure blockchain-based environment via smart contracts (Swan, 2017). For instance, a smart contract can automate the interest payment of each investor based on given issuance and due dates for loans and bonds (Cohen et al., 2018) by the algorithms and rules that can trigger transactions automatically (Rajnak & Puschmann, 2019).

As customers may prefer using different services from different banks, providing a personalized experience without a high cost is crucial for achieving customer retention. Tailored products offered by blockchain technology may better satisfy customer needs (Lee & Shin, 2018).

Other Benefits

In developing countries, there is not much information about the creditworthiness of individuals. For example, in Sierra Leone, about 75% of the population does not have access to financial services, and there is only one credit bureau with information on 2,000 individuals. For such countries, blockchain-based systems may provide banks with more relevant information and easier access to assess customers' creditworthiness without relying on governmental agencies (Kshetri, 2020).

As the pre-funding of trades is required for the transactions under the blockchain system, systemic (credit and liquidity) risks are eliminated, and uncertainties are reduced (Demarco, 2019). Also, R. Wang et al. (2019) proposed a blockchain model that will enable low-risk SMEs with no or insufficient collateral access to borrowings from banks. Such an innovative blockchain-based credit system will have a risk pool created by banks and companies. The risk pool will allow the control of aggregate default costs, reduce information asymmetry, and solve credit rationing problems that will improve total social welfare.

Blockchain technology offers users improved data privacy with self-sovereign identities, considering the recent scandals concerning user data sharing on social media sites. Thus, the data ownership remains with the user, and the company providing the services cannot share data without the user's consent (V. Garcia, 2018). Moreover, the protocol layer of blockchain offers a data storage and access framework, which can end the need for a centralized repository (Luo & Yan, 2021).

Banks and other financial institutions handle vast amounts of data. The blockchain system can reduce errors that often occur in traditional systems. In addition, repetitive and monotonous transactions and processes can be automated, and banking professionals may focus on providing value-based services to maintain service excellence (Garg et al., 2021) and create a competitive advantage.

Challenges

Regulation and Governance

The banks have problems with continuously changing and uncertain regulatory environments they need to comply with and high overhead costs of customer identification (Mason, 2017). Although the rules and regulations vary from country to country, all financial institutions and financial markets are heavily regulated. On the other hand, due to not having a regulatory framework for blockchain technology, the regulators and the industry need to work closely to comply with KYC and anti-money laundering (Zuberi, 2017). The use of blockchain ledgers will require agreements and governance processes regarding the management, approvals for improvement and updates, and roles and responsibilities, such as reporting for anti-money laundering (Zuberi, 2017).

There is no established legal framework for blockchains and blockchain-based programs, such as smart contracts. The first problem is related to jurisdictional issues. In addition to blockchain ledgers not having specific locations, the parties involved in an agreement or a smart contract may be located in different jurisdictions and subject to various laws and regulations. Second, the smart contracts may not work correctly due to design defects or miscoding. In such a case, it is not obvious which party should be held responsible for the damages (Cermeno, 2016). So, in general, there is no clarity about how conflicts or disputes can be solved between parties (Petrov, 2020) and who will be liable for losses, damages, or compensation regarding blockchain applications of financial services (Castell, 2018). Moreover, there is no regulatory oversight regarding blockchain networks. The environment is volatile, especially since cryptocurrency markets are open to manipulation (Marr, 2018).

Scalability, Privacy, and Security Challenges

A significant challenge related to the blockchain is scalability. Scalability problem is about latency (time taken to include blocks into the blockchain) and throughput (number of transactions that can be included in a block at any one time) (Cohen et al., 2018). The scalability problem arises from the inability of blockchain systems to process and store a growing amount of data and contain the enlargement (Swathi P. & Venkatesan, 2021). The scalability issue is affected by the block size and the time needed to generate a new block (Momoh et al., 2021), and this inherent issue needs consideration before blockchain is widely adopted (Peters & Panayi, 2016).

Although blockchains are considered more secure than traditional registries, the end-point security risks should also be assessed. The blockchain's systemic risk is much lower than centralized systems, but the security of users and their devices is a significant challenge. For instance, if a user loses control of the private keys, similar to losing a cell phone or a wallet, the user's assets might be lost. It is estimated that at least 6% of bitcoins that are in circulation have been stolen at least once, and this estimation does not give confidence (Narayanan & Clark, 2017) to potential blockchain users. For instance, the identity of a party may be traced from its transactions or by accessing another party with data decryption permission (Li et al., 2018). Hypothetically, it might also be possible to capture a blockchain ledger by controlling the majority of the participating computers (McLean & Deane-Johns, 2016). On the other hand, online banking customers are also subject to similar risks.

Blockchain technology also has some other deficiencies related to the privacy and security of financial data of banks due to the complexity and variety of customer data, the granularity of privacy-preserving of customer data not being suitable for current bank applications, and the need for data to be managed in blockchains hierarchically (H. Wang et al., 2020). Another critical issue is banks ensuring that only those with appropriate permissions will access sensitive data, whereas others will be restricted (Deshpande et al., 2017).

Organizational and User-Related Challenges

The management and users of the financial institutions may resist using blockchain technology for financial services for several reasons. First, as all the participating banks will share the blockchain network, it will negatively impact the competitiveness regarding improving their banking systems and platforms (Nguyen, 2016). Secondly, users may be worried about security threats, such as identity theft, being hacked, or money laundering (Ante et al., 2018). Moreover, successfully integrating blockchain technology into the existing systems and workflow of banks is another crucial challenge for the financial sector (Gan et al., 2021).

Firms develop different distributed ledgers, and there are no standard tools or administration interfaces (Li et al., 2018). So, individuals may find blockchain-based technologies hard to use due to their high degree of complexity (Kshetri, 2020) and unstandardized nature. Especially low-income individuals in developing countries might not have the necessary technological skills, cell phones, and internet connections to access financial services (Kshetri, 2020). Moreover, as the distributed ledger technology and encryption principles are pretty complex, it is not easy for people to understand the usefulness and benefits of the blockchain (Marr, 2018). Therefore, the technology needs to build trust in the public and marketplace to be adopted widely and can solve the KYC problem (Walker, 2018).

On the other hand, other users such as managers, auditors, accountants, bankers, and regulators may not be aware of the vulnerabilities of the blockchain systems because of having inadequate IT know-how, and they may be the targets of illegal activities (Iansiti & Lakhani, 2017).

Financial Services Employment and Changing Job Roles

Although blockchain technology is expected to create cost savings, it may also result in job cutting, and new roles may emerge in the finance sector. For instance, blockchain-based applications need little oversight for processing and reconciling transactions or verifying documents (Eaton-Cardone, 2017; Murray, 2016). Moreover, blockchain allows carrying out transactions without an intermediary. Thus, human traders and brokers may be eliminated (Moore, 2020). The roles of individuals in bank branches also move from routine transactions such as cash withdrawal to sales and high-end relationship management (Hetavkar, 2019).

On the other hand, financial institutions will need auditors in security fields like identity protection and encryption for fraud and threat detection. So, specific roles in the banking sector may vanish or evolve, whereas new ones may come into existence (Eaton-Cardone, 2017). Therefore, the banks are expected to focus on re-skilling their personnel considering the need to adapt to blockchain technology by designing new operations and architectures for future banks (Hetavkar, 2019).

Energy and Other Costs

Although blockchain technology is expected to decrease operational costs, the costs of maintaining an appropriate IT infrastructure for blockchain may reduce the savings (Zuberi, 2017) in addition to high development and implementation costs (Walker, 2018). Blockchain systems rely on complex algorithms that need vast amounts of computing power. This computing power consumes too much energy; therefore, the environmental implications of blockchain cannot be ignored (Marr, 2018). Especially public blockchains have high energy consumption that can be considered a waste of resources (Casino et al., 2019).

Other than energy consumption, another critical concern for blockchain in banking is the storage costs. The blockchain database requires the storage of vast amounts of data. The low-cost storage option provided by clouds does not fit, as the database needs to store data indefinitely, and the recurring payment model of cloud-based storage can create high long-term storage costs (Bloomberg, 2018). Lastly, in addition to the costs of adoption, implementation, and storage, the total costs of running the blockchain are uncertain (Deshpande et al., 2017). On the other hand, reduced transaction and processing costs attract fintech startups which may cause increased competition due to establishing a new bank with lower costs (Iskandar, 2017).

Other Challenges

In the blockchain, the interoperability among different networks is limited, and this technological weakness may create problems related to the transactions between banks (Osmani et al., 2021). As the number of blockchain-based applications increases, the wide diversity of features may prevent standardization and create interoperability problems (Casino et al., 2019). Moreover, the transition to a blockchain-based technology may require significant time and cost, as existing documents and contracts must be migrated to the new system (Crosby et al., 2016).

Although banks and financial institutions consider blockchain systems for KYC processes, there are some barriers to applying this technology. For instance, access to data from government databases and other sources and creating a common policy for the data set to achieve the standardization of the data model where there is no central party or authority are the fundamental problems that need to be solved (Walker, 2018).

Another challenge to be considered is taxation. The blockchain-enabled financial services created new assets and income types, leading to new tax bases. Therefore, a critical issue is related to the ways of taxing such income. The technology might affect the tax assessment, collection, and administration systems, and there may be inconsistencies between the tax treatments of different jurisdictions. Moreover, this emerging technology used in the financial sector may increase or decrease tax evasion and tax avoidance probabilities (Kimani et al., 2020).

The survey by Deloitte (2019) has also identified that replacing existing systems with blockchain and regulatory issues are the most common organizational barriers perceived by 1,386 respondents that participated in the research (Pawczuk et al., 2019). In the survey conducted in 2020, potential security threats and concerns about the sensitivity of competitive information were also regarded as essential barriers to greater adoption (Deloitte, 2020).

The relationships in the banking and finance sectors rely on trust. Therefore, operational and technical problems encountered during the blockchain implementation may have an unfavorable impact on the reputation of financial institutions (Osmani et al., 2020).

Table 1. Benefits, risks, and challenges of using blockchain technology for specific financial services

Financial Services	Benefits	Risks and Challenges
Exchange of assets and values (including crypto-currencies)	Increased interoperability, decreased entry barriers, removed burden of proof, analysis	Crypto-currencies being used as speculative assets rather than mediums of exchange
Money transfer and remittances	Low-cost money transfers and tracking	
Identity and record verification	By cryptography, secure and less vulnerable identification	
Record and document keeping and data sharing	Ensure secure recording by offering an immutable record of transactions, reduced error, preserving the authenticity and integrity of records or documents, secured data exchange	
Reconciliation of records and auditing	Providing clear financial trails for auditing and regulatory compliance, reduction in the number of required reconciliations, and working days spent on reconciliation	
Securities issuance	Issuance without a bank syndicate, an opportunity to trade less liquid private shares in a secondary market	
Asset registry and data storage	Reduced operational costs, complete control, and management by asset and data owners, high speed, security, and flexibility	Higher end-point security risks that may result in losing the assets
Blockchain embedded credit system for bank loan assessment	Provide solutions for information asymmetry and credit rationing problems of SMEs, creating risk pool, reducing counterparty credit risks, digitized mortgage lending	Paper-based and manual business processes and outdated ledger systems of companies, although digital data required
Financial risk mitigation	Provide valuable and practical insights into customers' borrowing behavior and decisions to default	
Derivative transactions	Enhanced information sharing that leads to better management of collaterals and cash movements in real-time, reduced operational and credit risks	

Source: (Demir et al., 2019; Deshpande et al., 2017; Garg et al., 2021; Kandil et al., 2019; Li et al., 2018; Luo & Yan, 2021; Maslova, 2018 Narayanan & Clark, 2017; Nofer et al., 2017; Nowinski & Kozma, 2017; Peters & Panayi, 2016; Ramchandra et al., 2021; R. Wang et al., 2019; Sanka et al., 2021)

Although blockchain technology has many advantages, there are difficulties of applying it in the financial sector due to achieving true disintermediation and true decentralization (Guo & Liang, 2016). It is also considered a threat to present models in commercial life (Lang, 2017).

The newness of the technology is another challenge related to data security, as well-developed security mechanisms have not been adopted and tested widely (Kshetri, 2017). On the other hand, the financial data are kept outside the secure firewall of banks. Although the system makes it difficult to manipulate the financial records, the irreversibility of transactions may cause problems when there are errors in data entry, such as adding an extra digit to a fund transfer (Hillsberg, 2018).

Blockchain technology is also a threat to the bank-centered financial system. As money can be transferred without centralized payment networks of banks, the intermediary role of banks may end, and non-banks may begin competing with traditional commercial banks (Harris & Wonglimpiyarat, 2019).

SOLUTIONS AND RECOMMENDATIONS

Although blockchain technology has certain limitations and challenges, due to the financial industry and blockchain being evolved rapidly, its applications in financial services are expected to increase (Pal et al., 2021). And as customers are a significant force, their preference for digital currencies will encourage the use of blockchain technology in the new face of banking. Any bank that does not consider the financial sector innovations will be left behind its competitors (Okere, 2020).

Overcoming the challenges of AI adoption is a prerequisite for the future of banking. Pilot projects may be tested in specific industry segments, and initiatives may start to establish a uniform rating system for KYC processes in blockchain ledgers (Petrov, 2020). In addition, when blockchain platforms are to be used for financial instruments like derivatives or bonds, regulatory bodies should recognize the validity of such tools (Cermeno, 2016). Also, in the following years, the scalability problems of blockchain technology will probably be solved, and the interface/user experience will be improved. In this way, blockchain applications will attract more individual and corporate users (Demarco, 2019).

Blockchain technology is not the end of banking, but it may be an existential threat to financial institutions that do not adopt the changes in technology (Tapscott & Tapscott, 2017). On the other hand, the cost-benefit analysis results may not be the same for different financial players, which might necessitate cooperation between financial institutions (Petrov, 2020).

Financial institutions have public accountability; therefore, they are heavily regulated. In addition, even if they are not open to the public, they need to implement

IFRS and are subject to independent audits and other regulations of related regulatory and authoritative bodies. Moreover, financial institutions need to comply with privacy laws regarding data safety when using blockchain-based technologies (Marr, 2017).

The literature suggests that, generally, governments are lagging in developing regulations for emerging technologies so that their fintech sector will not stay behind in terms of competing in the global financial markets (Lee & Shin, 2018). Besides, regulating blockchains is not easy due to decentralization and self-governance. However, international standards should be developed for this technology, and regulations should be published soon as the technology is accompanied by many problems to be resolved (Guo & Liang, 2016). Future government regulations may prevent some of the risks arising from blockchain adoption. But proposed regulations and heavy monitoring may also slow down the appetite for implementing blockchain in the financial industry (Ante, 2018).

As the interdependence between financial institutions is high in terms of data exchange regarding inter-institutional operations, blockchain technology may provide a shared communication and working platform for exchanging data, information, and digital values securely, efficiently, and transparently (Cuccuru, 2017). To achieve a global network of distributed computers, the blockchain system also requires investments by more than one party (Harris & Wonglimpiyarat, 2019). Another problem is the question of which bank will be the first to develop and implement a specific strategy regarding blockchain, as there is little reward if no other financial institutions are ready to use the blockchain technology (Lee, 2017). But still, the advantages and benefits of blockchain technology create incredible support for banking infrastructure and make it suitable for the financial sector to demonstrate pilot projects and revolutionize the processes of financial operations carried out by the actors (Cuccuru, 2017).

The study by Saheb & Mamaghani (2021) confirmed organizational and environmental factors such as lack of readiness, lack of understanding and familiarity with blockchain, cultural and political resistance, confusion and mistrust, environmental costs, and regulatory requirements preventing the banking industry from adopting the blockchain technology.

FUTURE RESEARCH DIRECTIONS

Blockchain is a promising technology for the banking sector, but it is still in the early infant stages. One main problem is the lack of regulations. Therefore, more studies should be conducted on the regulatory aspects to guide policymakers and regulatory bodies.

Most of the other problems are related to technical issues such as scalability, interoperability, privacy, security, and high energy costs. Future research should propose solutions to technical challenges encountered in the financial sector due to blockchain-based applications. The blockchain has a huge potential to revolutionize financial services and the financial system. But the broad implementation of blockchain technology can be achieved by overcoming the most significant challenges.

CONCLUSION

The financial industry has been discussing whether most of its services can be replaced by blockchain technology (Nofer et al., 2017). Although there are many challenges to implementing blockchain technology, it certainly will disrupt future banking (Zuberi, 2017). As more and continuous progress is made toward the risks and challenges of this emerging technology, it will be used more efficiently in the banking and finance sector. The more recognized the blockchain is, the better the potential benefits and strategic implications are realized (Gan et al., 2021).

With the adoption of blockchain, the transactions can be settled without an intermediary. Thus, new forms of banks and other financial institutions may emerge in addition to new forms of financial products and services (Deshpande et al., 2017).

The study by Yoo (2017) identified that blockchain technology is mainly applied in the financial sector for settlement, securities, remittance, and smart contracts. In this respect, the financial institutions should cooperate under a consortium, make thorough test-bed verification for improving the safety and efficiency of this technology, and estimate the cost of development and implementation. It is expected that focusing on private distributed ledgers in the future may result in the widespread use of blockchain by financial institutions due to enhanced stability, reliability, and efficiency.

Rather than treating it as a threat, the banks should improve their business models by implementing blockchain-based systems (Cucari et al., 2021), and considering many benefits, the banks should develop strategies to overcome the potential challenges of blockchain. Blockchain-based applications can disrupt and innovate the business models of financial institutions and provide many opportunities for the future of banking. But it may take a longer time than the claims of many people for blockchain to revolutionize the future of banking due to the technological complexity and regulatory and social issues (Iansiti & Lakhani, 2017).

REFERENCES

Alam, S., Shuaib, M., Khan, W. Z., Garg, S., Kaddoum, G., Hossain, M. S., & Zikria, Y. B. (2021). Blockchain-based initiatives: Current state and challenges. *Computer Networks*, *198*, 1–20. doi:10.1016/j.comnet.2021.108395

Ante, L., Sandner, P., & Fiedler, I. (2018). Blockchain-based ICOs: Pure hype or the dawn of a new era of startup financing? *Journal of Risk and Financial Management, 11*(4), 1-19. doi:10.3390/jrfm11040080

Appaya, S. (2021). *On fintech and financial inclusion*. Retrieved from https://blogs.worldbank.org/psd/fintech-and-financial-inclusion

Bank of America Corporation. (2020). *Annual Report (Form 10-K) for the fiscal year ended December 31, 2020*. Retrieved from https://investor.bankofamerica.com/regulatory-and-other-filings/annual-reports/content/0000070858-21-000023/0000070858-21-000023.pdf

Bloomberg, J. (2018). *Don't let blockchain cost savings hype fool you*. Retrieved from https://www.forbes.com/sites/jasonbloomberg/2018/02/24/dont-let-blockchain-cost-savings-hype-fool-you/?sh=239723435811

Broome, L. L. (2019). Banking on blockchain. *North Carolina Journal of Law & Technology*, *21*(1), 169–195.

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*, *36*, 55–81. doi:10.1016/j.tele.2018.11.006

Castell, S. (2018). Blockchain: Beware of the crypto-hype. *ITNOW*, *60*(4), 22–23. doi:10.1093/itnow/bwy093

Cermeno, J. S. (2016). *Blockchain in financial services: Regulatory landscape and future challenges for its commercial application* (BBVA Research Working Paper No. 16/20).

Cocco, L., Pinna, A. & Marchesi, M. (2017). Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology. *Future Internet*, *9*(3), 25, 1-20. doi:10.3390/fi9030025

Cohen, R., Sehra, A., & Smith, P. (2018). Banking on the blockchain. *International Financial Law Review*, *37*(1), 42–46.

Cointelegraph. (n.d.). *A beginner's guide to understanding the layers of blockchain technology*. Retrieved from https://cointelegraph.com/blockchain-for-beginners/a-beginners-guide-to-understanding-the-layers-of-blockchain-technology

Crosby, M., Nachiappan, P., Verma, S., & Kalyanaraman, V. (2016). BlockChain Technology: Beyond Bitcoin. *Applied Innovation Review*, *2*, 6–19.

Cucari, N., Lagasio, V., Lia, G., & Torriero, C. (2021). The impact of blockchain in banking processes: The Interbank Spunta case study. *Technology Analysis and Strategic Management*, 1–13. doi:10.1080/09537325.2021.1891217

Cuccuru, P. (2017). Beyond bitcoin: An early overview on smart contracts. *International Journal of Law and Information Technology*, *25*(3), 179–195. doi:10.1093/ijlit/eax003

Demarco, A. E. (2019). Analysing blockchain/distributed ledger technology in capital markets and know your customer process. *Journal of Securities Operations & Custody*, *12*(1), 58–71.

Demir, M., Turetken, O., & Ferworn, A. (2019). A financial evaluation framework for blockchain implementations. *IEEE 10th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*, 715-722. 10.1109/IEMCON.2019.8936297

Deshpande, A., Stewart, K., Lepetit, L., & Gunashekar, S. (2017). *Distributed ledger technologies / Blockchain: Challenges, opportunities and the prospects for standards.* The British Standards Institution (BSI) - Overview report. Retrieved from https://www.bsigroup.com/LocalFiles/zh-tw/InfoSec-newsletter/No201706/download/BSI_Blockchain_DLT_Web.pdf

Diemers, D., Lamaa, A., Salamat, J., & Steffens, T. (2015). *Developing a FinTech ecosystem in the GCC – Let's get ready for take off*. Retrieved from https://www.strategyand.pwc.com/m1/en/reports/developing-a-fintech-ecosystem-in-the-gcc.pdf

Eaton-Cardone, M. (2017). *How blockchain will affect financial services employment*. Retrieved from https://www.efinancialcareers.co.uk/news/2017/01/how-blockchain-will-affect-financial-services-employment

Fanning, K., & Centers, D. P. (2016). Blockchain and its coming impact on financial services. *Journal of Corporate Accounting & Finance*, *27*(5), 53–57. doi:10.1002/jcaf.22179

Gan, Q., Lau, R. Y. K., & Hong, J. (2021). A critical review of blockchain applications to banking and finance: A qualitative thematic analysis approach. *Technology Analysis and Strategic Management*, 1–17. doi:10.1080/09537325.2021.1979509

Garcia, A. (2018). *IBM's blockchain app store wants to help banks cut costs*. Retrieved from https://money.cnn.com/2018/07/30/technology/ibm-blockchain-app-store/index.html

Garcia, V. (2018). *4 key ways blockchain can facilitate people with no formal identify to access banking*. Retrieved from https://irishtechnews.ie/4-key-ways-blockchain-can-facilitate-people-with-no-formal-identify-to-access-banking/

Garg, P., Gupta, B., Chauhan, A. K., Sivarajah, U., Gupta, S., & Modgil, S. (2021). Measuring the perceived benefits of implementing blockchain technology in the banking sector. *Technological Forecasting and Social Change*, *163*, 1–18. doi:10.1016/j.techfore.2020.120407

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation*, *2*(1), 1–12. doi:10.118640854-016-0034-9

Harris, W. L., & Wonglimpiyarat, J. (2019). Blockchain platform and future bank competition. *Foresight*, *21*(6), 625–639. doi:10.1108/FS-12-2018-0113

Harsono, H. (2018). *Bank-based blockchain projects are going to transform the financial services industry*. Retrieved from https://techcrunch.com/2018/01/28/bank-based-blockchain-projects-are-going-to-transform-the-financial-services-industry/

Hassani, H., Huang, X., & Silva, E. (2018). Banking with blockchain-ed big data. *Journal of Management Analytics*, *5*(4), 256–275. doi:10.1080/23270012.2018.1528900

Hetavkar, N. (2019). *Bank digitisation creates new jobs: Robot programmer to blockchain expert*. Retrieved from https://www.business-standard.com/article/finance/bank-digitisation-creates-new-jobs-robot-programmer-to-blockchain-expert-119062900851_1.html

Hillsberg, A. (2018). *Can blockchain technology impact banking? We analyse this important trend*. Retrieved from https://www.comparethecloud.net/articles/can-blockchain-technology-impact-banking-we-analyse-this-important-trend/

Ho, F. (2016). *What blockchain actually means for the future of banking*. Retrieved from https://medium.com/decentralize-today/what-blockchain-actually-means-for-the-future-of-banking-4dd868d020cf

Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*, *95*(1), 118–127.

Iskandar, K. (2017). *What Blockchain Will Mean for Banks?* Retrieved from https://www.linkedin.com/pulse/what-blockchain-mean-banks-karim-iskandar/

Kandil, T. T., Nassar, S., & Taysir, M. (2019). Blockchain technology: A review of the contemporary disruptive business applications. In N. Shi (Ed.), *Architectures and Frameworks for Developing and Applying Blockchain Technology* (pp. 86–109). IGI Global. doi:10.4018/978-1-5225-9257-0.ch005

Kashyap, R., & Saurav, V. (2021). (in press). Blockchain technology: Road to transform the Indian banking sector. *Materials Today: Proceedings*, *1-4*. Advance online publication. doi:10.1016/j.matpr.2021.02.774

Kimani, D., Adams, K., Attah-Boakye, R., Ullah, S., Frecknall-Hughes, J., & Kim, J. (2020). Blockchain, business and the fourth industrial revolution: Whence, whither, wherefore and how? *Technological Forecasting and Social Change*, *161*, 1–16. doi:10.1016/j.techfore.2020.120254

Kshetri, N. (2017). Blockchain's roles in strengthening cybersecurity and protecting privacy. *Telecommunications Policy*, *41*(10), 1027–1038. doi:10.1016/j.telpol.2017.09.003

Kshetri, N. (2020). Blockchain-based financial technologies and cryptocurrencies for low-income people: Technical potential versus practical reality. *Computer*, *53*(1), 18–29. doi:10.1109/MC.2019.2951977

LangJ. (2017). *Three uses for blockchain in banking*. Retrieved from https://www.ibm.com/blogs/blockchain/2017/10/three-uses-for-blockchain-in-banking/

Lee, I., & Shin, Y. J. (2018). Fintech: Ecosystem, business models, investment decisions, and challenges. *Business Horizons*, *61*(1), 35–46. doi:10.1016/j.bushor.2017.09.003

Lee, P. (2017). Banking jumps to post blockchain. *Euromoney*, *48*(584), 82–84.

Li, L., Sy, M., & McMurray, A. (2018). Blockchain innovation and its impact on business banking operations. In M. Mittal, V. E. Balas, J. Hemanth, & R. Kumar (Eds.), *Data Intensive Computing Applications for Big Data* (pp. 583–598). IOS Press Ebooks. doi:10.3233/978-1-61499-814-3-583

Luo, H. R. & Yan, D. (2021). Blockchain architecture and its applications in a bank risk mitigation framework. *Economic Research-Ekonomska Istraživanja*, 1-19. do i:10.1080/1331677X.2021.1986672

Macrinici, D., Cartofeanu, C., & Gao, S. (2018). Smart contract applications within blockchain technology: A systematic mapping study. *Telematics and Informatics*, *35*(8), 2337–2354. doi:10.1016/j.tele.2018.10.004

Maiti, M., Vukovic, D., Mukherjee, A., Paikarao, P. D., & Yadav, J. K. (2021). Advanced data integration in banking, financial, and insurance software in the age of COVID-19. *Journal of Software: Practice and Experience*, 1-17. doi:10.1002/spe.3018

Marr, B. (2017). *Practical Examples Of How Blockchains Are Used In Banking And The Financial Services Sector.* Retrieved from https://www.forbes.com/sites/bernardmarr/2017/08/10/practical-examples-of-how-blockchains-are-used-in-banking-and-the-financial-services-sector/?sh=1c7c83a61a11

Marr, B. (2018). *The 5 big problems with blockchain everyone should be aware of.* Retrieved from https://www.forbes.com/sites/bernardmarr/2018/02/19/the-5-big-problems-with-blockchain-everyone-should-be-aware-of/?sh=2a18d4c21670

Martino, P. (2021). *Blockchain and banking: How technological innovations are shaping the banking industry*. Springer Nature Switzerland. doi:10.1007/978-3-030-70970-9

Maslova, N. (2018). Blockchain: Disruption and opportunity. *Strategic Finance*, *7*, 24–29.

Mason, J. (2017). *Why Blockchain will revolutionize the banking industry*. Retrieved from https://bravenewcoin.com/insights/why-blockchain-will-revolutionize-the-banking-industry

Mclean, S., & Deane-Johns, S. (2016). Demystifying blockchain and distributed ledger technology – Hype or hero? *Computer Law Review International*, *17*(4), 97–102. doi:10.9785/cri-2016-0402

Mishra, L. & Kaushik, V. (2021). Application of blockchain in dealing with sustainability issues and challenges of financial sector. *Journal of Sustainable Finance & Investment*, 1-16. doi:10.1080/20430795.2021.1940805

Momoh, M. O., Chinedu, P. U., Nwankwo, W., Aliu, D., & Shaba, M. S. (2021). Blockchain adoption: Applications and challenges. *International Journal of Software Engineering & Computer Systems*, *7*(2), 19–25. doi:10.15282/ijsecs.7.2.2021.3.0086

Moore, J. (2020). *11 Industries Blockchain Will Change Forever*. Retrieved from https://www.bairesdev.com/blog/industries-blockchain-will-change-forever/

Murray, S. (2016). *Blockchain can create financial sector jobs as well as kill them*. Retrieved from https://www.ft.com/content/3a9ef8d8-33d5-11e6-bda0-04585c31b153

Narayanan, A., & Clark, J. (2017). Bitcoin's academic pedigree. *Communications of the ACM*, *60*(12), 36–45. doi:10.1145/3132259

Nguyen, Q. K. (2016). Blockchain – A financial technology for future sustainable development. *3rd International Conference on Green Technology and Sustainable Development (GTSD)*, 51-54. 10.1109/GTSD.2016.22

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering*, *59*(3), 183–187. doi:10.100712599-017-0467-3

Nowinski, W., & Kozma, M. (2017). How can blockchain technology disrupt the existing business models? *Entrepreneurial Business and Economics Review*, *5*(3), 173–188. doi:10.15678/EBER.2017.050309

Okere, A. (2020). *Blockchain, Fintech and the Future of Banking*. Retrieved from https://www.afsic.net/wp-content/uploads/sites/78/2020/10/Fintechs-and-the-Future-of-Banking-28.09.2020-002.pdf

Osmani, M., El-Haddadeh, R., Hindi, N., Janssen, M., & Weerakkody, V. (2021). Blockchain for next generation services in banking and finance: Cost, benefit, risk and opportunity analysis. *Journal of Enterprise Information Management*, *34*(3), 884–899. doi:10.1108/JEIM-02-2020-0044

Pal, A., Tiwari, C. K., & Behl, A. (2021). Blockchain technology in financial services: A comprehensive review of the literature. *Journal of Global Operations and Strategic Sourcing*, *14*(1), 61–80. doi:10.1108/JGOSS-07-2020-0039

Patel, B. (2018). *How can blockchain help with AML KYC*. Retrieved from https://www.finextra.com/blogposting/15022/how-can-blockchain-help-with-aml-kyc

Pawczuk, L., Holdowsky, J., Massey, R., & Hansen, B. (2020). *Deloitte insights – Deloitte's 2020 global blockchain survey – From promise to reality*. Retrieved from https://www2.deloitte.com/mt/en/pages/technology/articles/2020-global-blockchain-survey.html

Pawczuk, L., Massey, R., & Holdowsky, J. (2019). *Deloitte insights – Deloitte's 2019 global blockchain survey – Blockchain gets down to business*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/se/Documents/risk/DI_2019-global-blockchain-survey.pdf

Peters, G. W., & Panayi, E. (2016). Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money. In P. Tasca, T. Aste, L. Pelizzon, & N. Perony (Eds.), *Banking beyond banks and money* (pp. 239–278). Springer International Publishing. doi:10.1007/978-3-319-42448-4_13

Petrov, D. (2020). A new digital age in finance: Blockchain and smart contracts. *Horizons Series A*, *26*, 7–20. doi:10.20544/HORIZONS.A.25.2.20.P01

Rajnak, V., & Puschmann, T. (2021). The impact of blockchain on business models in banking. *Information Systems and e-Business Management*, *19*(3), 809–861. doi:10.100710257-020-00468-2

Ramchandra, M. V., Kumar, K., Sarkar, A., Mukherjee, S. K., & Agarwal, K. (2021). Assessment of the impact of blockchain technology in the banking industry. *Materials Today: Proceedings*, 1–6. doi:10.1016/j.matpr.2021.11.554

Rust, R. (2019). Banking on Blockchains: A Transformative Technology Reshaping Latin American and Caribbean Economies. *The University of Miami Inter-American Law Review*, *50*(2), 184–211.

Saheb, T., & Mamaghani, F. H. (2021). Exploring the barriers and organizational values of blockchain adoption in the banking industry. *The Journal of High Technology Management Research*, *32*(2), 1–18. doi:10.1016/j.hitech.2021.100417

Sanka, A. I., Irfan, M., Huang, I., & Cheung, R. C. C. (2021). A survey of breakthrough in blockchain technology: Adoptions, applications, challenges and future research. *Computer Communications*, *169*, 179–201. doi:10.1016/j.comcom.2020.12.028

Stulz, R. M. (2019). FinTech, BigTech, and the future of banks. *Journal of Applied Corporate Finance*, *31*(4), 86–97. doi:10.1111/jacf.12378

Swan, M. (2017). Anticipating the Economic Benefits of Blockchain. *Technology Innovation Management Review*, *7*(10), 6–13. doi:10.22215/timreview/1109

Swathi, P., & Venkatesan, M. (2021). Scalability improvement and analysis of permissioned-blockchain. *ICT Express*, *7*(3), 283–289. doi:10.1016/j.icte.2021.08.015

Tapscott, A., & Tapscott, D. (2017). How blockchain is changing finance. *Harvard Business Review*, *1*, 2–5.

Walker, G. (2018). *Is KYC using blockchain the answer for banks?* Retrieved from https://www.refinitiv.com/perspectives/regulation-risk-compliance/kyc-using-blockchain-answer-banks/

Wan, N., Liu, Y., & Xiao, W. (2020). A Financial Transaction Methods Based on MapReduce Technology and Blockchain. *3rd International Conference on Smart BlockChain (SmartBlock)*, 109-113. 10.1109/SmartBlock52591.2020.00027

Wang, H., Ma, S., Dai, H., Imran, M., & Wang, T. (2020). Blockchain-based data privacy management with Nudge theory in open banking. *Future Generation Computer Systems*, *110*, 812–823. doi:10.1016/j.future.2019.09.010

Wang, R., Lin, Z., & Luo, H. (2019). Blockchain, bank credit and SME financing. *Quality & Quantity*, *53*(3), 1127–1140. doi:10.100711135-018-0806-6

Yoo, S. (2017). Blockchain based financial case analysis and its implications. *Asia Pacific Journal of Innovation and Entrepreneurship*, *11*(3), 312–321. doi:10.1108/APJIE-12-2017-036

Zhong, L., Wu, Q., Xie, J., Li, J., & Qin, B. (2019). A secure versatile light payment system based on blockchain. *Future Generation Computer Systems*, *93*, 327–337. doi:10.1016/j.future.2018.10.012

Zuberi, M. M. (2017). A Silver ('Chain') Lining: Can Blockchain Technology Succeed in Disrupting the Banking Industry? *Banking & Financial Services Policy Report*, *36*(3), 1–4.

ADDITIONAL READING

Dashottar, S., & Srivastava, V. (2021). Corporate banking—risk management, regulatory and reporting framework in India: A blockchain application-based approach. *Journal of Banking Regulation*, *22*(1), 39–51. doi:10.105741261-020-00127-z

Dozier, P. D., & Montgomery, T. A. (2020). Banking on Blockchain: An Evaluation of Innovation Decision Making. *IEEE Transactions on Engineering Management*, *67*(4), 1129–1141. doi:10.1109/TEM.2019.2948142

Ilievski, A. (2019). Blockchain technology in modern banking – Challenges and perspectives. *International Dialogue 'EAST-WEST', 6*(1), 45-48.

Lissa, L. B. (2019). Banking on blockchain. *North Carolina Journal of Law & Technology*, *21*(1), 169–195.

Patki, A., & Sople, V. (2020). Indian banking sector: Blockchain implementation, challenges and way forward. *Journal of Banking and Financial Technology*, *4*(1), 65–73. doi:10.100742786-020-00019-w

Stoica, E. A., & Sitea, D. M. (2021). Blockchain disrupting Fintech and the banking system. *Proceedings*, *74*(24), 1–10.

Vedapradha, R., & Ravi, H. (2021). Innovation in banking: Fusion of artificial intelligence and blockchain. *Asia Pacific Journal of Innovation and Entrepreneurship*, *15*(1), 51–61. doi:10.1108/APJIE-09-2020-0142

Xu, R., Zhai, Z., & Chen, Y. (2020). BIT: A Blockchain integrated time banking system for community exchange economy. *IEEE International Smart Cities Conference (ISC2),* 1-8. 10.1109/ISC251055.2020.9239045

Zhang, T., & Huang, Z. (2021). Blockchain and central bank digital currency. *ICT Express*, 1–8. doi:10.1016/j.icte.2021.09.014

Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352–375. doi:10.1504/IJWGS.2018.095647

KEY TERMS AND DEFINITIONS

Anti-Money Laundering (AML): Anti-money laundering includes laws, regulations, and procedures to monitor and prevent suspicious activities and transactions related to illegally obtained proceeds.

Financial Inclusion: Financial inclusion refers to financial and banking services being offered to all businesses and individuals, including disadvantaged and vulnerable groups.

FinTech (Financial Technology): This term refers to innovative technologies and software designed to provide automation to improve financial products and services.

IFRS (International Financial Reporting Standards): IFRS is a single set of high-quality accounting and financial reporting standards published by IASB (International Accounting Standards Board) to be used worldwide by public companies and companies with public accountability. The standards aim to provide a common framework and transparency in financial statements and financial information presented.

KYC (Know Your Customer): Due to anti-money laundering regulations, a financial institution needs to collect basic identifying information from real persons and legal entities before working with them as customers. The KYC verification process ensures that the financial institution will not act as an intermediary in money laundering or terrorism funding activities.

Long-Tail Personalized Service: It provides niche services to customers based on their needs rather than general and basic services. Such services are personalized and customized, aiming to improve customer loyalty and satisfaction.

Smart Contract: It is a program or protocol running on blockchain to automate the facilitation, verification, or enforcement of a contract when predetermined conditions are met.

SWIFT (Society for Worldwide Interbank Financial Telecommunication): SWIFT is a messaging network used by financial institutions for transferring international electronic payments via payment orders.

Syndicated Loan: It is a loan that is provided by multiple lenders on a single contract where one of the lenders is generally the lead lender or underwriter that administers the loan. Such credit facilities are extended when the loan amount is too high.

Chapter 4
Blockchain for SMEs:
Threats, Opportunities, and Future Research Trajectories

Nicola Del Sarto
Scuola Superiore Sant'Anna, Italy

Lorenzo Gai
University of Florence, Italy

ABSTRACT

Blockchain technology is spreading across many sectors as many firms are understanding its potential. In particular, such a technology may impact the way in which many SMEs compete, offering them new ways to achieve competitive advantage. However, many of them are struggling to embrace blockchain, thus requesting that the discussion on the issue be deepened. For this reason, in this chapter, the authors propose a review of the literature about blockchain and they show the main areas in which such technology is actually used. Moreover, they propose a discussion of the public policies adopted by Europe and they highlight possible future challenge for SMEs aiming at adopting the new technology.

INTRODUCTION

The financial crisis that occurred between 2008 and 2009 due to the chain of collapses of financials built on bad debts, has made evident the fragility and volatility of a system of connected and indebted financial institutions around the world (Hughes, Park, Kietzman & Brown, 2019). In an attempt to solve these problems, Nakamoto wrote an article (Nakamoto, 2008) in which he was the first to introduce the theme

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of blockchain, tracing the benefits of a decentralized exchange system of currency called "bitcoin". To date, cryptocurrencies are probably the most recognized case of adoption of the blockchain (Hughes, Park, Kietzman & Brown, 2019).

Considered one of the most popular emerging technologies, the blockchain (literally: "a blocks ") can be considered a distributed data infrastructure of the" peer to peer "type that allows a whole series of applications, such as the creation of cryptocurrencies, self-executing digital contracts (smart contract), smart property, etc. In the sector of financial services, the blockchain is used to manage transactions without the need to resort to recognized intermediaries (Wang, Han, Hugh & Beynon-Davies 2018).

In addition to its use in the financial sector, blockchain technology has found applications and is also under development in logistics and supply chain activities. It is a technology that promises to address current limitations in supply chain management food (Kim, Laskowski, 2018) where the traceability and authenticity of the product stand becoming an increasingly important requirement and key differentiators in many industries (Saberi, Kouhizadeh, Sarkis & Shen 2019).

BACKGROUND: THE BLOCKCHAIN TECHNOLOGY

The blockchain was essentially invented to solve problems related to electronic transactions. The creator developed two ideas that would have had a huge impact by offering the opportunity for more innovations. The first was related to the "bitcoin", a digital currency which works on a peer-to-peer network and is decentralized, cryptographically secure, immutable, without any kind of central support. The second was the introduction of blockchain. The blockchain is defined in different ways: the mainly diffused definition is that it consists of a digital ledger (i.e., a record of all transactions of payment) open, shared, decentralized, and distributed in which transactions and related data the parties involved in the transaction are recorded and added chronologically to create permanent and tamper-proof records (Nakamoto, 2008). It falls within the scope of Distributed Ledger Technology (DLT) which generally refers to technologies that permit the spread of information across multiple nodes, countries, or institutions. Blockchains are made up of "nodes" located on a network that uses some accepted communication protocols: each node on the network stores a copy of the transaction and a consensus function is implemented to verify transactions to preserve the immutability of the chain so that transactions can't be modified (Sarmah, 2018).

Blockchain doesn't need a centralized server to collect and maintain data. If the network maintains consensus on which transactions have occurred in the past, it acts collectively from servers to host the data (Patrickson, 2021). If a fraudulent participant decides to change the data, the majority of the nodes of the network are able to quickly excludes it (Hughes, Park, Kietzman & Brown, 2019). Blockchain is different from systems design existing information because is based on four key characteristics: a) non-localization; b) security; c) verifiability; d) smart execution (Saberi, Kouhizadeh, Sarkis & Shen, 2018). As said, a blockchain is a digital ledger that is stored on multiple computers on a public or private network. Whenever a transaction is verified, it is inserted in a “block”; each one of them is linked to the previous and the sequent to form an immutable chain in which each transaction is locked.

The advent of this new technology is seen a real revolution in the world of digital but at the same time represents a natural consequence of the evolution of the Internet (Firica, 2017).

Blockchains are developing in various sectors: medical record, the supply chain, banking, and financial services, insurance, long-term storage of digital archives, the Internet of things (IoT), the sharing economy, and access control distributed (Chang, Chen & Lu, 2019). Blockchain is based on several other technologies that encryption and the Internet which is used as an infrastructure (Treiblmaier, 2018).

Depending on to the type of access control, one can distinguish between two main types of blockchain: public and private. In a public blockchain, transactions do not need to be authorized, and users can remain anonymous. The most famous are Bitcoin and Ethereum. Instead, within a private blockchain, the participants must ask for an invitation or permission to join (Wang, Hugh Han & Beynon-Davies 2018).

One of the innovations generated by blockchains are smart contracts; they are self-managing contracts, i.e. contracts that, once defined, do not need a trusted person such as a notary to allow its implementation. Using this contract allow, for example, the payment of a due compensation or the initiation of a planned action upon the occurrence of certain circumstances. This kind of contracts have made possible the birth of the “smart marketplaces”, that make possible to obtain the disintermediation of transactions, due to the fact that blockchain has the characteristics of “trust-less” (Catalini, & Gans, 2020). Within this vein, the world of connected sensors introduces the opportunity to certify automatic events occurring without human interactions (Centobelli et al., 2021).

We can think at the verification of the punctuality of a train, which it records on the blockchain data related to the movement of them, making the verification of the data on effective arrival at the station public. A smart contract may provide for the automatic reimbursement for the traveler, upon the occurrence of a delay of the train.

AREAS OF APPLICATION

As often happens with new technologies, SMEs struggle to perceive the advantages deriving from such a type of innovation. For this reason, they are reluctant to invest in experimentation activities. However, some entrepreneurs have already realized that the scenario is changing changed and SMEs have begun to evaluate the use of this new technology following large companies that have already implemented their transformation. Accordingly, many of them are implementing a digital structure that sees blockchain technology as a real element of innovation. Is clear that within a global economy, in which companies have to manage a production demand in real-time, inefficiencies are no longer tolerated, and the use of blockchain technologies may help them in overcoming such problems. With the Blockchain firms can trust the technology without the use of an intermediary, developing an innovation ecosystem and reducing the bureaucracy. The Blockchain replaces central or intermediary authorities, with transparency and mathematics (cryptography) to create a new system of trust. All this can be of interest to entrepreneurs and professionals, so it is necessary to take advantage of it. Moreover, it should be added that the Blockchain, due to its innovative peculiarities, allows companies to be able to enjoy advantageous taxation or benefit from incentive measures. Due to its innovativeness, such new technology is spreading across various sectors, and firms are trying to take advantage of it in various ways.

Blockchain in Logistic

When we talk about logistics, we are talking about a complex process that involves the use of different operators and interaction with multiple players. In addition, the more this process is repeated over time and during the production of a material or product, the more this can negatively affect the quality, stability, and maintenance of the goods that are shipped and transported. For companies that find themselves using logistics services daily, any problem along the shipping chain is difficult to identify and resolve. It is therefore damage that negatively affects the finished product.

Blockchain in Human Resources Management

Reliable and transparent skills simplify the work of human resources. Hiring the right person at the right time is increasingly the need for our companies, especially in an era like this one in which the development of talents is ever faster and more continuous over the years. New technologies, such as Blockchain, come to our aid and make innovative scenarios feasible to support the verification of skills and employee mobility. Professionals, Companies, and Candidates need to have certified and reliable Certificates, Diplomas, and Curriculum vitae The Blockchain allow you to build the person's professional path in a guaranteed, non-manipulable, and accessible way in a shared way. The Digital Identity of the Professional is associated over time with information and digital content with the guarantee of whoever is creating each step of the path, the date, and the impossibility of counterfeiting such information. The entire path, but also the single documents/data/information on the Blockchain can be made available to interested and user figures for their activities (recruitment company, human resources DPT, etc.)

Blockchain in Banks and Financial Products

Financial services are in all likelihood the most advanced sector concerning the adoption of the blockchain, with initiatives pursued by many major players, united in a consortium (R3, Hyperledger, etc.). Numerous startups operate in the field of blockchain to develop products and services in the financial field, as well as a series of strategic partnerships have been undertaken by large banking groups, in addition to the launch of internal projects.

The great turmoil around the blockchain is justified if we consider how DLT technologies apply to a wide range of activities, ranging from investment risk management to the transfer of securities, as well as support for digital operations and payments, with the possibility of integrating new services to those present in the catalog. In the case of payments, for example, peer-to-peer technology can be used to transfer funds between different banks, enabling new options as regards the clearing and settlement methods for assets, securities, and derivatives. In this context, the blockchain allows for automated and much safer transactions, radically simplifying the management of tickets and the consequent risk of spreading counterfeit securities. The issue of security on the blockchain allows you to manage the entire life cycle of the security in a much more agile manner in the various operations envisaged: distribution of dividends, voting rights, etc.

Blockchain in the Insurance Market

Blockchain technology allows for a huge range of options, such as decentralized management of a policy, which can greatly reduce both the complexity and costs of activation and management, while though the elimination of the need for intermediation. Thanks to the blockchain, insurance companies can automate many operations: the system of appraisals and claims settlements, obtaining and guaranteeing the policyholder maximum transparency at every stage and the calculation of premiums.

Blockchain in the AgriFood Sector

The agri-food chain is probably the most complex of all, as the number of products and actors involved is very high, as well as the number of relation structured through the life cycle of the product, from its cultivation / breeding to consumption. Keeping track of billions of assets is a titanic undertaking, which the blockchain is starting to lighten and make much more efficient, specifically for what concern security and transparency for all stakeholders.

Blockchain in Industry 4.0

Within the generic Industry 4.0 context, blockchain is part of the applications of various enabling technologies, obviously starting from IT security. Its use is decidedly transversal and goes from the management of the supply chain, regulating contracts with suppliers and tracking the goods, simultaneously enabling new strategies for quality control. The blockchain is part of the dynamics of digital transformation and technology transfer that companies, especially those in the manufacturing sector, are facing, helping to innovate processes thanks to self-controlled and autonomous systems, able to optimize times, costs, and quality of factory operations.

Blockchain in Healthcare

The natural inclination to optimize services makes the blockchain a very interesting tool for healthcare. This is the case of direct payment for services, which can be automated and customized for each user registered in the system, also streamlining the necessary authentication procedures for dedicated platforms. Another very interesting area lies in the certification of ownership of medical records, with a unique identifier, managed as an immutable transaction. Thanks to the blockchain, doctors can directly certify the communications between the various IoT devices with which they are called to interact, making any diagnostic procedure transparent, which cannot be changed in its history. For example, this reduces the risk of manipulating medical records if they were recorded through a DLT. The tracking properties apply to the complex and burdensome supply chain of medicines and hospital supplies, where too often we see inappropriate speculations, which thanks to the blockchain would be easily monitored by the authorities in charge, without having to start long and tiring investigations.

Blockchain in Public Administration

The introduction of the blockchain in the procedures of the PA represents one of the most interesting application areas in terms of scope, as, once the pioneering applications can spread, they will produce a real revolution in the quality of services offered to citizens. The scenario is not easy to implement and there are barriers that we could define generational in terms of digital culture, not only on the part of institutions but above all on the part of end-users, the citizens. The blockchain could also in this case make services efficient and transparent. If to request an act, it is currently necessary to undergo mortifying relationship procedures with the offices, thanks to the blockchain it would be possible to authenticate access and request useful data, obtaining a response practically in real-time. In addition to reducing the number of human resources necessary for the provision of many services, the blockchain would also allow an enormous motivational factor for public employees, who would see the results of their work transparently tracked, also about the achievement of performance objectives. annually, which in their traditional conception are difficult to monitor and evaluate.

Blockchain in Telecommunication

Rather, it is surprising how the main Telco managers have not yet massively introduced blockchain technologies into their processes, since they appear to be tailored to their needs, especially as regards the security of communications, thanks to the protocols. that the blockchain is capable of enabling. Among the applications in the Telco field, for example, we find the possibility of certified IoT communications, secure and tracked, even in the presence of huge amounts of data. In the same way, decentralized storage is made possible, with peer-to-peer storage systems that make any attack on a centralized system in the cloud or even worse locally, useless.

The blockchain allows data to be “broken up” and distributed at various points of the network, allowing the legitimate owner, and only him, to be able to recompose and use them. Decentralization is also an intrinsic quality in the field of network security, not only for modernizing traditional infrastructures but also for more innovative solutions, such as SDN (Software Defined Network).

In the new business environment, the blockchain itself allows operators to offer new services as providers, such as blockchain-as-a-service cloud solutions, as well as a wide range of mobile services similar to what happens in the art market, we are witnessing a great spread of NFTs in the field of collectibles. The most famous case is probably made up of Cryptopunks, a collection of pixel art images that are continually resold among crypto collectors, who now come to pay them several million dollars.

Not bad, considering that it is a “limited” collection of ten thousand avatars. If Cryptopunks is a frontier product between art and the collectible, the NFTs have however enabled brands to sell digital versions of some of their products, creating completely new markets. This is the case of Gucci, which has released virtual sneakers in the form of NFT, at a price of only 12.99 euros, in sharp contrast with the value of its traditional products.

Blockchain in Art and Collecting

NFTs are deeply changing the art market. The chance of making a digital work unique is contributing to the value of goods that otherwise, due to their intrinsic reproducibility, would know they were completely lacking. This phenomenon has meant that lot of artists have begun to produce token of their digital works on special platforms (SuperRare, Raible, Foundation, etc.) that are regulating the market, recognizing the creator a royalty for each transaction of the product. An anthology of works made by Beeple, a famous digital artist, has been recently auctioned by Christie’s for an amount close to 70 million $, paid entirely in cryptocurrency. In a rather similar way to what happens in the art market, we are witnessing a great diffusion of NFTs in the field of collectibles. The most famous case is probably made up of Cryptopunks, a collection of pixel art images that are continually resold among crypto collectors, who now come to pay them several million dollars. Not bad, considering that it is a “limited” collection of ten thousand avatars. If Cryptopunks is a frontier product between art and the collectible, the NFTs have however enabled brands to sell digital versions of their products, creating new possibilities. This is the case of Gucci, which released virtual shoes in the form of NFT, at a price of only 12.99 euros, in sharp contrast with the value of its traditional products

OVERVIEW OF POLICIES RECOMMENDATIONS ON PUBLIC POLICIES

Blockchain platforms are evolving concerning their origins characterized by the management of cryptocurrencies. Currently, we look carefully at the use of this technology in numerous different application fields: financial services, manufacturing companies, supply chains, healthcare, insurance, real estate, TLC. This use takes place by integrating the Blockchain with already used Company systems that are part of the digital platform on which the activities and new technologies such as IoT and Business Analytics platforms are based. The growth of the architecture of the Business platform now sees the Blockchain as a value to be integrated internally to achieve the business objectives linked to digitization.

The Blockchain allows individuals, people, communities, and organizations to have agreements and to store and manage all information and processes without resorting to a central authority. It is recognized as an important tool for the creation of a shared trust, potentially the bearer of an infrastructure capable of promoting the growth of a digital economy. All of this has and will have significant implications involving many of the economic, social, and political institutions. The continuous succession of digital transformations can open up new scenarios for the exploitation of this technology, transforming it into a point of reference for rethinking efficient processes also for the Public Administration.

The Blockchain is a crucial component of the upcoming generation of the World Wide Web, often referred to as Web 3.0. It can facilitate and catalyze new, decentralized, and highly automated digital markets that create new businesses and are sources of innovation and economic growth. For this reason, the European Union has implemented several initiatives to explore and support the nascent Blockchain industry, including: "European Blockchain Observatory & Forum", "Blockchain4EU: Blockchain for Industrial Transformation", "Blockchains for Social Good", "Study on the Opportunity and feasibility of an EU Blockchain Infrastructure", "European Blockchain Services Infrastructure". Several reports have been drawn up that photograph the current situation in Europe, possibilities, and potential, emerging issues, and the evaluation of the best options available to foster innovation, allowing citizens and industries to reap the maximum benefits.

While European continent can count on a well-established legal and regulatory apparatus, such as to allow the development of a usable platform, there are some areas affected by this technology where there is no clear and shared legislation by all the component countries or exists in an embryonic way. This puts a brake on innovation, especially in terms of investments by companies.

The most obvious need is to clarify from a legal and regulatory point of view, first of all resolving the tensions between the GDPR and the Blockchain. The important topic of comparison concerns the implications related to reconciling the Blockchain with the General Data Protection Regulation (GDPR). This regulation was conceived before the new technology was well known and therefore is based on the implicit assumption that the Archive is a centralized mechanism for collecting, storing, and processing data.

Other priorities that have emerged can be listed as follows: the need to continue to focus on research and the growth of skills, to insist on addressing the adoption where possible of Blockchain technology in both the public and private sectors, promoting the greatest possible collaboration between Governments and Companies. However, the continuous study of the entire ecosystem remains essential, providing information, data, and analysis as well as in the objectives of the initiatives mentioned above.

The first answers can already be found in the EU Resolution of 3/10/2018 on DLT and Blockchain, in which, based on the study initiatives undertaken, numerous (14) areas of intervention have been defined where the introduction of Blockchain must be stressed, analyzed, and supported, both in terms of benefits and in terms of impact.

They follow a set of rules to grow Blockchain adoption in Europe. The demonstration of how the topic is of great interest in Europe is the institution of the Horizon award organized by EIC. It is worth mentioning other important initiatives aimed at providing recommendations for the adoption in Europe of technological standards on DLT / Blockchain (CEN-CENELEC Focus Group) and the various working groups in operation on the ISO / TC 307 standard aimed at establishing the standardization criteria relating to all implementation aspects of the technology.

Conclusion

We have analyzed what is meant by blockchain, what are the fields of application with their relative advantages, how blockchain integrates into the broader industrial processes and digital business platforms and how they reinforce it and ai solutions, and, finally, what is the current local and European regulatory scenario. Here we define the actions that SMEs need to take to benefit from these new solutions.

MODEL FOR ACCOMPANYING BLOCKCHAIN PROJECTS

To support the adoption of this new technology, it is important to make available supply chains and territories accompanying tools that facilitate the adoption of this technology by the various potentially interested parties (Ji et al., 2022). These new services based on blockchain may help SMEs to:

- improve knowledge about technologies and major projects underway;
- contributing to the development of skills and competencies (technical, legal, and process) and defining professional accreditations to facilitate better accreditation of solutions and regulatory compliance of applications;
- facilitate the creation of integrated initiatives and projects;
- support the agile development of solutions, thanks also to the use of properly "controlled" development environments and the sharing of semi-finished products and building blocks;
- support the definition of certification models for applications that use blockchain
- facilitate the onboarding of actors and the dimensional growth of projects.

A model such as the one described above should not necessarily be managed in a centralized way but could aim to "federate" different initiatives born in different territories and could aggregate around a set of common principles useful to ensure consistency and transversality of solutions (Huang et al., 2022). From this point of view, the accompaniment model could be managed by both public and private entities operating in the collective interest of a given supply chain or a specific product segment.

The pandemic has highlighted the importance of digital and how much the PA is lagging behind the rest of the country. It is highlighted as the public administrations should be called to implement projects with a high content of innovation aimed, not only at the rationalization of management costs and the development of services with a view to their modernization but also to the strengthening of a process of transformation of public services offered to citizens and businesses and that stimulates public demand, increases the competitiveness of the territories and points to the qualitative improvement of the services provided by the market.

SKILLS AND ORGANIZATIONAL MODEL FOR USING A BLOCKCHAIN

SMEs need to be aware of the new decentralized approach that the IT world has begun to use for application delivery and the creation of new ecosystems and business models (Kant, 2021). In case there is an IT sector within the company, it is necessary to provide the structure with the basic knowledge of this technology, the added values it can bring, the existing platforms, and the points of attention. It is, therefore, necessary to provide adequate classroom training and participation in Proof of Concept (POC) consistent with the company's target market. It is strongly recommended, moreover, to involve in the studies and POCs identified by the Company, also its customers and suppliers. A Blockchain use case is more effective and significant the more external and heterogeneous figures participate in it, and the resulting advantages are more tangible if exploited by the whole ecosystem. Particularly effective in a short time is obtained, for example, going to intervene in procedures involving multiple actors and where information and processes must be shared in a trusted and secure way. With the Blockchain, processes that would otherwise be more complex and composed of dozens of interactions are flattened and shared, with obvious inefficiencies in terms of time and costs.

When it is not possible to carve out dedicated roles within the company for these activities, it is necessary to turn to external IT professionals who can offer adequate consulting support on this complex issue (Rijanto, 2021).

The adjustment of procedures, involving the integration of Blockchain in the procedures and thus allowing for better services/goods, increased profits, and increased compliance, must not impact the normal operations of resources and must allow for speed of adoption of these new technologies.

It will then be up to the IT team - internal or external - to communicate directly to management what approach to use towards Blockchain, how this technology could affect the organization and the sector in which the company operates, in particular, reporting on potential problems and risks. The integration of the Blockchain in the Business Processes cannot be separated from an integrated work of the IT team with the operational Division owners of the processes (Operation, Production, Marketing, Sales, Provisioning, etc.) (Wan, Gao, & Hu, 2022).

To get the most out of blockchain technology, you need to know its main aspects and potential. Blockchain can help people to develop, store, transfer data and processes directly without a trusted authority. As described, it creates a widespread, peer-to-peer, self-regulated, and reliable economic and transaction infrastructure. It also creates the possibility for businesses to directly exchange value and data with each other and co-manage complete processes. This means that business models based on intermediation by large organizations are giving way to the opportunity to implement "instant" business models created to exploit temporary opportunities with new partners. The pervasiveness of technology is leading to a revolution in the way goods and services are priced and traded. The company must have a clear framework that highlights the concepts, opportunities, and risks of the new economic model that blockchain technologies will implement (Büyüközkan, Tüfekçi, & Uztürk, 2021).

The company must also be clear about the risks of underestimating the usefulness of the blockchain. Companies that initiate blockchain projects are taking risks. But companies that do not consider this technological revolution also risk being left behind. You can focus on three areas: business context specifics, risk management, and legal issues. Industry boundaries will become increasingly fluid as enterprise ecosystems develop and blockchain increasingly influences decision-making and automation. As the programmable economy takes shape, it is increasingly difficult to imagine what enterprises will look like five years from now, as blockchain business models are disruptive to even the most advanced platforms today.

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REFERENCES

Büyüközkan, G., Tüfekçi, G., & Uztürk, D. (2021). Evaluating Blockchain requirements for effective digital supply chain management. *International Journal of Production Economics*, *242*, 108309.

Catalini, C., & Gans, J. S. (2020). Some simple economics of the blockchain. *Communications of the ACM*, *63*(7), 80–90. doi:10.1145/3359552

Centobelli, P., Cerchione, R., Esposito, E., & Oropallo, E. (2021). Surfing blockchain wave, or drowning? Shaping the future of distributed ledgers and decentralized technologies. *Technological Forecasting and Social Change*, *165*, 120463. doi:10.1016/j.techfore.2020.120463

Chang, S. E., Chen, Y. C., & Lu, M. F. (2019). Supply chain re-engineering using blockchain technology: A case of smart contract based tracking process. *Technological Forecasting and Social Change*, *144*, 1–11. doi:10.1016/j.techfore.2019.03.015

Firica, O. (2017). Blockchain technology: Promises and realities of the year 2017. *Quality - Access to Success*, *18*, 51–58.

Huang, L., Zhen, L., Wang, J., & Zhang, X. (2022). Blockchain implementation for circular supply chain management: Evaluating critical success factors. *Industrial Marketing Management*, *102*, 451–464. doi:10.1016/j.indmarman.2022.02.009

Hughes, A., Park, A., Kietzman, J., & Brown, C. (2019). Beyond Bitcoin: What blockchain and distributed ledger technologies mean for firms. *Business Horizons*, *62*(3), 273–281. doi:10.1016/j.bushor.2019.01.002

Ji, G., Zhou, S., Lai, K. H., Tan, K. H., & Kumar, A. (2022). Timing of blockchain adoption in a supply chain with competing manufacturers. *International Journal of Production Economics*, *247*, 108430. doi:10.1016/j.ijpe.2022.108430

Kant, N. (2021). Blockchain: A strategic resource to attain and sustain competitive advantage. *International Journal of Innovation Science*.

Kim, H. M., & Laskowski, M. (2018). Toward an ontology-driven blockchain design for supply-chain provenance. *Intelligent Systems in Accounting, Finance & Management*, *25*(1), 18–27. doi:10.1002/isaf.1424

Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. Disponibile all'indirizzo https://bitcoin.org/bitcoin.pdf

Patrickson, B. (2021). What do blockchain technologies imply for digital creative industries? *Creativity and Innovation Management*, *30*(3), 585–595. doi:10.1111/caim.12456

Rijanto, A. (2021). Blockchain Technology Adoption in Supply Chain Finance. *Journal of Theoretical and Applied Electronic Commerce Research*, *16*(7), 3078–3098. doi:10.3390/jtaer16070168

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. doi:10.1080/00207543.2018.1533261

Sarmah, S. S. (2018). Understanding blockchain technology. *Computing in Science & Engineering*, *8*(2), 23–29.

Treiblmaier, H. (2018). The impact of the blockchain on the supply chain: A theory-based research framework and a call for action. *Supply Chain Management*, *23*(6), 545–559. doi:10.1108/SCM-01-2018-0029

Wan, Y., Gao, Y., & Hu, Y. (2022). Blockchain application and collaborative innovation in the manufacturing industry: Based on the perspective of social trust. *Technological Forecasting and Social Change*, *177*, 121540. doi:10.1016/j.techfore.2022.121540

Wang, Y., Hugh Han, F., & Beynon-Davies, P. (2019). Understanding blockchain technology for future supply chains: A systematic literature review and research agenda. *Supply Chain Management*, *24*(1), 62–84. doi:10.1108/SCM-03-2018-0148

KEY TERMS AND DEFINITIONS

DLT: Distributed ledger technology.
GDPR: General data protection regulation.
IoT: Internet of things.
NFT: Non-fungible token.
PA: Public administration.
POC: Proof of concept.
SDN: Software-defined network.

Chapter 5
Analysis of Key Barriers in Blockchain in Banking:
ISM Ranking Approach

Gargi Pant Shukla
Doon Business School, India

Nitin Balwani
Doon Business School, India

ABSTRACT

In this chapter, the authors holistically study different barriers in the path of implementation of blockchain technology in the growth of the banking sector. Over the last decade, blockchain technology has received a lot of attention. This disruptive force of digital technology is becoming an imperative factor around the world by changing the business models. This chapter includes three different research phases. In the first stage, barriers were identified from the literature followed by interviews with experts of the industry. Finally, the authors design an ISM impact matrix cross-reference multiplication model. For the mass application of blockchain technology, policymakers tend to remove the barriers that have been shown in this chapter. On the basis of their importance, the blockchain technology application tends to ease by eliminating the highlighted barriers. This study is one of the preliminary attempts at the implementation of blockchain by identifying barriers and ranking them according to their importance.

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INTRODUCTION

As the World is digitalizing rapidly it is high time we pay attention to the Security level involved in the data transfer and its impact on Business processes. Security of data had always been a concern and its importance are increasing as the processes go online. In the financial sector, Data frauds and Leakage has been a major concern for ages as the banks kept the processes away from public internet protocols., Blockchain is emerging as a "Saviour" in managing this transition.

Blockchain Technology has applications in control, materializing, and decentralizing the "Transaction" in the Financial Sector. Blockchain works on the concept of Breaking the "information" into small data nodes and encrypting the information for the next data node. This provides control on the data migration from one data node to another, essential for security as that is where the hacking happens. Each node is attached to an Encrypting code which helps the industry to build multiple layers of Firewall Structure. Even though the data is open, the information of the next data nodes is not leaked as the data is "Encrypted" and the Target and Source of data are not "Crackable."

The information from various sources is collected together in one group in blocks with storage capacities which hold the information in a database. This database is used in mining, creating a closed chain through cryptography. The immutability of decentralized blockchain makes the data irreversible, thus recorded permanently. The digital information, in form of hyper ledgers through distributed ledger technology, can record, alter, delete, and destroy the database.

Thus, blockchain can be used to store cryptocurrency transactional history, legal contracts, product specifications, inventories, etc. as they have the intrinsic value which is trustworthy and fast in transmission as it uses a public internet framework to transmit, with miniscule cost. This helps to sustain the all-important credibility of Blockchain.

Blockchain has played a crucial role in Crypto Market in controlling and making the transactions smoother, although it is still possible to hack as there have been a few instances of the same. The use case is still "Subjective" as many countries are in the dilemma of whether to Legalize the cryptocurrency usage or not.

This study determines the factors which focus on the application of blockchain in the Banking Industry, providing for the fast and smooth functioning of the banking industry. This research is one of the pioneering studies in the banking industry to study reciprocal relations among all the factors obstructing the application of Blockchain in the banking Industry. Ranking the barriers on their dependence and driving power and studying the interrelationship among all those barriers in the application of blockchain ISM is used by expert opinion method analysis.

To provide a deep and precise understanding of the subject matter, the paper is divided into seven sections. The introduction of the paper held in section 1 is followed by analyse of the research gap with the help of past literature in Section 2. In section 3 the detailed research methodology is discussed, forming a questionnaire. ISM is covered in section 4 and section 5 and the results and further discussion are covered in section 6 and section 7.

LITERATURE STUDY

We focused on literature related to cognizance and barriers impacting Blockchain and the ISM model, to establish the framework for the study.

Understanding Barriers to Application of Blockchain

The vigorous promotion of the development of Blockchain technology and its applications in various processes is done by several countries to reduce the spread of distorted information and to improve the trust between the enterprises that use the same (Wan & Li, 2021). He, 2021, focuses on the rapid use of Blockchain technology in Fintech research and how it has impacted the development of traditional financial formats. Blockchain technology is now being used by few Indian banks and they are deriving benefits from the same. However certain, challenges are faced by them in the implementation and adaptation of blockchain which act as barriers for widespread implementation (Patki. A & Sople. V, 2020). For the assessment of banking transactions blockchain assessment has been used sporadically and is successful (Shah, T & Jani, S., 2018). To address the issues of security, at the network, transaction, smart contract, and ledger levels, a common platform is needed to be created using the Blockchain technology (Karanam M. et. al., 2020) For the Indian service providers there are significant opportunities in the execution of blockchain technology in Indian industries. The growth of the blockchain ecosystem and implementation in India is driven by policy and regulations (Jani.S., 2019). Blockchain technology brings the revolution to the banking sector with applications in crowdfunding, KYC, digital verification of documentation, credit information, and various other services provided by the banks (Palihapitiya, T., 2020). Barriers in adoption of blockchain in the health care sector were identified (Sharma & Joshi,2021). The most marketable innovation in FINTECH is the Blockchain (Knewtson & Rausenbaum, 2020). In Blockchain cryptographic hash code is used to connect the blocks to eliminate every possibility of failure (Rabbani & Thalassinos, 2020).

Understanding ISM

Structuring, directly and indirectly, the mentioned elements into an inclusive methodical model, an interactive modeling technique (Interpretive Structural Modeling - ISM) is used. In 1974 John Warfield has first introduced ISM Analysis. In ISM Analysis the interrelation variables are studied with the logical and mathematical drivers and the relation between these variables will be established (Lohana, 2021). ISM is used as a process for model development and for identifying the relationship between various elements involved in textbook content transformation (Rahman, et al. 2013). To establish the association between the identified barriers for cloud computing ISM was used and Matrices d'Impacts Croises Multiplication Appliqué a un Classement (MICMAC) analysis was carried out to identify the most significant barrier (Raut et. Al, 2018). In the context of green economies, ISM was used to identify the drivers for adopting green business, ISM and MICMAC were used to build a set of knowledge for resource maximization in the green business (Sarkar, et.al, 2021).

For evaluating inter-relationship between identified Critical Success Factors, ISM was used which is carried out by MICMAC analysis to classify those factors based on their dependence and driving power (R. Attri et al., 2020). For the expansion and promotion of solar energy in the Indian rural sector, Fuzzy MICMAC was integrated with ISM methodology to identify the interrelationship among the identified barriers (Sindhu et. Al. 2016). To analyze the relationships among the elements for manufacturing wastes Interpretive structural modeling has been used and to find out the driving and dependence power of identified variables for manufacturing waste MICMAC is applied (Patidar et. al., 2017). ISM and MICMAC analysis has been used to identify the factors affecting the performance of reverse logistics in relation to customer satisfaction, (Tiwari. k R, 2013). ISM model was used in the cement industry to develop a direct relationship among different factors for energy conservation and management (Saxena et al. 1990). Interpretive Structural Modeling (ISM), was used to analyze the interrelationship among the factors and their influence on the development of the Portuguese Entrepreneurship Ecosystem (Banha et al. 2017). To establish interrelationship among the factors for the hospital inventory management ISM was used and on the basis of their driver and dependence powers categorization of the factors was done with the help of MICMAC (Kumar, D., 2015). Interrelated challenges in the Indian Context were ranked with the help of the ISM Approach and MICMAC Analysis was applied to categorize these challenges on the basis of Independence and interdependence power between these challenges (Hota, J. 2021).

With the rapid use of Fintech in the banking sector Blockchain has become a key factor for the banking industry. Little research have been conducted in the field of blockchain as the difficulty lies in finding literature by the researcher on which the barriers for the application of blockchain can be ranked by using ISM or any other model. This study will fill a vacuum in the literature by serving as a pioneer in the subject of blockchain in banking. In table 1, thirteen barriers that were found from the past published research and after discussions with experts are shown.

Table 1.

S. No	Barriers	Description	Author
1	Scalability	Scalability of processing power is a difficulty in terms of device computing capability.	P. Garg et al (2020); Saheb, T., & Mamaghani, F. H. (2021)., Palihapitiya, Thulya. (2020). Jayasuriya et. Al (2021)
2	Regulation and governance	There are few instructions and rules on how financial services can use blockchain to manage their internal network and external information exchange in terms of payments and transactions	P. Garg et al (2020); Jayasuriya et. Al (2021), Kumutha & Jeyalaksshmi. (2021)
3	Lack of awareness and understanding	Issue cost are very low when compared to traditional fund-raising methods	P. Garg et al (2020), Saberi et al., 2019, Kumutha & Jeyalaksshmi. (2021)
4	Cost and efficiency	The cost and efficiency of blockchain are crucial elements for mostly banking organizations. The transaction cost can be saved by the blockchain but it needs high initial capital investment.	P. Garg et al (2020), (Casino et al., 2019; Zheng et al., 2017, Kumutha & Jeyalaksshmi. (2021)
5	Infrastructure	For Infrastructure development the initial investment is very costly.	P. Garg et al (2020); (Reyna et al., 2018
6	The dependability of distributed networks	Blockchains dependability of distributed network may jeopardize blockchain applications' fault tolerance and performability.	Cinque & Esposito, 2018; T., & Mamaghani, F. H. (2021).
7	Security and Privacy	For the application of blockchain in enterprises Security and privacy in blockchain networks is the primary concern	T., & Mamaghani, F. H. (2021).
8	Technological unawareness	Managers are unaware of blockchain working and benefits it brings to their enterprise.	(Kersten et al., 2017)

continues on following page

Table 1. Continued

S. No	Barriers	Description	Author
9	Firm size	When considering organisations for blockchain applications, contextual factors such as firm size must be considered.	(Min, 2019), Kumutha & Jeyalaksshmi. (2021)
10	Energy and resource consumption	Heavy resources will be consumed by blockchain network. Banks have got to think about carbon footprints they are leaving behind by using Blockchain technology.	Palihapitiya, Thulya. (2020).; Jayasuriya et. Al (2021)
11	Transaction cost	The transaction cost will raise gradually in the later year after adapting the blockchain technology.	Palihapitiya, Thulya. (2020).
12	Currency stability	Given the significant volatility of the crypto currency market, the use of Blockchain payment will be heavily reliant on the stability of its underlying crypto currency.	Kawasmi et. Al. (2020)
13	Time and Complexity	Because of the circulated nature, Blockchain based exchanges may go through a few hours to finish until all gatherings update their relating records. This inactivity would make a lot of vulnerability for exchange members and open a gap for digital lawbreakers	Kumutha & Jeyalaksshmi. (2021)

RESEARCH METHODOLOGY

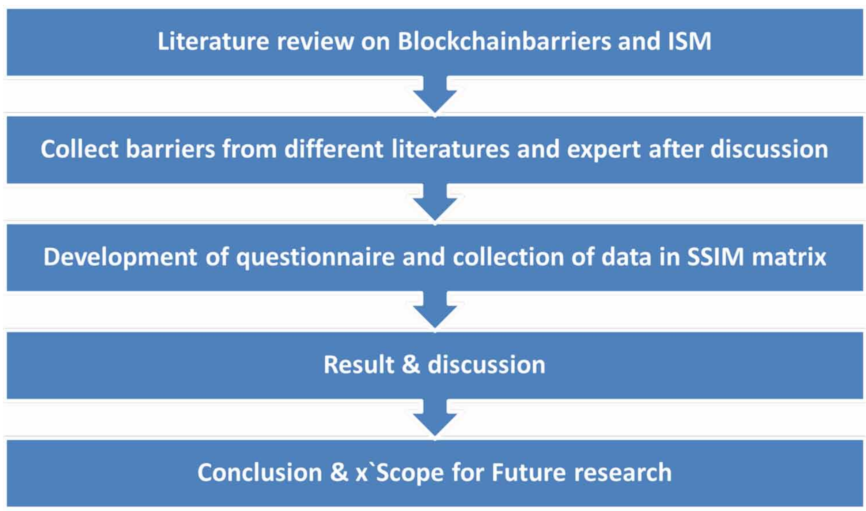
Details of research methodology implemented are elaborated in this section and Figure 1, explains the methodology followed in the study.

Post the Industrial revolution 4.0, with the introduction of Fintech and AI in banking industry, the application and adaption of blockchain is the need for the industry for the seamless functioning of the bank. 30% of the bank infrastructure cost can be reduced by the adaptation of blockchain. For application of blockchain public banks like SBI have collaborated with other commercial banks along with the other private banks like ICICI Bank, Yes Bank and Axis Bank who have also adapted the Blockchain technology for their banking business (Meity, 2021). The study's focus is on identifying and removing barriers to Blockchain technology application in the banking sector. ISM is used to rank the identified barrier and the below mentioned steps were involved in ISM methodology (Kannan et al., 2009):

- Step 1: All variables considered (Barriers) are listed
- Step 2: For pair wise examination, with the help of identified variables in step 1 a contextual connection is recognized

- Step 3: SSIM is developed to pair up the relationship among variables.
- Step 4: In ISM a fundamental hypothesis is made to check the transitivity among the variables. If variable P and Q are interrelated and the variable Q and R are interrelated, in that case variable P and variable R are related to each other.
- Step 5: The reach-ability matrix is spliced to different levels.
- Step 6: A directed graph is drawn on the basis of association found in the reach-ability matrix after removal of transitive links.
- Step 7: The resulting digraph is transformed into ISM
- Step 8: After development of resulting digraph some essential modifications can be made as required and review of ISM model and checking "conceptual inconsistency".

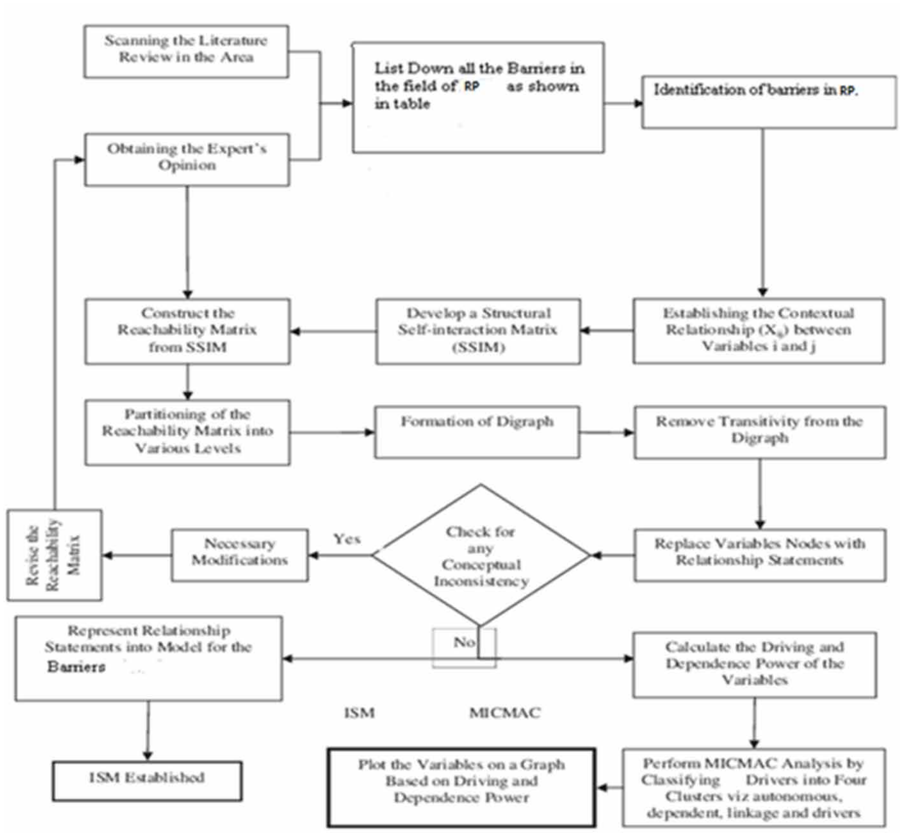
Figure 1. Research framework



Currency stability, Technological unawareness, Security and privacy, Regulation and governance, and Energy and resource consumption are included in the major barriers. From the past literature and opinion from the expert thirteen barriers are shown in the table 1 for study.

Modified from Diabat et.al. (2013)

Figure 2. Flow diagram for preparing the ISM model.



FORMATION OF QUESTIONNAIRE

Due to varied investment needs and government initiatives, an individual's investment attitude and behavior in India is considerably different from that of any other country. The major objective of the study is to highlight the importance of different factors for the adaption and application of blockchain by the implementation of ISM. From literature review and by discussion with experts, thirteen barriers are taken to analyze the barriers for the application of Blockchain in banking. Only 15 experts out of the twenty-seven experts participated in the research. These experts are the senior professors from different universities and senior managers from the banking industry. All the responses were combined and sent to the two experts for the final results analysis. Once the individual results from the individual experts were received, a response matrix was prepared based on expert responses and brainstorming among the authors. The specialists were chosen through personal contacts with researchers from various locations across India who had at least fifteen years of field experience.

APPLICATION OF ISM

Reachability matrix (Structural self-interaction matrix, SSIM) is developed with the succor of four chosen variables (V, A, X and O) to start the context-specific association between the identified variables in ISM analysis. With the help of these four symbols the pairwise relation is shown for the variable i and variable j. Symbol V stipulate that for factor j, factor i is responsible, Character A indicate that the responsibility of factor I lies on factor j. In case both factors i and j are in charge for each other it will be indicated by sigh X. If both factors j and i are not in charge for each other it will be specified by ideogram O.

Table 2. Structural self-interaction matrix (SSIM).

Factors affecting application of Blockchain		**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	Scalability	X	O	A	V	O	X	A	A	V	V	A	O	X
2	Regulation and governance	A	A	V	V	A	X	O	A	V	V	V	X	
3	Awareness and understanding	A	X	V	A	O	O	A	X	V	X	X		
4	Cost and efficiency	X	X	V	A	A	V	A	X	V	X			
5	Infrastructure	V	O	A	V	O	V	V	O	X				
6	The dependability of distributed networks	X	O	O	V	O	A	O	X					
7	Security and Privacy	X	A	A	A	A	V	X						
8	Technological unawareness	X	O	O	X	O	X							
9	Firm size	A	A	V	O	X								
10	Energy and resource consumption	V	V	A	X									
11	Transaction cost	X	A	X										
12	Currency stability	X	X											
13	Time and Complexity	X												

Once SSIM matrix is developed, the next step is to convert the matrix information into the binary numbers to develop reachability matrix.

The conversion is done by the rules as follows:

"(j, i) entry will becomes 0 and the (i, j) will becomes 1 in the reachability matrix if in the SSIM "V" is entered in the (i, j).

"(j, i) entry will becomes 1 and the (i, j) will becomes 0 in the reachability matrix if in the SSIM "A" is entered in the (i, j).

"Both (j, i) entry and (i, j) entry will becomes 1 in the reachability matrix if in the SSIM "X" is entered in the (i, j).

"Both (j, i) entry and (i, j) entry will becomes 0 in the reachability matrix if in the SSIM "O" is entered in the (i, j).

After required transitivity the reachability matrix is created and shown in table 3.

Table 3. Reachability matrix after transitivity

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	1	0	1	1	0	0	0	0	0	1	1	0	1
2	1	1	1	0	1	1	1	1	1	0	1	0	1
3	0	0	1	0	1	0	0	1	1	0	0	0	0
4	1	0	1	1	1	1	1	1	1	1	0	0	0
5	0	1	1	0	1	1	0	0	0	0	0	0	0
6	1	0	0	0	0	1	1	0	1	0	0	0	1
7	0	0	0	0	0	1	1	1	1	0	1	0	0
8	0	0	1	0	0	0	1	1	1	1	0	0	1
9	1	0	1	1	0	0	0	0	1	0	1	0	0
10	1	0	1	1	1	0	0	1	0	1	1	0	1
11	1	1	0	1	1	1	0	0	1	1	1	0	1
12	0	0	0	1	0	0	1	0	0	0	0	1	1
13	0	0	1	1	1	0	1	1	0	1	1	0	1

For each barrier the reachability and antecedent set is calculated from the final matrix (Warðeld, 1974). The reachability set for a factor includes the factor itself as well as any other factors that may aid in its achievement. The antecedent set for a factor is made up of the factor itself as well as other elements that aid in its attainment. To make the iterations, the intersection of the reachability set, and the antecedent set is determined for all the barriers. The barriers with same reachability and intersection were kept on the top-level barrier hierarchy of ISM. These are the factors that were ranked 1 in the making of iterations and other factors would not be impacted by these factors. These factors will be eliminated from the reaming factors after making the first iteration and leveling of all the 13 barriers is concluded in four iterations as shown in table 4. The Diagraph of final model of ISM is constructed by using all the identified levels of factors after all the barriers receive a level in ISM Hierarchy.

Table 4. Level split for barriers: iteration I to iteration IV.

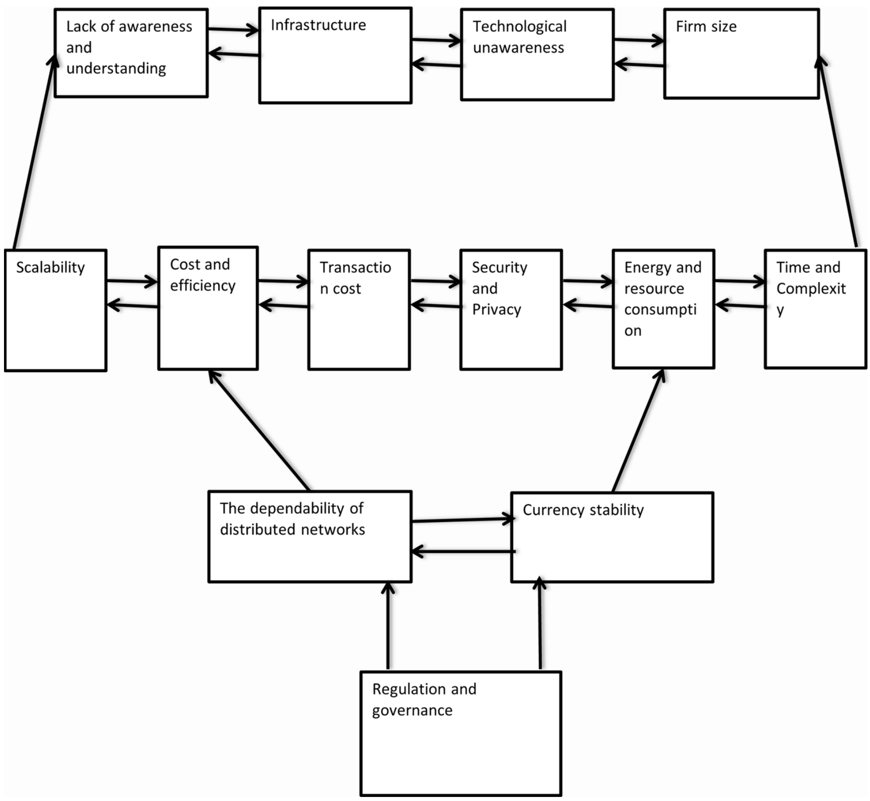
Key Factors	Reachability set®	Antecedent set ¯	Intersection set	Iteration
3	3,5,8,9	1,2,3,4,5,8,9,10,13	3,5,8,9	I
5	3,5,8,9	1,2,3,4,5,8,9,10,13	3,5,8,9	I
8	3,5,8,9	1,2,3,4,5,8,9,10,13	3,5,8,9	I
9	3,5,8,9	1,2,3,4,5,8,9,10,13	3,5,8,9	I
7	7,10,13	2,3,4,7,8,10,13	7,10,13	II
10	7,10,13	2,3,4,7,8,10,13	7,10,13	II
13	7,10,13	2,3,4,7,8,10,13	7,10,13	II
1	1,4,11	1,4,8,10,11,13	1,4,11	II
4	1,4,11	1,4,8,10,11,13	1,4,11	II
11	1,4,11	1,4,8,10,11,13	1,4,11	II
6	6	2,4,5,6,7,11	6	III
12	12	12	12	III
2	2	2,5,11	2	IV

The final reachability matrix is used for the creating of the structural model as shown in fig 3. The arrow heading towards j and i reveals the confederation allying the factors j and i. Finally, ISM model is presented through digraph converted through the resulting graph.

RESULT AND RECOMMENDATIONS

This analysis, by identifying and emphasizing on the most essential factors of blockchain technology, that prevents the application implementation in the banking sector, can help in faster and better implementation of blockchain. Below mentioned are the key findings of this research:

Figure 3. ISM based model for barriers.



In Fig 3 a complete model for ISM is developed. The ISM model reveals four distinct levels of factors with Lack of Awareness (B3), Infrastructure (B5), Technological Unawareness (B8) and Firm Size (B9) are on the top of the hierarchy level and Regulations and governance (B2) at the bottom level of hierarchy. Complexity (B13) has the highest driving power

LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

ISM framework has been developed through thirteen elements as barriers to the usage of blockchain in the Indian banking Industry. To denote the suitability of the research objective to focus on impediments, few barriers have been identified but not included in this study. Further suggestive measures are derived for the smooth functioning of Indian banking industry, leveraging the implementation of blockchain technology and to eliminate the identified barriers for the same.

REFERENCES

Attri. (2013). Interpretive Structural Modelling (ISM) approach: An Overview. *Research Journal of Management Science*, *2*(2), 3–8.

Attri, R., Ashishpal, N.A., Khan, No. Z., Siddiquee, A. N., & Khan, Z. A. (2020). ISM-MICMAC approach for evaluating the critical success factors of 5S implementation in manufacturing organisations. *International Journal of Business Excellence, 20*(4), 521–548.

Banha, F., Almeida, H., Rebelo, E. & Orgambídez-Ramos, A. (2017). The main barriers of Portuguese entrepreneurship ecosystem: Interpretive Structural Modeling (ISM) approach. *Tourism & Management Studies, 13*(2), 60-70.

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification, and open issues. *Telematics and Informatics*, *36*, 55–81. doi:10.1016/j.tele.2018.11.006

Dubey, V. (2019). FinTech Innovations in Digital Banking. *International Journal of Engineering and Technical Research*, *8*(10), 597.

Garg, P., Gupta, B., Chauhan, A. K., Sivarajah, U., Gupta, S., & Modgil, S. (2021). Measuring the perceived benefits of implementing blockchain technology in the banking sector. *Technological Forecasting and Social Change*, *163*, 120407. Advance online publication. doi:10.1016/j.techfore.2020.120407

He, Q. (2021). Application of Blockchain Technology in Commercial Banks. *2020 International Conference on New Energy Technology and Industrial Development (NETID 2020)*. 10.1051/e3sconf/202123503070

Hota, J. (2021). *Framework of Challenges Affecting Adoption of People Analytics in India Using ISM and MICMAC Analysis*. *Vision-The Journal of Business Perspective*. doi:10.1177/09722629211029007

Jani, S. (2019). *The Emergence of Blockchain Technology & its Adoption in India*. Academic Press.

Jayasuriya Daluwathumullagamage, D., & Sims, A. (2021). Fantastic Beasts: Blockchain Based Banking. *Journal of Risk and Financial Management*, *14*(4), 170. doi:10.3390/jrfm14040170

Karanam, M., Ramani, S. E., & Srinivasan, R. (2020). Leveraging the New Business Model: The Blockchain World of Banking. *Test Engineering and Management*, *82*, 11525–11531.

Kawasmi, Z., Gyasi, E. A., & Dadd, D. (2020). Blockchain Adoption Model for the Global Banking Industry. *Journal of International Technology and Information Management*, *28*(4), 5.

Kersten, W. (2017). *Blockchain in logistics and supply chain: Trick or treat?* Academic Press.

Kittu, V. M., & Aruna, P. (2018). Status Check on Blockchain Implementations in India. *International Conference on Technological Innovations in Management Ecosystem*.

Knewtson, H. S., & Rosenbaum, Z. A. (2020). Toward understanding FinTech and its industry. *Managerial Finance*, *46*(8), 1043–1060. doi:10.1108/MF-01-2020-0024

Krishnan, K. (2021). Dispelling Challenges and Applications of Blockchain Technology. Academic Press.

Kumar, D., & Kumar, D. (2015). Modeling Hospital Inventory Management using Interpretive Structural Modeling (ISM) approach. *International Journal of Logistics Systems and Management*, *21*(3), 319–334. doi:10.1504/IJLSM.2015.069730

Li, R., & Wan, Y. (2021). Analysis of the Negative Relationship between Blockchain Application and Corporate Performance. Mobile Information Systems. doi:10.1155/2021/9912241

Lohana, Y. (2021). ISM and MICMAC Model for Construction Delay. *International Research Journal of Engineering and Technology.*, *8*, 1382–1391.

Min, H. (2019). Blockchain technology for enhancing supply chain resilience. *Business Horizons*, *62*(1), 35–45. doi:10.1016/j.bushor.2018.08.012

Palihapitiya, T. (2020). *Blockchain in Banking Industry*. Academic Press.

Patidar, L., Soni, V. K., & Soni, P. K. (2017). Manufacturing wastes analysis in lean environment: An integrated ISM-fuzzy MICMAC approach. *Int J Syst Assur Eng Manag*, *8*(S2), 1783–1809. doi:10.100713198-017-0669-6

Patki, A., & Sople, V. (2020). Indian banking sector: Blockchain implementation, challenges, and way forward. *Journal of Banking and Financial Technology*, *2020*(4), 65–73. doi:10.100742786-020-00019-w

Rabbani, M. R., Khan, S., & Thalassinos, E. I. (2020). FinTech, blockchain and Islamic finance: An extensive literature review. *International Journal of Economics and Business Administration*, *8*(2), 65–86.

Rahman, A., Nazri, M., Alias, N., Siraj, S., & DeWitt, D. (2013). Textbook Content Transformation: Interpretive Structural Modelling (ISM) Approach. *Life Science Journal*, *10*, 1736–1745.

Raut, R., Priyadarshinee, P., Jha, M., Gardas, B. B., & Kamble, S. (2018). Modeling the implementation barriers of cloud computing adoption: An interpretive structural modeling. *Benchmarking*, *25*(8), 2760–2782. doi:10.1108/BIJ-12-2016-0189

Report on National Strategy on Blockchain. (2021). Ministry of Electronics and Information Technology, GOI.

Reyna, A., Martín, C., Chen, J., Soler, E., & Díaz, M. (2018). On blockchain and its integration with IoT. Challenges and opportunities. *Future Generation Computer Systems*, *88*, 173–190. doi:10.1016/j.future.2018.05.046

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. doi:10.1080/00207543.2018.1533261

Saheb, T., & Mamaghani, F. H. (2021). Exploring the barriers and organizational values of blockchain adoption in the banking industry. *The Journal of High Technology Management Research*, *32*(2), 100417. doi:10.1016/j.hitech.2021.100417

Sarkar, A., Qian, L., Peau, A. K., & Shahriar, S. (2021). Modeling drivers for successful adoption of green business: An interpretive structural modeling approach. *Environmental Science and Pollution Research International*, *28*(1), 1077–1096. doi:10.100711356-020-10490-z PMID:32829426

Saxena, J. P., Sushil, & Vrat, P. (1990). The impact of indirect relationships in classification of variables e a MICMAC analysis for energy conservation. *Systems Research*, *7*(4), 245–253. doi:10.1002res.3850070404

Shah, T., & Jani, S. (2018). *Applications of Blockchain Technology in Banking & Finance*. Academic Press.

Sharma, M., & Joshi, S. (2021). Barriers to blockchain adoption in health-care industry: An Indian perspective. *Journal of Global Operations and Strategic Sourcing*, *14*(1), 134–169. doi:10.1108/JGOSS-06-2020-0026

Sindhu, S., Nehra, V., & Luthra, S. (2016). Identification and analysis of barriers in implementation of solar energy in Indian rural sector using integrated ISM and fuzzy MICMAC approach. *Renewable and Sustainable Energy Reviews, 62*, 70–88. doi:10.1016/j.rser.2016.04.033

Tiwari, K. R. (2013). Identification of factors affecting reverse chain performance in relation to customer satisfaction using ISM Modelling & MICMAC Analysis. *Uncertain Supply Chain Management*, *1*, 237–252. doi:10.5267/j.uscm.2013.08.005

Zheng, Xie, Dai, Chen, & Wang. (2017). An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. *International Congress on Big Data (BigData Congress)*, 557-564. 10.1109/BigDataCongress.2017.85

Chapter 6
Significance of Blockchain in Banking and Insurance

Priti Sharma
IMT CDL, Ghaziabad, India

Ritesh Chandra
YES Bank, India

ABSTRACT

The chapter focuses on robustness of blockchain technology for recording a chain of transactions and maintenance of data. The initial sections of the chapter explain basic concepts like cryptography, double-entry ledger, cryptographic hashing, etc. that have been used in the development of blockchain technology. The authors explain the functioning of blockchain and its advantages in terms of time- stamped, immutable records. Blockchain represents a chain of transactions in the form of blocks that are connected through a hash unique to each block. Blockchain offers solutions to many real-world problems like recording the transactions and maintaining the records in a decentralized manner making the system efficient and yet ensuring transparency and safety. In subsequent sections, the authors discuss several use cases of blockchain in insurance and banking. The important applications include fraud detection and risk prevention, decentralized insurance and cheaper premiums, reinsurance, cross-border payments, trade finance, and compliance.

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INTRODUCTION

This chapter focuses on the application of Blockchain Technology in the Banking and Insurance industry. Banks as well as insurance companies have large data which is to be shared with their clients. An insurance company handles numerous data sets for policies issued to their clients, claim processing and settlement. Blockchain Technology enables the handling of this voluminous process in automated manner without much human intervention. All the records can be shared in the form of digital ledger and the permission can be given to network users in the open form or the restricted access with permission. This enables the users to add the information without permitting any editing in the records. It's a safe and secure way to share the records and increase the efficiency in processing and settlement of claims.

Similarly, Banks also handle huge data sets pertaining to mortgages and other loans. These records have to be maintained and payments have to be recovered. Smart contracts and digital ledger can make the process robust and smooth for the bank as well as clients. The Block Chain Technology may cause huge disruptions in Payment system. Cryptocurrency based on decentralized ledger enables the faster payment system though the benefits come with probable risks of fraud in the banking system.

In this study we begin with the understanding of basic concepts related to Blockchain Technology like cryptography, distributed ledger etc. The discussion further extends to describe the blockchain technology and its features like, how the technology offers transparency, data security, record keeping, immutability, cost effectiveness etc. The next section describes several applications of blockchain in insurance sector like claim settlement, micro insurance, reduced premium cost, fraud detection etc. The study covers the start-ups which are offering blockchain based solutions to insurance companies to solve the problems of record keeping, double dipping fraud investigation, faster claim processing etc. Next section covers the application of blockchain in banking services like cross-border payments, trade finance, compliance and financial inclusion. The discussion covers the real-life use cases of blockchain by banks and solutions offered by fintech companies.

BLOCKCHAIN CONCEPTS

Background

Property title frauds has been a significant problem in Honduras - a Central American country. Almost 70-80% of privately owned land was estimated to have an improper or no title at all. Title records were unreliable, and bureaucrats could simply assign properties to themselves by modifying the records. In 2015, Honduran government decided to have a national level digital database of land titles (Andrikos, 2021) that would be secure and reliable. Such a database could be used to prevent land thefts (mostly from poor people), illegal deforestation and mining and protect mortgages and contracts.

United Nations World Food Program (WFP) helps feed millions of people around the globe. Since 2009, the program shifted to transferring money to people who needed food instead of delivering food itself. While this approach was expected to expand the program's reach and help the local economy, it required coordination with local banks. Besides transaction fees, the key challenge was how to reach out to the people – often living in refugee camps and war-torn areas – without any government identity documents or bank account. In 2017, WFP launched a tech-based pilot project to make cash transfers cheaper, faster, and more secure (UN Women, 2021).

You must have heard about companies selling property on the moon. Many celebrities have bought into these schemes even though international treaties do not allow ownership of extra-terrestrial land and these schemes may be outright illegal. Now, how about the idea of non-existent or virtual land being sold for millions of dollars? Sounds unbelievable? Recently, New York based company spend $4.4million to purchase digital land through The Sandbox (News 18, 2021), a virtual world platform where people can socialize and perform all kinds of activities including purchase of goods and services and financial transactions. Platforms like the Sandbox claim to be a part of the Metaverse – an internet based digital world where online interaction would be as good as the real world using Virtual Reality (VR) technology. There are only limited plots of land in the two largest Metaverse platforms – Sandbox and Decentraland – and both companies have said that they will never create more land. Technologists believe the metaverse will grow into a fully functioning economy in a few short years and investors are buying concert venues, shopping malls and other properties in the Metaverse (Kamin, 2021) What would be the money in this digital world? What would be the technology to conduct financial transactions and purchase goods and services? How would you prove ownership of your digital home and other things that you own?

Over the last few years, Bitcoin and cryptocurrency have become mainstream names. Cryptocurrencies are digital currencies that can be used for decentralized peer-to-peer financial transactions without the need of a bank. In 2021, the overall market cap of cryptocurrencies grew by ~300% and hit the $3 trillion mark which is more than the GDP of India. Despite being highly volatile, cryptocurrencies have become a major asset class today. But what is the underlying technology behind cryptocurrencies?

All the above-mentioned applications are based on a single underlying technology – something called the Blockchain. What is a blockchain? How does it work? Before getting into the details, let us look at some basic concepts. Understanding these concepts will improve your understanding of the blockchain itself.

Ledgers

A ledger is a book of records. Ledgers are generally associated with financial accounting. However, financial accounting is only one of the areas where ledgers are used. Ledgers can be used to record all kinds of transactions. In addition, ledgers can be used to record ownership (property registers), identities of individuals and business entities (UIDAI or Aadhar database, registry of company records), rights and status (voter register, marriage register).

Human beings have been known to maintain ledgers since ancient times. Clay tablets discovered in Iraq, dating back to 5,000 BC were used to keep records of sales and purchase of goods.

Double-entry Book-Keeping and Origin of Banking

The most important contribution of ledgers to our economic development was through a technique called *double-entry bookkeeping*. In this form of bookkeeping, every entry into an account must be accompanied by a corresponding and opposing entry into a different account. The two types of entries are called 'debits' and 'credits. In double-entry bookkeeping, every debit entry in one account must be accompanied by a credit entry in some other account and vice-versa. The concept of double-entry bookkeeping was known to the Romans and some of the early Middle Eastern civilizations. Jewish bankers in Cairo, Egypt were supposed to be using this system of bookkeeping in the 11th century and merchants of Northern Italy brought the technique to Europe in the 14th century.

In 1494, Luca Pacioli – an Italian mathematician, a monk and a partner of Leonardo da Vinci – published a mathematical treatise named *Summa* (Devlin, 2019). *Summa* covered almost all the mathematics known at that time and due to the recent invention of printing press, it became one of the first mass-produced mathematics books and was widely circulated. The ninth chapter of this book dealt with business mathematics. It was in this section that Pacioli documented the accounting techniques in use amongst northern Italian merchants including double-entry bookkeeping and trial balances. This was the first known documentation of the double-entry bookkeeping process and Luca Pacioli is regarded as the "Father of Accounting" because of this work.

With single entry ledgers, a merchant recorded all the transactions in a single column and counted the money at the end of the day. Whether you bought something or sold something, whether you owed money to someone, or someone owed money to you – all transactions were recorded in a single column.

Double-entry bookkeeping was revolutionary as it allowed a merchant to check different aspects of his business. A trader could separately see what he bought and sold over a period. The difference between sales and purchases was the profit from trading. He could even segregate the profits from different activities and figure out which businesses were more profitable than others. Similarly, a merchant could separately represent what he owed to others (suppliers and lenders) and what was owed to him (customers and borrowers). The difference between the merchant's assets and liabilities was the capital invested in his business. This allowed merchants to focus on profitability and maximization of capital. It also led to the development of financial statements like balance sheets. Financial statements became the common language for businesses to demonstrate their value and creditworthiness. Scholars have considered double-entry bookkeeping as one of the enablers for a society based on the allocation of capital, the system known as capitalism.

While lending and borrowing have been in existence for thousands of years, roots of modern banking can be traced to medieval Italy. The most famous Italian banking family was the Medici family of Florence (Wikipedia, 2021). Giovanni de Medici founded the Medici family bank in 1397. Medicis were the pioneers of branch banking with branches in all major European cities. They also pioneered the use of Letters of Credit for settlement of trade transactions. They also popularized double-entry bookkeeping. Medici realized that it was critical to accurately track the capital flowing through their banks and eliminate any reconciliation errors. With the use of double-entry bookkeeping, they were able to provide an accurate representation of customer transactions as well as their own financial position. Thus, they created a reputation for reliability and safety of funds which helped them expand their banking empire.

Public Key Cryptography

The word cryptography (Merriam-Webster,n.d.) comes from two Greek words – "kryptos" meaning "hidden" and "graphein" meaning "to write". We can think of cryptography as the study of techniques for secure communication (Wikipedia, 2022). Cryptography is primarily used for encryption.

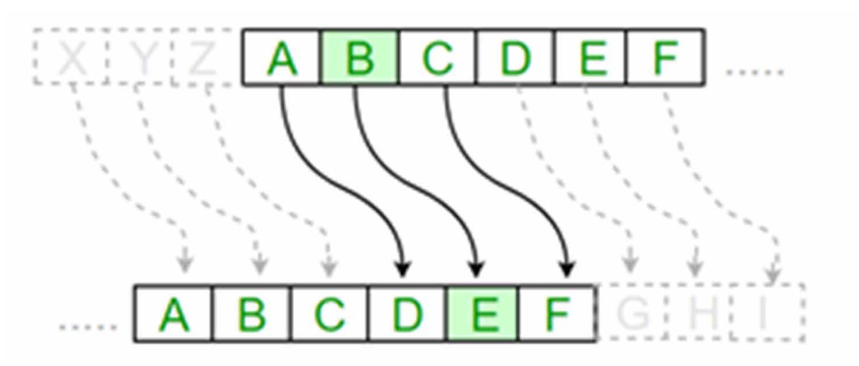
Encryption involves encoding a message in such a way that it is accessible to the intended recipient only. As part of secure communication, information is encoded using encryption techniques into something that appears unintelligible. The encrypted message is sent to the authorized recipient who converts it back to its original form. The reverse process – converting an encoded message back to its original form – is called decryption and it requires password or secret key. Encryption technique should be such that any unintended recipient should not be able to extract the original information from the encoded message.

Till 1980s, encryption techniques were primarily based on the sender and the intended recipient using the same key. The sender encodes the message using some mathematical rule. Upon receiving the encoded message, the recipient applies the same mathematical rule in reverse and extracts the original message. Because the sender and the receiver used the same mathematical rule (or key) to encode and decode a message, this encryption technique is also known as *symmetric encryption*

One of the earliest examples of such a technique was the *Caesar Shift Cipher* used by the Roman army. It was a substitution-based technique where each letter or alphabet was replaced by a letter some fixed number of positions away. Encryption and decryption were based on *shift,* an integer value indicating the number of positions each letter in the message had to be moved up or down.

Common symmetric encryption algorithms include DES, 3DES, AES and RC4. 3DES and AES are used in various types of Virtual Private Networks (VPNs)

Figure 1. Cryptography
Shift*: 4*
Cipher*: EXXEGOEXSRGI*



Encryption and decryption using symmetric keys is fast and straightforward and this technique was very popular till 1970s. One of the most used forms of symmetric encryption was the Enigma machine used by the Germans during the World War II. However, it suffered from several shortcomings.

Key distribution was a major issue with symmetric encryption – a secret key had to be created upfront and shared between the sender and receiver before any secure communication could be initiated. There was always a chance that the key could be stolen or copied while in transit. Theoretically, key exchange was still possible, if sender and receive belonged to a small, closed group. But this would be impractical for commercial data exchange especially over the internet, where the buyer and seller would have never met before. Another problem was the number of unique keys to be created and maintained. For 'n' communicating parties, a total of $\frac{n(n-1)}{2}$ keys would be required. If you communicate with 100 different parties, you will need $\frac{100*99}{2} = 4,950$ unique keys

Trust was another major issue with sharing symmetric keys – your counterparty could turn rogue and share the common key with other parties.

The solution came in the form of *asymmetric encryption also known as public key cryptography.*

Asymmetric encryption was proposed by two Stanford researchers – Whitfield Diffie and Martin Hellman – in their 1977 paper, "New Directions in Cryptography". Their system allowed an unlimited number of people to communicate in complete privacy.

In asymmetric encryption, each participant uses two keys – a public key which is known to everyone and a private key which cannot be seen by others. The two keys are related – in the sense that the public key is mathematically generated from a private key. The mathematical function is such that the reverse is not possible – someone cannot generate your private key even if they know your public key. The sender encrypts the message using the public key of the receiver and only the receiver can decrypt it using their private key. The message cannot be decrypted by a third party who doesn't have the private key of the receiver.

Asymmetric encryption solved the above-mentioned problems of key exchange and trust and formed the basis of secured electronic communication over the internet.

RSA algorithm was the first implementation of public key cryptography. The name "RSA" is based on the surnames of Ron Rivest, Adi Shamir and Leonard Adelman, who publicly described the algorithm in 1978.

Bitcoin uses ECDSA (Elliptic Curve Digital Signature) algorithm to generate a public key based on your private key. This public key becomes your Bitcoin address.

Cryptographic Hashing

While public key cryptography ensures confidentiality of communication, ensuring data integrity is also critical. Data integrity ensures reliability and accuracy of data and prevents any unauthorized modifications. This is especially important for financial transactions and proof of ownership.

While buying property, we always do a title search. Title search involves constructing the chain of ownership from the present owner back to the original owner of property. The chain of title ensures that the current ownership is legally "clean" and can be transferred to a new buyer. In the digital realm, a sequence of transactions is ordered by 'timestamping' the digital documents.

A commonly used method to authenticate data and ensure data integrity is to 'hash' the data that you have received and compare it with the hash of the original message. The hash process is also used to create a digital snapshot of data in time.

A hash is an algorithm that converts an arbitrary sized input into a fixed size string. If you give it the same input, it will always produce the same output. A hash is a one-way function – running algorithm on a data will generate the hash for it but by using hash, data cannot be generated. Even if there is a minor change in the data, the hash will change. The industry standard is SHA-256 (Secure Hash Algorithm).

In the Bitcoin network, the party doing the transactions uses their private key to sign the hash of the transaction (and not the transaction itself) – this results in a small, fixed size signature even if the underlying transaction data is large. This signature acts as the proof of ownership –network participants are sure that the person with the right private key has signed the transaction.

Distributed Ledger Technology

Historically, recordkeeping has been a centralized process where the recordkeeper is a trusted entity – government agency, bank, corporation. The centralized authority controls access and updating of the database

Distributed ledger technology (DLT), on the other hand, is a decentralized database wherein the control over the ledger does not rest with anyone entity – it is managed by several or all the network participants depending on the type of distributed ledger. In this sense, distributed ledger is different from other shared ledger technologies likes cloud computing. In a distributed ledger, no single entity can amend past ledger entries and no single entity can approve new additions to the ledger. There is a pre-defined consensus mechanism based on cryptography – and built into the design of the distributed ledger itself – to validate new data entries in the ledger.

At any given point of time, each network participant (or node) has a fully up-to-date copy of the entire ledger. Any new entry must be broadcasted to all nodes. Once the nodes collectively validate the change, the new entry is added to all the ledgers, and everyone again has an up-date copy of the database.

BLOCKCHAIN

What is a Blockchain?

A blockchain is a type of distributed ledger technology. The name 'blockchain' comes from the chronological linking of data blocks, like blocks of a chain. An individual block consists of a group of transactions appended to the blockchain as a single unit (called a 'block')

Timestamping is integral to a blockchain. Every block has a timestamp allowing an audit trail of the correct order of all the blocks in the blockchain.

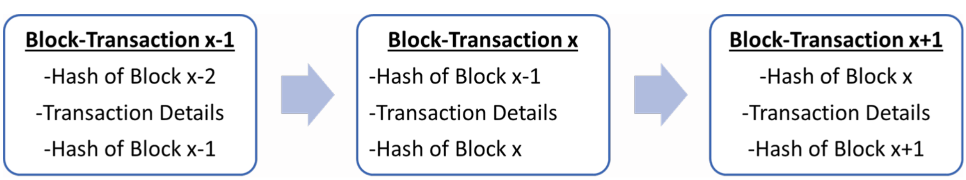
How Does a Blockchain Work?

Blockchain is a mechanism to store data in the secure and tamper-proof manner. As the name indicates, blockchain is a chain of blocks where, each block represents a specific transaction. These blocks are linked to each other through a mechanism and hence the name Blockchain emerged. Whenever a transaction is done in the chain, a new block is created, and a unique hash linked to that block is generated. This enables the instantaneous sharing of information with all the members of block chain. As soon as a transaction takes place, it is updated in the form of a block, visible to all members and connected to all other blocks through its hash. A hash is a unique code specific to a block. Each block contains the following components:

1. Details of Transaction
2. Hash of Previous Block
3. Hash of this Block

This implies these blocks are linked to each other through their hash codes. By looking at each block, one can see its linkage to preceding and successive blocks through hash code. This gives rise to a chain like structure of blocks. Figure 2 depicts the pictorial view of Blockchain where, each block carries the hash of previous block resulting into chain of blocks.

Figure 2. Blockchain - a pictorial view
Source: Author Created



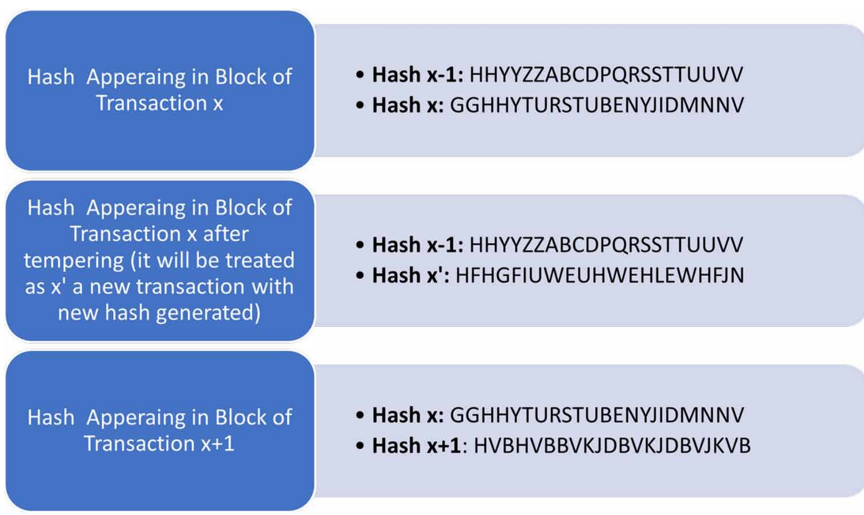
Unique Hash and Tamper-Proof Blockchain

Hash is a unique code generated for a block. Each hash code length is to be 256 bits and it must be unique for each block. Generally, SHA256 encryption is used to create a Hash which generates a hash of 256 bits. Even if it is simple word like "table" or "full book content encyclopedia" the outcome of hashing them would always be a fixed length of 256 bits.

Blockchain mining is a concept associated with Cryptocurrencies which is a use case of blockchain. It is to reward individuals to solve the "proof of work" consensus algorithm to validate a block before it can be added to the block chain. The "Miners" are the individuals/entities, who use Processors with very high speed known as Graphic Processing Units (GPUs) with high computation power to generate the hash. Each block is connected to its previous and successive block through this hash. As depicted in the figure 2, a block for transaction x contains the hash of transaction no. x-1 and hash of transaction no. x.

If someone tries to tamper the chain by changing the information in one block then a new hash x' is generated, this x' hash has no linkage with all the subsequent hashes and the hash mentioned in x+1 block for previous transaction will not be matched with previous hash and the tampering in chain will be immediately caught. It can be understood with the following figure:

Figure 3. Blockchain – change of information and change of hash
Source: Author Created



From figure 3, one can see that post-tampering, Hash of Block x changes to Hash x' which is completely dissimilar to Hash x. This Hash x' does not have any linkage to next block and thereby successive blocks. Block x+1 continue to show the previous hash as Hash x which is nowhere reflected in the previous block and tampering will be caught and make the chain invalid.

To tamper with information in any one block, the hash of all the successive blocks has to be changed, which is not an easy task, because generation of a hash is time consuming process and with high-speed processors to change all the hashes in chain, time may be as long as 6 months to several years depending upon the number of blocks in the chain. This mechanism makes the blockchain a secure system of recording transactions, storage of all relevant information, simultaneous sharing of information with all members of blockchain, enforcing transparency and yet making it tamper proof and thereby eliminating the need of any further validation by some centralized authority.

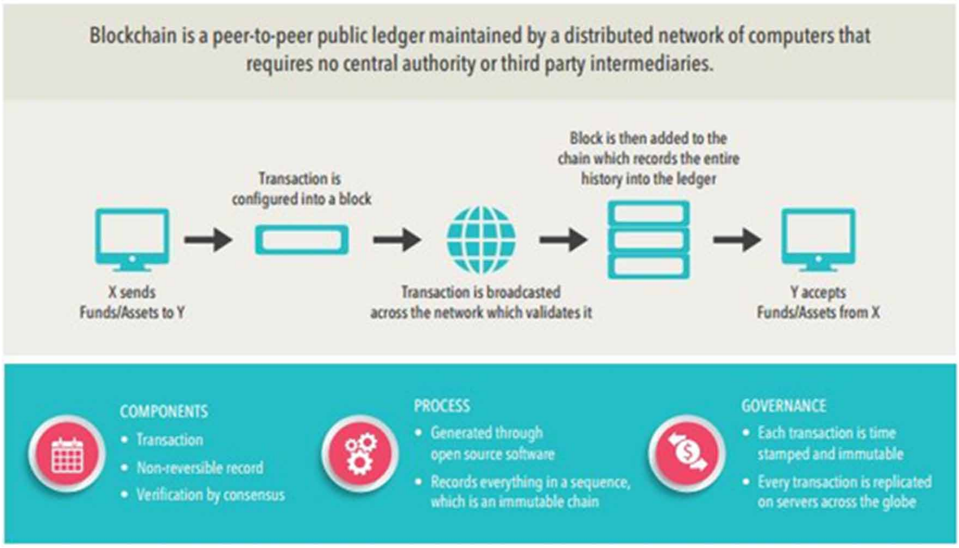
Distributed Ledger

In common accounting parlance, a ledger is record in which all the transactions are chronologically recorded. These records, wherever needed are substantiated by the transaction records in the form of vouchers, invoices etc.

Blockchain is one type of a distributed ledger. Independent computers, known as nodes, record transactions in their respective electronic ledgers resulting into decentralized ledger. Blockchain organizes data into blocks, which are chained together in an append only mode.

All the transactions are confirmed and validated through a consensus mechanism among the members. All validated transaction blocks are linked and chained from the beginning of the chain to the most current block. All members have exact copies of ledger. This lowers the risk of fraudulent transactions. Any tampering attempt would require changing the data across many places at the same time. Cryptographic hashes generated by algorithm such as the SHA256 will result into a completely different hash value even in case of very minute tampering with data. This will indicate potentially compromised transaction input. Also, the digital signatures using private key ensure that transactions are originated from legitimate senders. The working mechanism of a blockchain can be understood from the following figure:

Figure 4. Working mechanism of blockchain
Source: *https://www.wipro.com/insurance/adopting-a-new-approach-to-demystify-the-future-of-insurance-wit/*



Private vs. Public Blockchains

Permissioned and Permissionless Blockchains

Blockchains, which are open to everyone and does not require the permission from some centralized authority, are known as permissionless or public blockchain. Public blockchains have double protection in the form of linkages of blocks through hash and distributed ledger technology. The most widely used form of permissionless blockchain is for cryptocurrencies like Bitcoin or Ethereum. Each transaction leads to the generation of a new block.

Permissioned Blockchains, also known as Private Blockchains are the ones which are meant to be used only by a closed group of members and every new member is to be validated by some centralized authority. This may be the case when data on the block is sensitive and private in nature and data privacy is crucial in nature.

Oracles

Oracles are the third-party services which allows the smart contracts on blockchain to interact with outside public data. The Blockchain contains the smart contracts. Conditions on contract are to be matched with data off the chain. The blockchain cannot directly interact with off-chain data and oracles bridge this gap. Oracles can be thought of an intermediary through which on-chain data can be matched with off-chain data. The blockchain can take input from outside world through oracles and send the output. For example, taking information whether a storm happened in a particular area and matching this for insurance claim for a customer. Once data is matched, output is to be sent to a bank network for release of payment. This is to be done through input and output oracles. Other examples of data inputs from oracle are price data,weather data, voting data, etc.

Blockchain oracles are entities that connect blockchains to external systems, thereby enabling smart contracts to execute based upon inputs and outputs from the real world.

Example of Oracles - Projects like *Chainlink* provide decentralized oracle network services to many different blockchains. The input and output data feed to blockchain through oracles can be understood with the help of following figure:

Figure 5. Oracles as a link between blockchain and off chain data
Source: https://chain.link/education/blockchain-oracles

An Oracle feed is provided by an external entity. While the whole premise of blockchain is to ensure trust in the transaction data with the use of technology, here trusting an external data source can lead to issue. For example, data feed may be hacked by someone or manipulated by oracle feed provider in their favour.

Smart Contracts

Smart contracts are one of the most promising features of a blockchain. A smart contract is a piece of computer code residing in a blockchain. As and when, certain pre-determined conditions are met, the code will autonomously execute a contract (e.g., a value transfer). Smart contracts can be used to fully automate insurance payouts, financial instruments and legal processes – presently these processes are paper based and incur significant time and costs.

LITERATURE REVIEW

The blockchain has many potential finance applications—mainstream payment and settlement, securities issuance, clearing and settlement, derivatives and other financial instruments, trade repositories, credit bureaus, corporate governance, and many others. Blockchain applications in many of these domains are already technologically feasible, and the challenges are primarily legal, regulatory, institutional, and commercial. (Varma J. R. 2019)

Blockchains could revolutionize the underlying technology of the payment clearing and credit information systems in banks, thus upgrading and transforming them. Blockchain applications also promote the formation of "multi-center, weakly intermediated" scenarios, which will enhance the efficiency of the banking industry. It is worth noting that the problems of regulation, efficiency, and security have always sparked extensive debate in the process of each new financial innovation. (Guo Y. and Liang C. 2016)

Non-cryptocurrencies applications based on permissioned blockchains are currently being explored in many different sectors, such as energy, industry, supply chain management and healthcare. A plethora of such applications are also considered by financial organizations, as part of the wave of FinTech innovations. (Polyviou A., Velanas P. and Soldatos J. 2019)

Companies have alluring opportunities to inculcate innovative skills and improve their performance with the implementation of smart contracts. For instance, better customer engagement, decreased time frame with reference to claims handling, elimination of report duplication, payment automation and avoidance of disputes may be experienced as a result of smart contracts. Blockchain technology attempts to promise in revolutionizing the insurance industry, with an umbrella of bold claims by facilitating and elevating the speed of claims settlements thus leading to improvement of fraud management. (Shetty et al 2022)

Research Gaps

The existing research indicates that blockchain as a technology presents immense potential in the areas like data storage, data security, transparency & enhanced credibility in transactions etc. This chapter focuses on the application of blockchain in the Banking and Insurance sector. There have been very few studies covering the implementation of blockchain by fintech companies in terms of offering solutions to challenges faced by banking and insurance sector. This study fills the gap in terms of studying the real-life applications of blockchain technology by start-ups which are offering the blockchain based solutions to industry. Specific use cases are studied, and the work put by start-ups on the application side of technology is discussed in detail. The study also included the discussion with the industry incumbents to gain insights on the benefits offered and challenges in the application of technology.

APPLICATION OF BLOCKCHAIN IN THE INSURANCE INDUSTRY

Insurance industry is one of the earliest sectors which started employing blockchain technology. The insurance industry has voluminous data storage needs in the form of policy documents, premium collection data, customer Information, claim related data etc. Despite lot of advancements in financial services sector, still majority of data handling is done manually in insurance industry. At each stage right from purchase of policy, generation of policy document, premium payments, claim processing and settlement, customer KYC, human involvement is there which creates a probability of error. This coupled with inherent complexity of insurance as a product/contract for risk coverage makes the entire data chain quite amenable to erroneous record generation and storage. For example, because of a wrong name entered at the time of policy bond creation, the settlement of claims may be delayed as the identity proofs of policy holder may not match with name on policy bond. Getting the name changed in policy again requires human intervention in the form of defined process and matching of all the records. There may be several other examples which warrants the requirement of a more transparent and yet secure mechanism of storing records and processing transactions.

As described in the initial sections of this chapter, Blockchain can be a solution of this complex problem as blockchain offers a cryptographically secured method of data storage in large quantity. The important applications of blockchain in insurance industry are discussed as follows:

Efficient Claim Processing and Settlement

Presently claim processing and settlement process is completely handled manually, it is lengthy, requires multiple verifications and open to human errors. The settlement process may be delayed leading to customer troubles and causing regulatory compliance issues for insurers.

The claim handling can be made smoother and more efficient with the help of Smart Contracts in Blockchain Technology. Smart contracts are pre-coded conditions which if satisfied by the data input in blockchain by customers will lead to automatic claim processing. A large part of claim processing involves standard documents to be submitted by insured and standard conditions to be fulfilled. Smart contract may ensure automated handling & verification of all these standard pre-conditions. It will fetch data from oracles (data record outside the blockchain) to verify whether the loss event took place or not. For example, in case of travel insurance, if the information from oracles confirms that flight was cancelled then as the condition is matched in smart contract, the loss will be automatically reimbursed. The process can be quite simple in case of standardized insurance contracts where claims are to be processes based on standard conditions like whether a particular area was draught affected in case of crop insurance, whether car accident took place, etc. Undeniably, each claim may have some unique elements to be verified manually; yet majority of data validation can be efficiently managed with the instantaneous updating of information by customers and its matching through coded smart contract making the claim processing fast and efficient. This will lead to increased customer satisfaction, reduced cost and robust & timely claim processing.

Further if all the transactions of claim processing are done on blockchain then these transactions are secure, non-alterable and time stamped, no one can change the details and timing of transaction. If the policy documents are on the blockchain then identity of insured can be mapped to policy document and creation of forged documents for probable misuse can be prevented.

Decentralized Insurance through Blockchain and Cheaper Premiums

Insurance premium in the current form of functioning of insurance industry are high and many a times out of the reach of a sizable part of population. People need protection from probable risk of life, health, property, travel, etc.; but can't buy the insurance due to high cost involved. When an insurance company is managing everything, large number of people pay premium that becomes the part of a pool which is invested to get returns. Insurance company expects to get good returns on investment and fewer amount of claims in comparison to premium collected to make money. However, they need to incur several costs which include, cost of assessing the risk and deciding on premium, i.e., actuarial expenses, cost of staff, building, paperwork, record maintenance, claim processing cost, etc. All this cost is to be covered from the premiums collected. This makes the insurance premium very high.

In case of insurance on blockchain, all the stakeholders in the ecosystem are participating. Required information related to risk is available on public data like which areas are flood prone, health hazards in a particular age group, etc. which actuaries can use to access risk and decide on premiums. Customers record their data, that need not be maintained by insurance company. The policy documents are generated electronically, reducing the paperwork. Claim processing is done by matching the claim processing conditions in the form of pre-coded smart contracts on block chain which take the feeds from Oracles to match the conditions. The policies need not to be sold through large number of intermediaries and transactions can be done directly through blockchain. The customer feeds their data, based on which conditions are matched, premiums are decided, and policy can be generated to complete the transaction. The entire process results into less human effort, less paperwork, reduced need of large infra for insurance company, reduced cost of insurance distribution, etc. This implies that insurance can be offered at reduced premiums and penetration can be increased even to those geographies where existing distribution channels does not reach.

Nexus, an insuretech start-up is developing blockchain-based solutions for the insurance industry. Their goal is to replace existing insurance models with smart contract-driven mutual markets. They want to replace the large insurance brick and mortar infrastructure and big insurers by tech-enabled insurance offerings and thereby reducing the insurance cost.

Lemonade, a New York based start up firm uses the combination of Artificial Intelligence and Blockchain to offer insurance through smart contracts. From the monthly charges from customers, company takes a part of charges as fee and balance is allocate towards future claims. When a claim is made the customer is paid quickly by verifying the claims through smart contracts.

Fraud Detection and Risk Prevention

The inherent complexity of insurance, Data stored in silos and manual paper processing offers an open opportunity to fraudsters to exploit the loopholes in the system and make substantial money. A potential fraudster can claim a loss for single event from multiple insurers. This is because data sharing between the insurers is not there. For data needs they depend upon paid public or private data. They are unable to gauge patterns of previous frauds due to non-availability of data and non-sharing of previous fraud cases and patterns among each other. Further, the claim files move very slow and the delay in claim processing makes their task easy of claiming the loss from multiple insurers and no centralized repository of claim settlement.

If the insurers share the claim data on a blockchain then they will have the access of data and patterns of transaction in which malpractices were applied. This will require coordination between insurers but if they record all previous transactions of fraud then pattern of fraudulent behavior can be analyzed, and risk can be prevented, or fraud can be detected at early stage. The blockchain will also contain the personal data of those who were involved in previous frauds. The insurers will not be dependent on paid data as the data on chain is accessible to all. Though this may be an early stage and require substantial efforts but blockchain can be one of the solutions to prevent fraud.

ClaimShare is a product from global technology vendor IntellectEU that enables insurers to identify "double-dipping" fraud. It is one of the first solution for this problem, leveraging R3's trust technology. Across the globe insurers lose several billions by payment of multiple claims made on different insurers on same loss event, popularly known as double-dipping fraud. People take advantage of the absence of any system to share such fraud cases among insurance companies. Insurers are reluctant to share any data with their competitors while there are legal restrictions too on sharing the personally identifiable information (PII) of the client.

Till the time there was no way that insurers share the claim data with each other to know the patterns of previous double dipping fraud and yet exercise the full control on the data. Blockchain technology enable this because insurers can share the claim data which is immutable, and time stamped.

"ClaimShare is the first platform that allows the detection and prevention of double-dipping fraud in the insurance industry. Using Corda and Conclave, we are one step closer to fighting fraud in real- time." - Chaim Finizola, ClaimShare Director

In the solution offered by blockchain, insurers share only the public data of a claim and when an insurer receive a claim from a client it checks all the details available to them like details of loss event, personal data of insured once everything is confirmed a check on public data stored on blockchain is run, if there is similarity found in two claims as per public data for example, for car accident, place, make of car, date & time is matching then it indicates an alarm to further check the claim. Then the private data of these two matching claims is mapped without one insurer sharing the personal data with another. This is to be done off the chain because Personal data cannot be shared also one insurer will not directly share this with other. This is done using privacy enhancing technology which allows private data matching but only would share data between insurers if only it really is a fraudulent case. ClaimShare applies confidential computing hardware intel chip known as SGX that are enclaves and in black boxes where private data linked to suspicious claims that are found on the distributed ledger are then off chain be mapped with each-other, encrypted within the systems of the insurers and shared in this black-box, decrypted in this black-box, compared with each other. In case, they are same, fraud can be confirmed. In case, the personal data of insured is found to be different then claim will be paid. However, if the scrutiny shows the matching of personal data, then claim payment will be stopped and fraud is detected in real time. This is done without exchange of any private data of customers between the insurers.

Blockchain and Internet of Things (IoT)

Combining the technologies like Blockchain and IoT can bring enormous benefits to the insurance sector. Insurance industry's data requirements are very high and in the real-world humongous data is generated every minute which is captured through IoT. This may be in the form of data generated through smart homes, IoT device connected to automobile, IoT enabled watches used by a person etc. This data can be made useful by connecting the blockchain to these IoT devices. The data like speed of car, accelerating and breaking pattern of car driver etc. can be of extreme use for actuaries to decide on premium. Similarly, the automatic data captured on blockchain through smart watches about a person's health indicators like pulse rate, walking speed etc. can be useful to assess health risk and decide on term plan premium or health insurance policy premiums.

Blockchain and Reinsurance

Reinsurance is the insurance for insurer. An insurance firm protects itself from perils through reinsurance services provided by reinsurers. This is specifically useful for property and other losses in catastrophic events such as earthquake, flood, forest fire, etc.

The reinsurance process efficiency is contingent to speed, transparency, and efficiency of data sharing with reinsurer. The data is often captured by different entities and lacks these features which makes reinsurance and claim settlement processes lengthy and inefficient.

Blockchain is a solution to this problem where entire data is stored on blockchain in an immutable and time stamped manner and accessible to all the stakeholders. The Blockchain Insurance Industry Initiative (B3i), a technology firm which was incorporated in the year 2018 has done tremendous work in risk transfer. They developed their first application in reinsurance, named as **B3i Reinsurance (B3i Re).** As per B3i - **"**The initial version supports the electronic placement and administration of Property Catastrophe Excess of Loss (Cat XoL) treaties, from structuring the submission to negotiating, binding, endorsing and technical accounting." B3i developed the application in close coordination with all the stakeholders in insurance sector so that product best serves the needs of industry.

Microinsurance Distribution

Microinsurance services are designed for low-income people to protect them against specific hazards. Specific risk related to life, health, property etc. are covered costing very small premiums. For example, coverage may be for live-stock or road-side shop, etc. Because microinsurance is for low-income people, the premiums must be very small. The penetration of microinsurance can be increased only if it is offered at low premium. The present distribution channels through agents, brokers, etc. results into high distribution cost. Currently, data recording and maintenance is centralized and involves lot of human efforts, paperwork, data center cost, etc. The entire traditional insurance system involves huge cost in the form of human resource cost, infrastructure cost, cost of paperwork, distribution cost, etc. This entire cost is to be absorbed into the premiums charged to the insured. This makes success of microinsurance, almost impossible. Blockchain can be a solution to this problem as it eliminates a large part of these costs. Microinsurance can be distributed through blockchain to increase their reach to masses in the low-income groups and yet keeping distribution and other costs at lower level and thereby enabling the lower premiums.

SURETY.AI, a project from Hearti, is using blockchain to offer microinsurance to unbanked populations, particularly in Asia. Their working model includes combining the blockchain technology with their AI and other technology platforms and making microinsurance cost-effective. Their project aims at offering the insurance at lower cost and large scale and thus making it a profitable business case. This will result into generating enough motivation to insurers to invest in microinsurance to cover unbanked population.

Poleecy is another blockchain-based microinsurance provider in Italy. Their platform uses the smart contracts which increases trust timely claim settlement, transparency, and reduced cost.

APPLICATIONS OF BLOCKCHAIN IN BANKING AND FINANCIAL SERVICES

Cross-Border Payments

If you want to transfer money to someone else, these days, it will mostly be in the form of electronic transfer of funds from your bank account to the other person's bank account. For domestic transfers, this is done through the domestic clearing system – commercial banks within a country are part of the clearing system and transfer funds to each other through a central bank operated clearing centre e.g., RBI operated National Electronic Fund Transfer (NEFT) clearing centre. All member banks of the clearing system maintain an account with the clearing centre. To make a payment, the sending bank will instruct the clearing centre to transfer funds from their account into the account of the recipient bank. The clearing centre may follow some kind of netting mechanism to reduce the balance that each clearing member has to maintain in their account.

For international / cross-border payments, there is an added complexity. Suppose you want to remit money from India to USA. The sending and the receiving banks (S and R* - asterisk indicating foreign institution) are no longer members of the same clearing system and cannot settle an international payment by debiting / crediting their accounts with a centralized clearing centre. The traditional solution has been to use correspondent banks.

In this case, the sending bank (S) will have a correspondent bank in USA (C*) which is a member of the US clearing system. The two correspondent banks maintain accounts with each other. These accounts are traditionally called – *loro (meaning "yours" i.e., your account with us)* and *nostro (meaning "ours" i.e., our account with you).*

For an international remittance, S sends a payment instruction to C*, which in turn makes the payment to the recipient bank R* through the US clearing system. The correspondent banks reconcile their accounts with each other on a periodic basis.

Global payment revenues totalled US$1.9 trillion in 2020. Of this, cross-border payments accounted for ~US$ 175 billion (The 2021 McKinsey Global Payments Report, 2021).

Compared to domestic payments, there has not been any major innovation in cross-border payments despite much higher revenues per transaction (compared to domestic payment transactions). Most countries have enabled domestic real time payments (RTGS, IMPS in India). International payments are, however, still processed through correspondent banks and the overall process is inefficient, slow, and error-prone with high transaction costs. These inefficiencies arise from operations across different currencies, time zones, message formats, customer due-diligence requirements and legal systems.[1] Charges and time taken for cross-border payments vary across market and service providers. Charges could be anywhere between 0.3-20% of the transaction amount and it may take 2-5 business days for the payment to clear.

Using blockchain technology for cross-border payments may result in much faster payments, lower transaction costs and fewer reconciliation errors. As per Deloitte report (Deloitte, 2016), enabling blockchain based B2B (Business to Business) and P2P (Person to Person) cross-border payments will result in 40-80% reduction in transaction costs (~8% of transfer today) and will take ~4-6 seconds to clear (instead of 2-3 days today).

Ripple was the first fintech to tap the international remittance market with their *xCurrent* real-time gross settlement system enabling cross-border payments within seconds using blockchain technology and real-time messaging. Banco Santander became the first bank to use blockchain technology for the international transfer of customer funds. Santander One Pay FX, a ripple[2]-enabled mobile app for cross border payments was launched in 2018. The service uses the underlying distributed ledger technology to enable same-day international money transfers (Delventhal, 2018).

It remains to be seen whether blockchain can become the key technology for cross-border remittances. Given the in-built transparency in a blockchain based system, a bank's competitors may gain knowledge about their remittance business; banks may be reluctant to make such information public.

The most important player in the international remittance business is the Society of Worldwide Interbank Telecommunications (SWIFT). Set up after World War II, SWIFT transmits messages between banks for a fee. Presently, SWIFT network includes approx. 11,000 financial institutions around the world and processed around 33 million transactions per day in 2019 (Blaney, n.d.).

While SWIFT has described blockchain technology as too complex and inadequate for cross-border payments, threat from blockchain based start-ups has made them act as well. In 2017, SWIFT launched a new service – SWIFT gpi – that settles cross-border payments within a day. In June 2021, ICICI Bank became the first bank in Asia-Pacific to offer instant cross-border inward remittances (for beneficiaries in India) using the SWIFT gpi service.

Trade Finance

Trade finance is another area - where distributed ledger technology and blockchain – can play a positive role. It is estimated that 80-90% of global trade, worth $10 trillion per year, is reliant on trade and supply chain finance in some form or the other (Trade Finance Global, 2020).

Despite its critical role in global commerce and the general trend of technology led innovation in financial and commercial service, trade finance has been relatively slow to modernize its processes. Trade finance continues to operate in the old-fashioned way with lots of paper-based processes, reconciliation and a complex chain of several intermediaries between the ultimate buyer and seller of goods and services.

The global trade finance ecosystem is complex and includes a diverse set of intermediaries and facilitators including financial institutions, credit insurance companies, export credit agencies, logistics providers, government agencies and regulators. These intermediaries facilitate the flow of goods and funds and operate across different languages, currencies, accounting systems, business customs, regulatory regimes, and legal systems. This result in extensive paperwork across multiple ledgers (often duplication of data and documents), due diligence and compliance processes at various stages of a trade transaction. All these add time and cost to the overall transaction and also increase the risk of documentation and reconciliation errors. These issues are especially challenging for MSMEs (Micro, Small and Medium Enterprises) with limited expertise and liquidity.

Blockchain technology can reduce these inefficiencies by providing a single mechanism to cover various stages in a trade transaction including order, shipment, insurance, logistics, financing, customs and delivery. Having all the intermediaries on a single network reduces transaction costs and time, eliminates duplication across multiple ledgers, improves accuracy and increases transparency.

Blockchain based solutions can also address the issue of gap in trade finance availability. As per an Asian Development Bank (ADB) study, the gap in trade finance availability reached US$ 1.7 trillion in 2020, representing almost 10 percent of global trade (McKinsey & Company, 2021). The problem is especially acute for MSMEs that get rejected for trade financing due to relatively weaker balance sheets and availability of limited information about the credentials of the MSME and their overseas trade counterparts. A blockchain based system makes it easier for the financing bank to track the transaction at various stages and establish the bonafides of the various parties to the transaction – which may have a positive impact on the bank's appetite to fund the underlying trade.

In 2016, Barclays issued the world's first blockchain based letter of credit, cutting a process that normally takes between seven and 10 days to less than four hours. The transaction guaranteed the export of $100,000 worth of cheese and butter from Irish agricultural food co-operative Ornua - formerly the Irish Dairy Board - to the Seychelles Trading Company. The deal was executed via a blockchain platform set up by Wave, an Israel based start-up. In this transaction, both parties were able to transfer the shipping, insurance and other original documents that had been cryptographically sealed via the blockchain (Kelly, 2016).

In May 2018, HSBC and ING Bank executed a live trade finance transaction for international food and agriculture conglomerate Cargill using R3's Corda scalable blockchain platform. The blockchain transaction involved a bulk shipment of soybeans from Argentina, through Geneva's trading arm of Cargill, to Malaysia, through Cargill's Singapore subsidiary as the purchaser. A Letter of Credit was issued using Corda by HSBC to ING. Compared to traditional exchanges for paper-based documentation related to letters of credit that usually takes 5-10 days, this exchange was done in 24 hours (HSBC, 2018).

These transactions demonstrate commercial and operational viability of blockchain based trade finance solutions. We might witness widespread adoption of these solutions within the next 5-10 years.

Compliance

Since the global financial crisis of 2008, there has been a significant increase in the volume and complexity of regulations and compliance requirements for financial institutions. Besides periodic structured report, regulator also make a lot of adhoc data requests. Regulations and compliance rules are dynamics and keep getting modified over time. Banks have to incur significant costs to interpret and implement these regulations and even then, compliance cannot be guaranteed (von Solms, 2021).

In addition, the cost of non-compliance has steadily increased. In 2020, fines for non-compliance with Anti-Money Laundering (AML), Know your Customer (KYC), data privacy and MiFID regulations against the financial sector totalled $10.6 billion, rising 27% from the year before (Fenergo, 2020).

Presently, compliance functions use manual paper-based processes resulting in delays and errors. It is more important than ever that banks use technological innovation to strengthen their compliance functions.

Blockchain technology can be used to automate regulatory compliance, this can significantly reduce the associated time and costs. Through smart contracts, it is even possible to ensure upfront compliance rather than verifying it post-facto. This will further improve the quality and accuracy of regulatory compliance.

Blockchain can also help the regulator. A blockchain based compliance process can keep track of the steps that regulations require – transactions are immutably recorded and provide an irreversible audit trail for the regulator to verify compliance without any requirement to collect, aggregate and analyse data. A blockchain based allowing near real time access to compliance related data, will enable the regulator to think ahead instead of analyzing past information and creating reactive regulations.

Financial Inclusion

Globally, about 1.7 billion adults (approx. 31 percent of adults) do not have a bank account.[3] Similarly, almost half the MSMEs in emerging markets did not have access to banking services. [4]

Lack of proper government issued identification is one of the reasons. In the absence of a proper ID, banks are unable to implement KYC and other customer due diligence requirements for opening an account. Not having enough money, high cost of maintaining an account and limited geographical access to financial institutions are also cited as reasons for not opening a bank account. Tapping into this unbanked population represents a huge business opportunity for financial institutions and banks. As per EY report (2017), banks could generate incremental annual revenue of about US$ 200 billion by serving the unbanked population of individuals and MSMEs.

A blockchain based solution can allow banks to serve the unbanked and underbanked population. A blockchain system can be used to establish a digital identity and resolve KYC related issues. Through the use of digital currencies and allowing direct peer to peer transactions, a blockchain based system can be used to significantly cut down transaction costs for this group of customers

CONCLUSION

Undoubtedly Blockchain is a very strong technology which offers numerous benefits to insurers as well as insured in the form of efficiency, data privacy, transparency of information, low cost, etc. Large insurance companies as well as insuretech start-ups are working hard to exploit the benefits of the technology. Blockchain is in its nascent stage and there is lot of work still to be done to explore the multifaceted benefits it offers to all the stakeholders.

Blockchain can be used to reduce transaction costs and improve the efficiency of banking processes. Payment systems, trade finance and regulatory compliance are the main areas that can benefit from blockchain based solutions. Blockchain can also help banks to tap into the unbanked customer population and create new revenue streams.

Block Chain Technology has the potential to be a game-changer in the field of financial services in terms of handling of bulk records, sharing of client records, faster processing of agreements and settlement of payments without human interventions in most efficient manner. The shared networks are considered robust in terms of negligible possibility of failure. The ledger is end to end encrypted wherein users can add the information and every small change will be recorded without allowing any editing in the previous records. As always, usage of a new technology may pose unforeseen challenges which may lead to issues like data privacy or fraud in case the blockchain network is hacked, though the probabilities are quite low. However, results are encouraging so far and doesn't indicate any required halt in the implementation of technology.

The solutions offered by fintech firms implies that to realize the complete benefits offered by the blockchain technology, it should be coupled with other technologies like Internet of Things (IoT), Artificial Intelligence (AI) etc. Blockchain could be the next big disruption in the industry which will change the way in which businesses are conducted, transactions entered, records maintained, and customers are served.

REFERENCES

Andrikos, J. (2021). *Blockchain-based land registry in Honduras.* The Borgen Project. Retrieved from https://borgenproject.org/blockchain-based-land-registry/

Arslanian & Fischer. (2019). *The Future of Finance.* Retrieved from https://link.springer.com/book/10.1007/978-3-030-14533-0

Asian Development Bank Institute. (2019). *SME Finance in Asia: Recent Innovations in Fintech Credit, Trade Finance, and Beyond.* Retrieved from https://www.adb.org/sites/default/files/publication/535836/adbi-wp1027.pdf

Blaney, B. (n.d.). What Are SWIFT Payments & How Does a SWIFT Payment Work? *Tipalti*. Retrieved from https://tipalti.com/swift-payments/

CBInsights. (2021). *How Blockchain Is Disrupting Insurance*. Retrieved from https://www.cbinsights.com/research/blockchain-insurance-disruption/

Chainlink. (2021). *What Is a Blockchain Oracle?* Retrieved from https://chain.link/education/blockchain-oracles

Chang, Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How Blockchain can impact financial services – The overview, challenges and recommendations from expert interviewees. *Technological Forecasting and Social Change*, *158*, 120166. doi:10.1016/j.techfore.2020.120166 PMID:32834134

Consensys. (n.d.). *Blockchain in Insurance*. Retrieved from https://consensys.net/blockchain-use-cases/finance/insurance/

Deloitte. (2016). *Cross-Border Payments on Blockchain*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/global/Documents/grid/cross-border-payments.pdf

Delventhal, S. (2018). Santander Launches Blockchain Payments Service. *Investopedia*. Retrieved from https://www.investopedia.com/news/santander-launches-blockchain-payments-service/

Devlin, K. (2019). How double-entry bookkeeping changed the world. *Mathematical Association of America*. Retrieved from https://www.mathvalues.org/masterblog/2019/4/26/how-double-entry-bookkeeping-changed-the-world

Disruptor. (2018). *19 Startups Using Blockchain to Transform Insurance*. Retrieved from https://www.disruptordaily.com/blockchain-market-map-insurance/

Excellarate. (2021). *Blockchain in Insurance: Use Cases and the Way Forward*. Retrieved from https://www.excellarate.com/blogs/blockchain-in-insurance-use-cases-and-the-way-forward/

Fenergo. (2021). *Global Financial Institution Fines for AML, Data Privacy and MiFID Rise 27% in 2020.* Retrieved from https://www.fenergo.com/press-releases/global-financial-institution-fines-for-aml-data-privacy-and-mifid-rise-26-in-2020/

Findex, G. (2017). *2017 Findex Full Report Chapter 2*. Retrieved from https://globalfindex.worldbank.org/sites/globalfindex/files/chapters/2017%20Findex%20full%20report_chapter2.pdf

Global, T. F. (2020). *Trade finance explained an SME guide for importers and exporters*. Retrieved from https://www.tradefinanceglobal.com/wp-content/uploads/2020/10/SME-Trade-Finance-Guide-for-Importers-and-Exporters_TFG.pdf

Guo and Liang. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation, 2*(24). Retrieved from https://link.springer.com/content/pdf/10.1186%2Fs40854-016-0034-9.pdf

HSBC. (2018). *HSBC and ING execute groundbreaking live trade finance transaction on R3's Corda Blockchain platform*. Retrieved from https://www.hsbc.com/news-and-media/media-releases/2018/hsbc-trade-blockchain-transaction-press-release

IFC. (2017). *Blockchain in Financial Services in Emerging Markets*. Retrieved from https://www.ifc.org/wps/wcm/connect/f12930a4-a78b-43c0-9fe1-35018cdd9fb5/EMCompass+Note+44.pdf?MOD=AJPERES&CVID=m4Qcm5N

Inform, I. T. (2003). *Asymmetric Cryptography*. Retrieved from https://www.informit.com/articles/article.aspx?p=102212

Kamin, D. (2021). Investors Snap Up Metaverse Real Estate in a Virtual Land Boom. *New York Times*. Retrieved from https://www.nytimes.com/2021/11/30/business/metaverse-real-estate.html

Kelly, J. (2016). Barclays says conducts first blockchain-based trade-finance deal. *Reuters*. Retrieved from https://www.reuters.com/article/us-banks-barclays-blockchain-idUSKCN11D23B

McKinsey & Company. (2018). *Blockchain explained: What it is and isn't, and why it matters.* Retrieved from https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-explained-what-it-is-and-isnt-and-why-it-matters

McKinsey & Company. (2021). *Reconceiving the global trade finance ecosystem.* Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/reconceiving%20the%20global%20trade%20finance%20ecosystem/reconceiving-the-global-trade-finance-ecosystem-final.pdf#:~:text=Reconceiving%20the%20global%20trade%20finance%20ecosystem%201%20Analysis,and%20to%20position%20the%20sector%20for%20the%20future

Merriam-Webster. (n.d.). *Cryptography*. Retrieved from https://www.merriam-webster.com/dictionary/cryptography

Mitra, M. (2018). *5 Real-world Blockchain Use-cases in Insurance Industry*. Retrieved from https://www.mantralabsglobal.com/blog/blockchain-use-cases-in-insurance-industry/

News 18. (2021). Metaverse Hype Boosts High Investment in Digital Real Estate. *Cable News Network*. Retrieved from https://www.news18.com/news/buzz/metaverse-hype-boosts-high-investment-in-digital-real-estate-4521755.html

Polyviou. (2019). Blockchain Technology: Financial Sector Applications Beyond Cryptocurrencies. *Proceedings of e 3rd annual Decentralized Conference*. 10.3390/proceedings2019028007

Popovic, D., Avis, C., Byrne, M., Cheung, C., Donovan, M., Flynn, Y., Fothergill, C., Hosseinzadeh, Z., Lim, Z., & Shah, J. (2020). Understanding blockchain for insurance use cases. *British Actuarial Journal*, *25*(13), 1–23. Retrieved from https://www.cambridge.org/core/journals/british-actuarial-journal/article/understanding-blockchain-for-insurance-use-cases/3F0FBE7A633CE3EAC2CEA0DD98A63286

Re, M. (n.d.). *Blockchain and its Implications for the Insurance Industry*. Retrieved from https://www.munichre.com/us-life/en/perspectives/underwriting/blockchain-implications-insurance-industry.html

Saha, S., & Finiloza, C. (2021). *How blockchain and smart contracts will disrupt insurance claims*. Retrieved from https://www.youtube.com/watch?v=oxpCf6KeC5Q

Shetty. (2022, January-March). Block Chain Application in Insurance Services: A Systematic Review of the Evidence. *Artificial Intelligence for Smart Society - Literature Review*, 1–15. https://journals.sagepub.com/doi/pdf/10.1177/21582440221079877

The 2021 McKinsey Global Payments Report. (2021). Retrieved from https://www.knowledgeinnovations.com/2021/10/14/a-report-entitled-the-2021-mckinsey-global-payments-reports-by-alessio-botta-philip-bruno-jeff-galvin/#:~:text=The%202021%20McKinsey%20Global%20Payments%20Report%20is%20based,payments%20leaders%E2%80%99%20actions%20will%20help%20determine%20market%20trajectory

UN Women. (2021). *UN women-WFP blockchain pilot project for cash transfers in refugee camps Jordan case study*. UN Women. Retrieved from https://jordan.unwomen.org/en/digital-library/publications/2021/un-women-wfp-blockchain-pilot-project-for-cash-transfers-in-refugee-camps-jordan-case-study

Varma, J. R. (2019). Blockchain in Finance. *Vikalpa*, *44*(1), 1–11. doi:10.1177/0256090919839897

von Solms, J. (2021). Integrating Regulatory Technology (RegTech) into the digital transformation of a bank Treasury. *J Bank Regul*, *22*, 152–168. https://doi.org/10.1057/s41261-020-00134-0

Wikipedia. (2021). *Medici Bank*. Retrieved from https://en.wikipedia.org/wiki/Medici_Bank

Wikipedia. (2022). *Cryptography*. Retrieved from https://en.wikipedia.org/wiki/Cryptography

Wipro. (n.d.). *Adopting a New Approach to Demystify the Future of Insurance with Blockchain*. Retrieved from https://www.wipro.com/insurance/adopting-a-new-approach-to-demystify-the-future-of-insurance-wit/

ENDNOTES

1. FSB 2019.
2. Ripple is a blockchain-based digital payment network and protocol with its own cryptocurrency, XRP.
3. 2017 Findex full report_chapter2.pdf (worldbank.org).
4. Ernst & Young 2017.

Chapter 7
Blockchain and Financial Market Innovation

Vandana Mehrotra
https://orcid.org/0000-0003-0942-3547
GD Goenka University, India

Meena Bhatia
https://orcid.org/0000-0003-4579-0109
Birla Institute of Management Technology, India

ABSTRACT

The financial sector, which witnesses millions of transactions every day, is exploring the possibilities with blockchain and how it can leverage this technology for a safer and secured investment environment. This chapter explains the innovative products and services that have been introduced in the financial markets based on this technology. It further explains the benefits derived in the securities market and the insurance sector through the adoption of this technology. Usage of blockchain also faces many challenges in the technical, business, and regulatory areas, which are discussed in the chapter.

INTRODUCTION

The technology likely to have the greatest impact on the next few decades have arrived. And it's not social media. It's not big data. It's not robotics. It's not even AI. You'll be surprised to learn that it's the underlying technology of digital currencies like Bitcoin. It's called the blockchain. Don Tapscott TED Talks (2016)

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The global financial markets and, more specifically, the financial services industry is experimenting with blockchain in many of its functions. Blockchain technology since its introduction in 2009 has shown immense potential in this industry. Its applications and solutions range from payments, investments, exchanges to trading platforms, trade finance, etc. All these services are provided on public or private infrastructure. The table 1 below explains the blockchain ecosystem in the financial services industry.

Table 1. Blockchain ecosystem of financial services

Applications and Solutions				
Exchanges	Merchants	Soft wallets	Hard wallets	Retail banks
Payments	Brokerage	Payroll and Insurance	Micro transactions	Corporate banks
	Trade Finance		Capital markets	
Investments	Financial data	Trading platforms	ATMs	Money services
Middleware and services				
Services	Software development	General & Special APIs	Platforms	Smart contracts
Infrastructure and base protocols				
Public	Private	Payment	Miners	

Source: Blockchain adoption in financial services, Infosys Limited (2019)

It is expected that the global blockchain in the banking and financial services market will grow at a compound annual growth rate (CAGR) of 61.9% from $1.17 billion in 2021 to $1.89 billion in 2022 (ReportLinker, 2022). The role of miners is significant in the blockchain ecosystem. The miners, which could be a computer of a group of computers, verify the block created by other miners. This verification and validation are considered one of the most significant advantages of blockchain technology adoption. For financial institutions, it promises huge cost reduction and security as well. If implemented correctly, there would be a reduction in the transaction, administrative and infrastructure costs. Disintermediation through the digital transfer of financial assets can reduce the dependency on central counterparties. The adoption of this technology, however, requires trust between parties. It helps in improving accuracy and gives strength to the financial ecosystem. According to a 2015 report of Santander InnoVentures, by 2022, when blockchain is adopted industry-wide, there would be a considerable reduction in banks' infrastructure costs attributable to cross-border payments, securities trading and regulatory compliance. This reduction may amount to US$20 billion per annum (Infosys, 2019).

Blockchain technology can transform the financial products and services available in the financial markets. The key features of blockchain technology have enabled this vision. Its attributes include a secure, time-stamped transaction ledger; cryptographic peer to peer network; copies of ledger on multiple systems, public or private network, the consensus of all for updating records, etc. Setyowati (2021) developed a framework design for higher education finance record keeping.

In commercial banking, it is expected that the industry will introduce newer products and services based on blockchain technology. There will be more cryptocurrency-based products, asset and real estate track, real-time loan funding and servicing via smart contracts. When the capital market adopts blockchain technology, it will make the clearing and settlement process more efficient, real-time trade executions will be normal, and security and custody services will see a new dimension. There is enormous potential for blockchain adoption in trade and supply chain finance. Real-time multiparty tracking and management of letters of credit will lead to exponential growth in trade financing.

Foreign institutions are also adopting blockchain looking at its immense potential in the financial markets. The last decade has seen some very innovative products and services being introduced in the sector. The next section looks at adoption of blockchain and the innovations in the global financial markets.

INNOVATIONS IN THE GLOBAL FINANCIAL MARKETS

Blockchain Technology in Financial Markets

Blockchain is a technology that has generated significant interest in the financial sector across the globe. This industry has millions of transactions every day, with trillions of dollars exchanging hands. It is observed that the financial sector is now experimenting with the latest technology of blockchain. It has enabled new digitised products and services in the financial markets. These products are transforming the entire financial system.

Blockchain is considered to be a tamper-proof technology. It can run simultaneously on multiple devices (in millions!) connected as a network that makes it failure-tolerant.

Application of Technology

Over the last decade or so, Blockchain technology has disrupted traditional business processes. The transactions and applications which necessitated centralised architecture or third-party surety for verification and validation can now be made operational in a decentralised manner with the same level of assured certainty. Due to the design of its architecture, blockchain provides transparency, security and auditability. These inherent characteristics make it ideal for the banking sector.

1. **Digital Currencies**: A digital currency is an electronic form of money issued by governments. Whenever users transact with digital currency, there is the usage of computers or electronic wallets. A digital currency can be either centralised or decentralised. It is considered centralised when a body controls its supply in the market, for instance, a Centralised Bank. It is considered decentralised when the control is pre-determined or agreed upon democratically. In the digital currency world, the term associated with this is 'mining'. Popular cryptocurrencies like Bitcoin, Ethereum, Dogecoin, etc., are examples of decentralised digital currency systems which runs on blockchain technology.

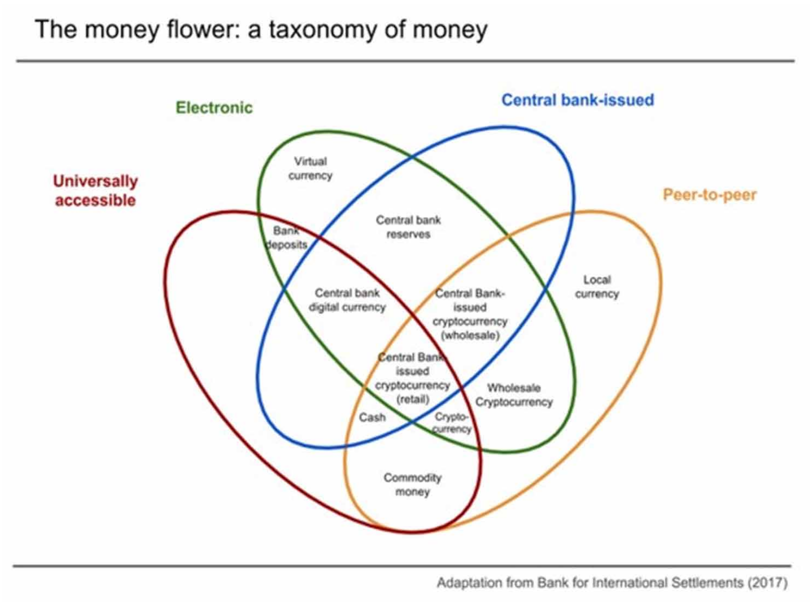
The first major blockchain innovation in the financial markets was a cryptocurrency called Bitcoin, launched in 2009. It was a successful experiment in digital currency using blockchain technology. Cryptocurrency got its name from the cryptography algorithm used in blockchain technology to keep information safe. It can be deduced that a cryptocurrency is a digital currency that uses cryptography for keeping transactions secure and verifiable. Thus, cryptocurrencies are thus created, traded, allotted, and stored using a decentralised ledger system known as a blockchain. Figure 1 below explains the world of virtual and real currencies.

Over the years, the global financial markets have seen the launch of thousands of cryptocurrencies. In terms of market capitalisation, the significant cryptocurrencies being traded in the world are Bitcoin (BTC), Ethereium (ETH), Binance Coin (BNB), Tether (USDT), Solana (SOL), Cardano (ADA), XRP (XRP), U.S.Dollar Coin (USDC), Polkadot (DOT) and Dogecoin (DOGE). The global crypto market cap at the end of March 2022 was around $2.245 trillion, with Bitcoin's share of around 40% (Statista website).

Amongst the different types of cryptocurrencies trading in the market, there is one type called 'stable coins'. Stable coins are termed as they are considered more stable than other cryptos. The stable coins derive their value from an underlying asset, unlike other cryptos that are 'mined' by an open computer network. It makes them less volatile. Fiat-Collateralised Stable coins derive value from a fiat currency like the US dollar. Tether (USDT), U.S.Dollar Coin (USDC) are examples of the same. Crypto-Collateralised Stable coins derive their value from other cryptocurrencies. An example of a crypto-collateralised stable coin is MakerDAO's DAI (DAIUSD), backed by Ethereum and pegged against the US Dollar. It permits using a basket of crypto assets as its reserve. The market capitalisation of stable coins in February

2022 was around $180 billion as compared to $38 billion in 2021 (Bloomberg, 2022). Tether is the largest stablecoin, but its market share has declined sharply. This decline has been majorly caused by centralised crypto exchanges introducing their stable coins (USD Coin by Coinbase and Binance USD by Binance).

Figure 1. The money flower: a taxonomy of money
Source: Bank for International Settlements Quarterly Review, September 2017



Millions of people are using cryptocurrencies for making payments. In September 2021, El Salvador became the first country to use Bitcoin as a legal tender along with US Dollar. Some countries are experimenting with issuing their official digital currency. Nigeria, the Bahamas and the Eastern Caribbean region have already launched their digital currency. China, too plans to launch a digital yuan soon. The Indian government is framing a policy to introduce a central bank digital currency (CBDC).

2. **Decentralised Finance (DeFi)** – An innovation that is an extension of a cryptocurrency is 'Decentralised finance' (DeFi). It is an umbrella term used for all the financial services available on public blockchains like Ethereum. DeFi may be better understood as a bank substitute in providing services like borrowing, lending, buying insurance, trading in derivatives, trading in certain

assets and much more. DeFi is fast, paperless and does not require third-party intervention. Its reach is global and is a form of peer-to-peer service.

The financial services under DeFi include sending money across the globe, accessing stable currencies, borrowing funds with/without collaterals, trading tokens, buying insurance, and managing a portfolio. Users engage with DeFi through 'dapps' (decentralised apps) software. Most of these apps currently running on the Ethereum blockchain. Table 2 below highlights the difference between the crypto financial system and the traditional system.

Table 2. Crypto vs. traditional financial system

Function	**Service**	**Crypto financial system**		**Traditional finance**
		Decentralised finance (DeFi)	**Centralised finance (CeFi)**	
Trading	Funds transfer	DeFi stablecoins (DAI)	CeFi stablecoins (USDT, USDC)	Traditional payment platforms
	Asset trading	Crypto asset DEX (Uniswap)	Crypto CEX (Binance, Coinbase)	Exchanges and OTC brokers
	Derivatives trading	Crypto derivatives DEX (Synthetix, dYdX)		
Lending	Secured lending	Crypto decentralised lending platforms (Aave, Compound)	Crypto centralised lending platforms (BlockFi, Celsius)	Broker-dealers active in repo and securities lending
	Unsecured lending	Crypto credit delegation (Aave)	Crypto banks (Silvergate)	Commercial banks and non-bank lenders
Investing	Investment vehicles	Crypto decentralised portfolios (yearn, Convex)	Crypto funds (Grayscale, Galaxy)	Investment funds
CEX = centralised exchanges; DEX = decentralised exchanges; OTC = over-the-counter; USDC = USD Coin; USDT = Tether				
Illustrative examples are given in parentheses				

Source: Bank for International Settlements Quarterly Review, December 2021

As per International Monetary Fund, DeFi has grown by over 600% from $15 billion at the end of 2020 to about $110 billion as of September 2021. It is mainly due to the rapid growth of decentralized exchanges that allow users to trade crypto assets without intermediary and credit platforms that match borrowers and lenders without a credit risk evaluation of the customer.

3. **Centralized Finance (CeFi)** – The concept behind CeFi is to offer an opportunity to make crypto investments that offer yield returns similar to DeFi and the security of traditional investment products. With CeFi, an investor can borrow money, trade-in crypto, spend and earn rewards with a crypto debit card, etc. In CeFi, crypto trading orders are made through a centralized exchange. One of the popular crypto exchanges is Binance. US and Coinbase. Besides providing crypto trading services, these exchanges also support services like borrowing, lending, margin trading, etc.

The main difference between DeFi and CeFi is regulation. CeFi is a regulated system where the exchange is responsible for safeguarding the investors' money (Bellapu, 2021). It is not so in DeFi. Under DeFi, it is the responsibility of the investor himself to safeguard his fund. Also, limitations are imposed on users. It is not feasible in DeFi as no permissions are taken here. Another critical difference between the two is that it is possible to convert fiat currency to cryptocurrency through CeFI exchanges and vice versa. CeFi also supports cross-exchange for multiple cryptocurrencies.

4. **Digital assets** – Each time a physical asset (real estate, gold, stock certificates, etc.) is traded in the market, it must be verified and examined. It delays the transaction time for each trade. Using Distributed Ledger Technology (DLT) or Blockchain technology, physical assets are converted digitally to transact and recordkeeping. These digitized assets then function like an online financial instrument that changes hands with a change in ownership recorded in the ledger. Each digital asset has a unique digital representation which enables the trade of any asset in less time and at a lower cost.

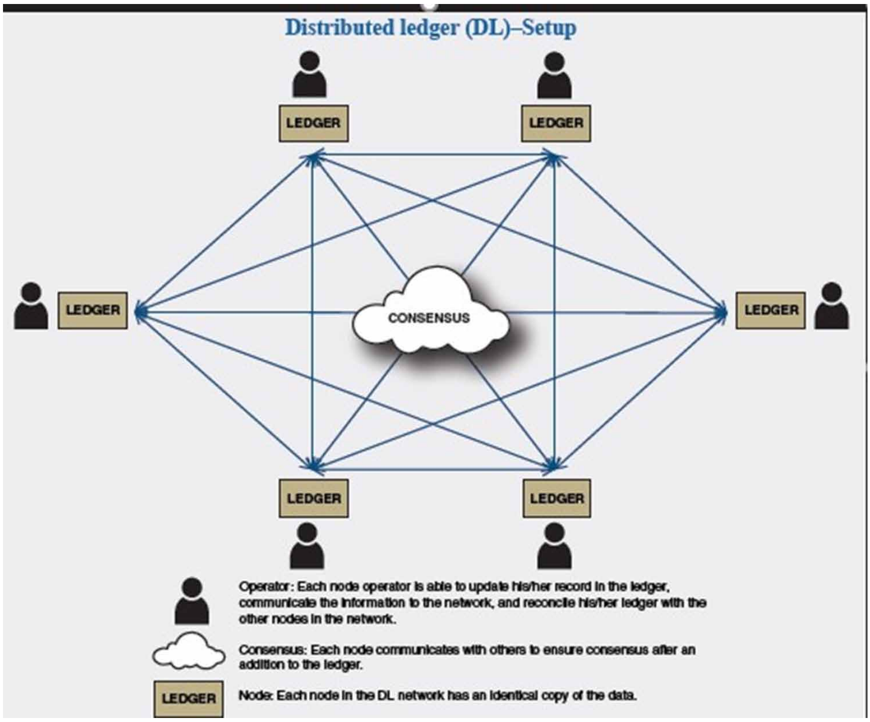
A non-fungible token (NFT) is also a type of digital asset. The market for NFT has grown over the past year. People have been creating and selling NFTs that represent various assets ranging from digital images, internet memes, event tickets, and memorabilia.

5. **Digital recordkeeping –**

"The Internet of Everything needs a Ledger of Everything" - Don and Alex Tapscott (2016)

Blockchain technology, in essence, is a record-keeping technology. It is a very innovative but safe way of recording transactions in the financial markets. Unlike the traditional method of maintaining a centralized ledger, blockchain uses a distributed

Figure 2. Distributed ledger setup
Source: Economic Perspective (2017), Financial Management Group, Federal Reserve Bank of Chicago



record-keeping system. The ledger is distributed to all the computers in the chain as can be seen in figure 2 above. A vital benefit of this technology is that an audit trail of every transaction is maintained. Blockchain databases create standardized records that are unchangeable but easy to query.

There are four functions that a client can perform in a traditional database. These are Create, Read, Update and Delete (CRUD commands). Compared to this, in a blockchain database, users can only Read and Add data. Previous data is permanently stored and cannot be updated or altered. This ensured against manipulation or fraud. Thus, the main difference between traditional and blockchain database technology is public verifiability, enabling integrity and transparency. Users of blockchain databases can thus verify how data has been added in the chain without being altered or corrupted.

6. **Smart Contracts –** Smart contracts have brought about many positive benefits to the financial markets. Earlier blockchain technology was being used for cash-like tokens of Bitcoin. With the introduction of smart contracts on the

blockchain system of Ethereum, these contracts enabled the representation of financial instruments like loans or bonds. The smart contracts are stored on a blockchain. These contracts get executed automatically when the stated terms and conditions are met. Unlike traditional contracts, smart contracts are paperless as these are computer coded.

Smart contracts have the potential to automate business processes. Hence, banks are exploring the usage of the same for evaluating loan eligibility, claims processing, and KYC compliance (Khan et al., 2021). The main features of smart contracts are:

- Smart contracts are independent contracts that are self-executing. There is no involvement of any party in compliance and control.
- Information is automatically sourced from external data sources. It makes the contracts self-verifying.
- Smart contracts are secured contracts that are tamper-resistant.
- There is no trust issue as these are transparent contracts.
- It is free of cost execution.
- Sensitive data in the contracts is secured as all associated data is traceable in the blockchain platform.
- A cryptographic digital signature verifies participation in the contract, which makes these contracts ideal for big contracts.

There are three different types of smart contracts in the Internet of Things (IoT) system. These are –

- Smart legal contracts – Simplify legal processes and ensure compliance with regulatory guidelines. Best suited for financial contracts, trade contracts and real estate contracts.
- Decentralized autonomous organizations (DAOs) – Built for the blockchain community itself. Participants abide by the rules set in the code and used by crowdfunding platforms.
- Application logic contracts (ALC) – Act as a communicator between different IoT devices. These are application-specific codes that work in sync with other programs on the blockchain.

Smart contracts available on NXT, Ethereum and Sila blockchain platforms are popular.

BENEFIT OF BLOCK CHAIN TECHNOLOGY IN FINANCIAL SERVICES

The financial services industry has an enormous number of transactions involving huge funds that run into trillion dollars a day. These transactions involve risk, especially the security risk and also many become victims of cybercrime. Due to the considerable involvement of funds, parties expect higher transparency and lower cost with high efficiency.

The use of blockchain brings considerable advantages to the financial services sector by ensuring secure and fast transactions, reducing fraud, and managing risk in the global market space. This technology is resistant to hacking as it uses cryptography, resulting in better trust in the transaction network.

1. **Benefits for Securities Market:** The securities market is a market for equity, debt, and derivatives. The stock exchange, a part of the securities market, provides a platform to buy and sell securities. The primary participants are brokers, investors, traders, and regulators.

Blockchain offers multiple benefits to its participants:

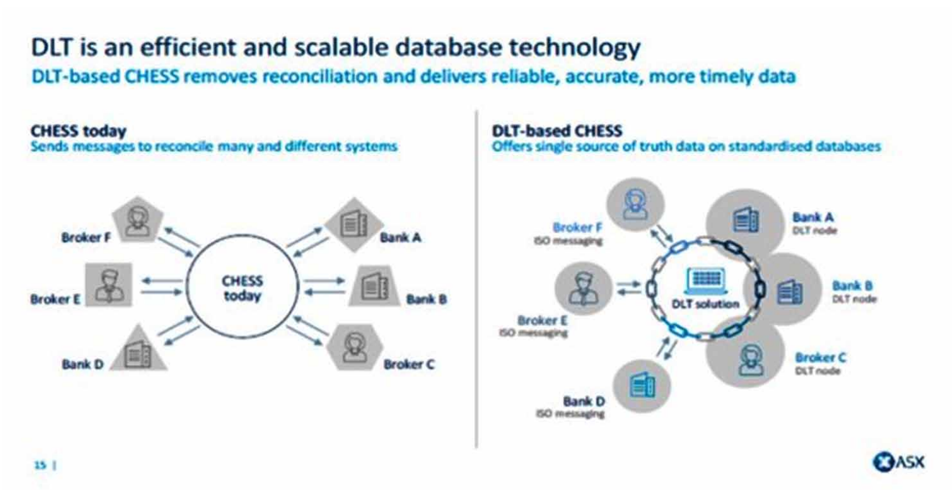
a. **Interoperability:** The trading happens on stock exchanges (Bombay Stock exchange-BSE and National Stock Exchange-NSE in India). The clearing corporations handle the settlement (NSE Clearing and Indian Clearing Corporation). Interoperability refers to a mechanism wherein trades executed on any exchange can be settled or cleared through any clearing corporations and not necessarily restricted to the clearing corporation of the exchange on which the trade was done. For instance, a trade executed on NSE can be settled through BSE's Indian Clearing Corporation and vice versa. The stock markets around the globe want to accelerate towards standardisation and interoperability. The race for blockchain interoperability is truly on.

b. **Quicker settlement:** The global capital market is enormous and complex and is further becoming so. As per the World Federation of Exchanges database, there are 47,919 companies listed globally with 109 trillion-dollar market capitalisation, and the total value of stocks traded is around 80 trillion dollars. The primary concerns are around operational costs and transaction time. Blockchain technology offers immediate settlements and automated compliance through smart contracts, with a higher level of transparency and security (Abhay Padda, n.d).

A blockchain settlement solution reduces the time needed for clearing and settling the transaction. It uses cryptocurrency that immediately completes transactions and transfers to the beneficiary happen in the wallet, confirming updates in the ledger and faster settlement.

In the latest high-profile move to blockchain technology, the Australian stock market will become the world's first blockchain-based stock exchange. The Australian Securities Exchange (ASX) stated that the technology is used to clear and settle trades. The above move has been in the works since January 2016, when ASX began working on a blockchain-based system with US-based blockchain firm Digital Asset Holdings (BBC News, 2017). The Clearing House Electronic Sub-Register System (CHESS), which has been in operation for decades, is being used by the exchange (shown in figure 3 below). According to Michael McCarthy, chief market strategist at CMC Markets in Sydney, the new approach will save tens of millions of dollars. By eliminating the third-party middleman that banks presently use, the technology will assist in making clearing and settling transactions less expensive, easier, and faster.

Figure 3. DLT – A scalable database technology
Source: Australian Securities Exchange



c. **Unified data model:** By using blockchain, the overall unified data set is correct all the time without the involvement of a central governing authority. Only one data set needs to be reconciled across databases, which helps report efficiently. This technology allows multiple independent parties to work with, and a multitude of data types can be 'hashed', encrypted and entered into the ledger to create richer datasets than today (Oliver Waynman, 2016).

d. **Democratisation of trading:** Blockchain technology also offers democratisation as it uses a decentralised mechanism. It brings down the correlation between distance from the stock exchange and entry price, consequently making the nearness to exchange servers irrelevant. It will make trading faster, efficient, of low cost, bring higher transparency in the trading and settlement process, and reduce the need for market intermediaries. It makes stock exchanges much more optimal through decentralisation and automation. Also, the customers benefit from lower costs and fast transaction processing. It also results in higher liquidity as it increases participants' access to the market because of higher automation and reduction in cost

The NSE, Tokyo Stock Exchange, London Stock Exchange are exploring the opportunities this distributed ledger technology offers. NASDAQ has been using blockchain since 2015. It has installed LINQ, a blockchain-backed platform that expedites trade settlements in minutes rather than days.

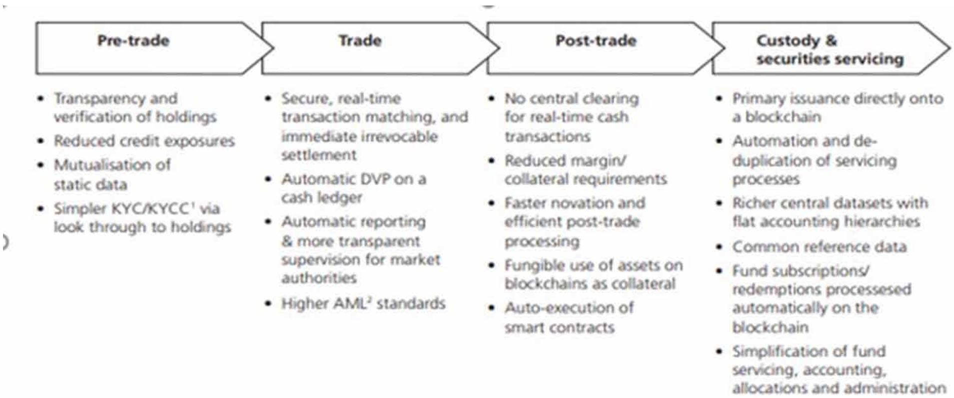
e. **Availability of transparent real-time data:** The use of blockchain technology will also result in updated data at every point in time. It will result in time savings due to no need for data enrichment and reconciliations and avoidance of disputes between counterparties. Participants can quickly disclose reliable data to other parties well in time, building trust and reducing risk.

f. **Risk containment:** Margining and margin payment can be made quickly using blockchain technology. The frequency of valuation of stocks can be done daily rather than the weekly process currently used, reducing risk. Also, the entries in this technology are irreversible, which results in lesser risk due to manipulation. The Credit and liquidity risk would be almost removed with blockchain-based transactions because they demand pre-funding of a deal, resulting in a reduction in systematic risk (Oliver Waynman, 2016).

g. **Increased precision in Asset Management:** The sector uses intermediaries to meet investors' requests for a global selection of products, making the process complex and time-consuming. The distributed ledger concept can enable cross-border direct trading and settlements, lowering costs, improving data accuracy, and reducing delays.

FundsDLT, a blockchain-powered funds distribution technology, was developed by Luxembourg Stock Exchange subsidiary Fundsquare, Post Group subsidiary InTech, and KPMG Luxembourg in partnership. FundsDLT is projected to provide asset managers with a new distribution channel with lower transaction costs and delays, thanks to smart contracts and distributed ledger principles. Fundsquare is also teaming up with iHub, an innovation and hacking space for innovators, investors, and tech startups, to launch a blockchain-based Know Your Customer platform for the financial services industry (Abhay Padda, n.d).

Figure 4. Benefits of adoption
Source: (Oliver Waynman, 2016).



The financial services sector is highly regulated, and the rate of blockchain adoption will be determined by how regulators around the world support the developments. A few have already implemented the technology; for example, Delaware, a state in the United States, has approved legislation that recognises stock trading on the blockchain. To function, financial services companies using distributed ledger technology must have sufficient infrastructure and risk management procedures in place, according to the Australian Securities and Investment Commission regulatory framework. Because of its cryptocurrency-friendly regulations, the Zug region of Switzerland has earned the moniker "Crypto Valley." Switzerland is positioning itself as a hotbed for Initial Coin Offerings (ICOs) (Open Access Government, 2019).

2. Benefits to the insurance sector

The primary benefit of the blockchain as a decentralised ledger is that it can exist in an infinite number of nodes since the greater the number of nodes, the more transparent it is. Blockchain assures lower fees by eliminating intermediaries, regardless of what the ledger contains. The distributed ledger's data can store any amount or type of information, not only cryptocurrencies like bitcoin. Individually identifiable and customisable data is available. It means that data can have attributes assigned to it by users. The data can also be programmed to represent a currency amount, a corporation share, or even diamond certifications.

By automating critical processes, insurance-related use cases are expected to benefit from allowing expansion, enhancing effectiveness, and lowering costs. Many incumbents have competitive constraints, such as poor consumer engagement, limited development in mature industries, and digitisation tendencies, which blockchain might address.

The insurance industry is making steady progress to benefit from the blockchain and the most substantial use cases for blockchain in insurance are:

a. **Fraud free and effective claims management:** The first key advantage of blockchain is its trustworthiness. Provenance, auditability, and immutability are enabled by its ability to have consensus mechanisms built into it. It simplifies the creation of smart contracts on the blockchain, which might benefit the insurance business.

Claims triage and processing can be automated using smart contracts, and easy access to client history and centralised customer identification can all help to improve claims efficiency. Data exchange across industries will allow for proactive fraud prevention. Smart contracts provide quick, transparent, and trustworthy transactions since blockchain is an immutable ledger. Because regulators would be able to monitor all insurance variables on the ledger in real-time, auditing will be considerably more accessible and less time-consuming.

b. **Increased automation:** Smart contracts do more than making transactions more transparent. They can also make the insurance process more efficient. A smart contract can facilitate and enforce the contract and its fulfilment since it stores its immutable terms. Blockchain automatically executes the smart contract requirements, resulting in less time in the insurance claims process. Automation is a significant feature of blockchain. For example, at First Notice of Loss, impacted assets and insureds are quickly confirmed via blockchain. Insurance payments can also be streamlined and made more trackable. When payment information is stored in a blockchain database, it can be used to expedite multiple payments to different parties in accordance with the smart contract and responsibility determination.
c. **Enabling data transformation:** Data is the lifeblood of insurance firms. Blockchain can capture various useful data when used in conjunction with other technologies such as the internet of things (IoT) and artificial intelligence (AI). For instance, if an insured wears a fitness watch and agrees to share data — such as heart rate, oxygen levels, and sleep times — you might be

able to give them a lower healthcare insurance cost. IoT data is saved on the blockchain and then interpreted by AI, allowing your firm to make smarter insurance premium selections.

Vehicles can be affected in the same way. IoT devices that monitor a car can qualify insureds for safe-driver discounts and provide your insurance company with more data regarding driver habits and vehicle performance.

Actuaries will be able to access digitised, contextual data via blockchain, which will considerably reduce the work and improve the accuracy of risk models and estimations.

d. **Facilitating product innovation:** With its near-real-time transaction settlement capabilities, blockchain will enable insurers to offer new risk instruments and capitalise on market capital opportunities. A large multiline global insurer, Allianz, has recently released a blockchain-enabled captive insurance solution. The company is also looking into additional blockchain potential in the corporate insurance area. Peer-to-peer transmissions are supported by smart contracts recorded on blockchain's decentralised ledgers. Other types of bespoke insurance products can now be created due to this.
e. **Cost reduction:** One of the most significant advantages blockchain may give is cost reduction. It's easy to understand how blockchain may affect claims, administration, underwriting, and product development, and many of the current blockchain use cases are centred on cost reduction. The use of blockchain to automate the payment of claims is one of the first areas that insurance firms are considering. By validating coverage between corporations and reinsurers, blockchain has the potential to help automate claims operations. It will also streamline payments between parties for claims, lowering insurance firms' administrative costs. According to Gartner, by 2030, blockchain will have generated $3.1 trillion in new company value. We can also see a future in which new life insurance applications are submitted via blockchain technology.

According to Oberoi. & Kansra (2021), the adoption of blockchain technology in the field of insurance is developing at a fast pace, and is gradually becoming the default platform for the insurance industry.

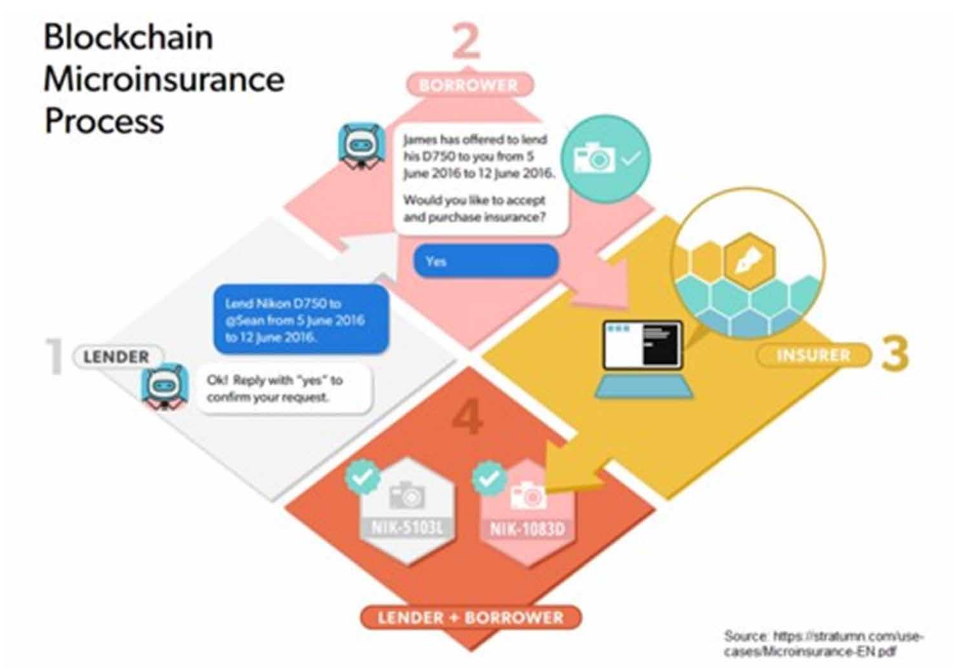
Case Study: LenderBot

LenderBot is a proof-of-concept micro-insurance platform that insures all kinds of items using the bitcoin blockchain. Most notably, sharing economy products and services such as Airbnb stays and Uber rides. Deloitte, Stratumn, and LemonWay, a next-generation insurance platform, have teamed up to demonstrate the possibilities of many innovative blockchain-based applications and services aimed at the insurance business (Brave New Coin., n.d.).

Micro-insurance might be added to purchases, leases, and service contracts in various ways, including texting, via a smartphone app, or during the checkout process of a shopping cart. These could enable several parties to agree on simple options, with the results being recorded on the bitcoin blockchain for accessibility and immutability. While corporations may include such restrictions with their product or service, people may do so when lending something to a neighbour, such as their blender. Just substituting the retail store's "service plan" could be a fantastic use case for LenderBot insurance on high-dollar items like electronics. The big and rising sharing economy, on the other hand, need better insurance choices that are flexible enough to match its non-standard format.

According to the company, micro-insurance enrollment is a four-step process: The 'policy' is first proposed to the buyer or sold to them. The buyer then reviews it and signs off on it. After that, the contract is signed and notarised on the bitcoin blockchain, and a copy is sent to all parties. Finally, a digital token, such as a counterparty coin or one designed specifically for the job by Stratumn, is transferred to one or both parties as an asset that can be held, exchanged, or redeemed.

Figure 5. Blockchain microinsurance process



CHALLENGES IN THE ADOPTION OF BLOCKCHAIN TECHNOLOGY IN FINANCIAL MARKETS

The rapid advancement of blockchain technology in the financial services sector has fuelled the demand for higher quality blockchain-based applications. The adoption of blockchain technology itself poses many challenges for the markets in terms of technology, business and regulatory aspects. Some of the critical challenges are explained below -

1. **Achieving consensus** – This is one of the biggest challenges the participants face as the application of blockchain technology requires significant trust among them for carrying out any change in the protocol. Consensus is required amongst the vast number of nodes while verifying new transactions. Any change in protocol needs to be approved by all the nodes, or it gets rejected. Each node requires access to the entire blockchain. It amounts to running over a vast database which takes time. It results in thousands of transactions waiting in queues for verification. To overcome this challenge, some ecosystems have partially decentralised their ledger so that only a few nodes need to reach a consensus. Another possible solution could be granting authority to one or a few participants to make protocol changes that are binding upon the entire network. However, this cannot happen without significant trust amongst the participants.
2. **Design standardisation** – Design standardisation is the key to adopting blockchain technology in the financial sector. Lack of design standards has emerged as the main bottleneck to the mass implementation of blockchain technology. The key benefits of standardisation are that standards provide a baseline for performance, consumer protection and interoperability systems. It leads to developing a familiar concept that helps in scaling, auditing, and regulating the technology. According to research conducted by MarketsandMarkets in 2019, the blockchain IoT market is expected to be to the tune of USD 113.1 million by 2024, having an average growth rate of 92.92% annually over five years. Such huge global possibilities will not actualise unless standardisation is achieved. Therefore, many national and international organisations are trying to establish generally accepted technical standards.
3. **Operational complexities** – There are many operational issues in adopting and implementing blockchain technology in financial transactions. When adopted at a large scale, businesses may face an interoperability challenge in relating their existing internal systems with blockchain platforms. A more significant challenge would be seen in the operation of blockchain from multiple businesses with each other.

Another complexity faced is the transaction time. At present, transaction speed related to Bitcoin is plodding. Only three to seven transactions happen every second. Ethereum, considered better, can only handle 15 transactions per second. On the other hand, the traditional payment systems can handle thousands of transactions per second (Mazer, n.d).

The transaction cost associated with this technology is very high. The electricity consumed and the cost of computer servers needed to process the transactions add to the transaction cost. As we all know, Bitcoins are created through 'mining'. We, therefore, say that coins are 'mined'. The mining process of Bitcoin or any other digital coin is a complex computational problem. It appears that the mining of Bitcoin consumes more electricity than the intrinsic value of Bitcoin.

The slow speed of transactions also increases the transaction cost. The cost per transaction needs to go down drastically, maybe more than a thousand times to become viable for larger systems.

4. **Scalability** – The financial markets will benefit from blockchain technology only when adopted on a mass scale. It appears to be complicated. With more transactions happening, the blockchains become voluminous and slow down. The time taken for verification of each transaction is very long. According to Jackson (2018), Visa handles about 24,000 transactions per second, and Ethereum and Bitcoin can manage less than 20 transactions per second. Thus, blockchain technology can't process millions of transactions happening in the financial markets in a short time. The reason behind the delay is the limited capacity of blocks. As each node in the network maintains its copy of the distributed ledger, the entire network (permissioned/permissionless) needs a large amount of storage space. Thus, the requirement of high computing power and more storage resources poses a considerable challenge to the scalability of the technology in the financial markets across the globe.
5. **Legal uncertainties** – The legal concerns over digital assets and currency holding is another big challenge. Due to a lack of clarity on the legal standing of the digitised assets and securities, there is hesitancy amongst the financial market participants to deal in it. There is a lack of clarity regarding the applicability of laws in the case of bankruptcy, fraud or any other financial failure. A primary legal concern relates to jurisdictional problems. The nodes of a decentralised ledger may be present in multiple locations spread across the globe. It is difficult to determine which jurisdiction's laws will be applicable in such a situation. Transaction done by an entity may fall under the jurisdiction of every place where each node of the network is situated. Another concern area related to smart cards is dispute resolution and fixation of liability. The rules are not yet clear. Some countries have started accepting electronic contracts,

but it is yet to be seen whether the lawmakers include smart contracts within the legal framework of these electronic contracts.

6. **Security concerns** – Blockchain technology is considered ‘tamper proof’. For a dishonest participant to tamper with any block, he would have to change the information in all subsequent blocks. It would mainly be challenging in the case of a public blockchain which may have a network spread over different countries. Usage of cryptography in files also helps in securing data on a blockchain. Despite the high order of security, blockchains are not protected against cybercrimes. Actual blocks are considered safe from hacking but not wallet accounts. Hacking is also attempted when data is being transferred. Blockchain technology is associated with transferring large volumes of data in real-time. Hackers conduct a routing attack during the transfer. It is challenging to detect too. The number of phishing attacks in the blockchain network is increasing too. The vulnerability of public and private blockchains to hacking does not give much confidence to the participants in the financial markets. Bitcoins are now associated with money laundering and criminal activities. Cryptocurrency exchanges have also lost much value due to criminal theft through hacking. Distributed nature of blockchain also creates security concerns.
7. **Tax implications** – The Indian government has not yet framed any particular guideline on the taxation of income earned or gains made through crypto-assets. At present, income from cryptocurrencies is taxable according to the tax slab of the investors. The Government of India plans to tax it according to its usage – investment, payment or utility. Many countries have a taxation system in place for cryptocurrencies. Crypto is treated as property in the US, and capital gains tax (CGT) applies to it when it is sold. Australia also recognises it as an asset that attracts CGT when disposed of but treats it as a business activity if traded. For smooth adoption of blockchain technology in financial markets, tax implications on income earned through crypto assets and cryptocurrencies must be very clear to the participants, including investors. The governments across nations need to provide clear guidelines and legal frameworks which are consistent tax provisions on other assets.
8. **Regulatory challenges** – Currently, there is a lot of uncertainty over regulatory agencies’ rules regarding blockchain applications. The advancement in technology is ahead of its regulators. The centralised systems in financial markets like banks, stock markets, etc., work within the regulatory framework defined for such institutions. On the other hand, it isn’t easy to regulate a decentralised system like a blockchain application. Although tracing transactions is possible with blockchain technology, it isn’t very easy to identify parties to a transaction. In addition, the regulatory framework of this ecosystem may fall in different countries. Thus, monitoring becomes difficult as sharing of information across

jurisdictions becomes a challenge. According to the Financial Stability Board, there is a need to analyse the crypto economy and make appropriate regulations. The main challenges faced by regulators are –

a. Classification – Correct classification of existing cryptocurrencies poses a challenge to the regulators. With the advancement of technology, crypto assets of varied kinds have emerged. Many analysts treat cryptocurrencies as an entirely new asset class, and others treat them as assets similar to other investments or financial transactions. Therefore, while framing regulation rules, the regulators need to clarify the classification of these assets.
b. Over-regulation – A school of thought prevailing in the market is that regulation will stifle innovation in the crypto market. It will prevent growth in the sector. However, it has been observed that there is a rapid rise in the value of Bitcoin, which helped in fundraising by beginners. Hence, the regulatory framework should be designed to permit cash strapped firms to raise funds through this market.
c. Technology revolution – The blockchain technology used by the Crypto market is revolutionising the banking and finance sector. Many banks and financial institutions have started using blockchain technology for some of their operational and investment functions. Hence, the regulators need to keep a close watch on these advancements and create a regulatory environment that is dynamic enough to absorb these changes.

CONCLUSION

In the last decade, the world has seen the rise of usage of blockchain technology in financial markets. It has enabled many market innovations, including cryptocurrencies, crypto assets, smart contracts, decentralised financing, etc. Despite considerable fluctuations in the value of cryptocurrencies, this form of digital currency is attracting more and more investors. Governments of many countries are planning to launch their cryptocurrency, a legal tender for all, after realising the benefits of blockchain technology. While more work needs to be done in terms of regulation, framing laws, etc., most agree that financial markets will see many more innovations based on blockchain. The DLT technology has the potential and capability to bring in efficiency and security in the financial markets. However, this is possible only if implemented correctly. According to Flovik et al., (2021), the practitioners find infrastructural qualities (reliability, immutability, transparency) a challenge which overshadows the blockchain´s transformative potential (automation of transactions, decentralization). Shortly, financial markets will see the development of specific applications of DLT. It is expected that this will improve trust, transparency, sharing of information and audit trails relating to transactions. Another benefit would be better cooperation and understanding between the public and private sectors.

The benefits from the usage of blockchain technology can be manifold. These benefits have the potential to revolutionize the financial world. The settlement periods of transactions can be drastically reduced, enabling more liquidity in specific trades where the existing settlement periods are long. Shorter settlement periods will lead to better capital usage. The payment processes will also benefit from DLT, especially the foreign exchange market with many intermediaries. A DLT service that will provide digital identities to the parties involved will enable direct funds transfer, thereby reducing the time in the process of settlement.

Even though there are many benefits of blockchain technology, its usage also faces many challenges. These challenges can be seen as opportunities for improvement in the technical, business and regulatory aspects. As far as technical challenges are concerned, achieving consensus among the blockchain network's members is a big challenge. Blockchain being an emerging technology, is facing a skill gap. The demand for blockchain engineers is on the rise. Trust amongst the users is also required to adopt the blockchain ecosystem.

As the governments and regulators across the globe are still in the process of developing a robust regulatory framework for the various applications of blockchain technology in the financial sector, the value of cryptocurrencies continues to rise. This uncontrolled and fluctuating rise poses a considerable risk for market investors. Many types of investors have kept away from the market due to an uncertain regulatory environment. Hence, to make it more popular and acceptable to all, the regulators need to develop more dynamic regulatory solutions. For effective regulation, coordination is required between governments of different countries and between governments and the industry. It will help in protecting investors and users across the globe. It will also curtail the growth of fake crypto, hacking, and other problems this industry faces. A proper security system needs to be provided to protect investors against fraud. It includes developing a legal framework that clarifies the legal status of all participants, processes and products based on blockchain technology.

Blockchain has already made an impact in the financial markets. We hear more voices in the financial services industry advocating for adopting this technology as DLT has shown immense potential. The thrust of financial institutions towards blockchain adoption is in the right direction. However, Foreign Institutions need to move cautiously. While the blockchain's transformation capability is enormous, FIs its adoption and implementation are a challenge. Therefore, looking forward, regulators have a critical role to play. The regulators are expected to ensure security for all the participants and reduce uncertainty without bringing disruption to the market system.

REFERENCES

Aramonte, S., Wenqian, H. & Schrimpf, A. (2021, Dec.). DeFi risks and the decentralisation illusion. *BIS Quarterly Review*.

BBC News. (2017). *Australian stock exchange to move to blockchain.* https://www.bbc.com/news/business-42261456

Bech, M. & Garratt, R. (2017, Sept.). Central bank cryptocurrencies. *BIS Quarterly Review*.

Bloomberg. (2022). *Stablecoins Soar in Value as Everything Else in Crypto Shrinks*. https://www.bloomberg.com/news/articles/2022-02-24/stablecoins-soar-in-value-as-everything-else-in-crypto-shrinks#:~:text=The%20total%20market%20capitalization%20of,compiled%20by%20The%20Block%20show

Brave New Coin. (n.d.). *LenderBot by Deloitte and Stratumn to bring insurance to the sharing economy using bitcoin's blockchain*. Retrieved January 2, 2022, from https://bravenewcoin.com/insights/lenderbot-by-deloitte-and-stratumn-to-bring-insurance-to-the-sharing-economy-using-bitcoins-blockchain

Flovik, S., Moudnib, R., & Vassilakopoulou, P. (2021). Determinants of Blockchain Technology Introduction in Organizations: An Empirical Study among Experienced Practitioners. *Procedia Computer Science*, *181*, 664–670. doi:10.1016/j.procs.2021.01.216

Khan, S. N., Loukil, F., Ghedira-Guegan, C., Benkhelifa, E., & Bani-Hani, A. (2021). Blockchain smart contracts: Applications, challenges, and future trends. *Peer-to-Peer Network and Appications.*, *14*(5), 2901–2925. doi:10.100712083-021-01127-0 PMID:33897937

Lewis, R., McPartland, J. & Ranjan, R. (2017). Blockchain and Financial Market Innovation. *Economic Perspective*.

Ludlow, A. (2018). *Blockchain in capital markets: benefits and challenges.* https://www.bobsguide.com/articles/blockchain-in-capital-markets-benefits-and-challenges/

Mazer, J. (n.d.). *Demystifying Cryptocurrencies, Blockchain, and ICOs.* Retrieved April 26, 2022, from https://www.toptal.com/finance/market-research-analysts/cryptocurrency-market

Oberoi, S., & Kansra, P. (2021). *Motivating Antecedents and Consequences of Blockchain Technology in the Insurance Industry*. IGI Global. doi:10.4018/978-1-7998-8081-3.ch017

Open Access Government. (2019). *Crypto Valley: Why Switzerland is a world-leading location for blockchain companies.* https://www.openaccessgovernment.org/crypto-valley-switzerland-blockchain-companies/58442/

Padda, A. (n.d.). *How Will Blockchain Revolutionize the Global Financial System?* https://www.wns.com/insights/articles/articledetail/534/how-will-blockchain-revolutionize-the-global-financial-system

ReportLinker. (2022). *Blockchain In Banking And Financial Services Global Market Report 2022.* https://finance.yahoo.com/news/blockchain-banking-financial-services-global-114700539.html

Rupareliya, K. (2021). How smart contracts are transforming banks and financial institutions, *BusinessofApps*. https://www.businessofapps.com/insights/how-smart-contracts-are-transforming-banks-and-financial-institutions/

Setyowati, W., Rahardja, U., Aini, Q., Santoso, N., & Prihastiwi, W. (2021). Design financial accounting using blockchain approach in education. *Media Riset Akuntansi. Auditing & Informasi*, *21*, 161. doi:10.25105/mraai.v21i2.9448

Singh, S. S. (2018). *How blockchain will change the way you trade in stock markets.* https://economictimes.indiatimes.com/markets/stocks/news/how-blockchain-will-change-the-way-you-trade-in-stock-markets/articleshow/62161610.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution*. Penguin Random House.

Vysya, V. N., & Kumar, A. (2019). *Blockchain adoption in financial services. In Perspective*. Infosys Limited.

Waynman, O. (2016). *Blockchain in Capital Markets The Prize and the Journey.* https://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/feb/BlockChain-In-Capital-Markets.pdf

Wipro. (n.d.). *Adopting a new approach to demystify the future of insurance.* https://www.wipro.com/insurance/adopting-a-new-approach-to-demystify-the-future-of-insurance-wit/

Chapter 8
Blockchain in the Banking Sector:
Revolution or Digital Disruption?

Tanveer Kajla
https://orcid.org/0000-0002-5528-9804
NALSAR University of Law, India

Vishal Sarin
https://orcid.org/0000-0001-8916-8974
Lovely Professional University, India

Sahil Raj
Punjabi University, India

ABSTRACT

Financial institutions opting for blockchain technology raise controversy about how this new technology can disrupt the traditional banking sector. Many issues like a decentralized system with no middlemen and untrusted parties pose serious threats to the banking system. Hence, there is a serious need to do research on the impact of blockchain on financial institutions, especially in the banking sector, to understand the influence of blockchain as a disruptor and a technology that is revolutionizing the banking sector. The chapter will explain the concepts and role of blockchain in the banking domain. Secondly, the ongoing criticism of the blockchain as a disruptor in the banking domain is answered in this chapter. Third, the role of blockchain in the transformation of the banking sector is discussed by explaining the blockchain process in the key banking services.

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INTRODUCTION TO BLOCKCHAIN TECHNOLOGY

There has been a cryptocurrency revolution in the past ten years (Liu et al., 2021). Bitcoin started digital currencies and cryptocurrency, and simultaneously, the concept of blockchain has emerged, which acts as a record keeper for Bitcoin (Nakamoto, 2008). Blockchain operates as a database in which all the information got stored in a structured manner. The traditional databases assist in finding the information efficiently and quickly. They were designed with the distributed architecture on very powerful computers. The architecture has exceptional computing power and storage capacity to handle multiple records at a time.

However, blockchain structures data in groups known as blocks holding the information (Oh & Shong, 2017). When the block is overflowed with information, the existing blocks are chained to the previously filled blocks, forming a chain of blocks; the reason it is known as 'blockchain'. According to IBM, blockchain is defined as "*Blockchain* is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network."

In the recent years, the emergence of digital technologies such as online banking and fintech has contributed to the new experiences (Tian et al., 2021). The new technologies can handle the financial processes and handle the common bottlenecks such as transparency, convenience, speed and efficiency in facilitating the transactions across different sectors. The blockchains are considered as the upcoming technology for the transformation of the banking and finance sector (Ji & Tia, 2021).

A blockchain is focused on a distributed ledger system that works on the network of computer nodes (George et al., 2019). Blockchain had a very critical role in the Bitcoin, which is a very popular cryptocurrency (Nam et al., 2021). It is responsible for maintaining the transactional records in a decentralization architecture. The main advantage of blockchain is that it provides a secure transaction without the need of third party (Queiroz et al., 2020).

The typical difference between the database and blockchain is the structure of the data. Blockchain collects information in the groups which are known as blocks (Oh & Shong, 2017). Blocks helps in the storage of the data and exceeding the storage capacity, it is linked to the previous block, hence forming a chain of blocks. Hence, the name is given as Blockchain to the chain of the blocks. In the databases, the data is stored in the forms of rows and columns making it a tabular data. However, in the blockchain the data is stored in the blocks which are attached together, hence forming an irreversible chain of blocks with a timestamp for individual block in a decentralized structure (Rane & Narvel, 2019).

The information stored in the blockchain cannot be edited or deleted. Therefore, blockchains are also termed as distributed ledger technology in which the records or blocks cannot be altered (Garg et al., 2021). Blockchains are very difficult to hack.

It is having a very secure network and over the years this technology got trusted by internet users. When the new blocks are added at the end of the blockchain, it is very difficult to reverse and alter the contents of the transactions. Since, any transactions, that needs to be altered, has to be confirmed by majority of the networks.

Blockchain is highly used in the cryptocurrencies such as Bitcoin (Ghaemi Asl et al., 2021). It has its origin from the transaction system in 1991 given by two researchers who wanted to develop a tamper proof timestamps. However, this idea of tamper proof stamps was first implemented in the year 2009 with the launch of Bitcoin. Satoshi Nakamoto, referred this new system as “a new electronic cash system that’s fully peer-to-peer, with no trusted third party”.

TYPES OF BLOCKCHAIN

When any organization is implementing a blockchain solution, then beforehand it has to be decided that what type of blockchain has to be implemented. Broadly, the blockchain can be created with permissions or without permissions (Alam et al., 2021). Permissioned and permissionless blockchain has their own limitations. The permissionless blockchain on the one hand requires no authentication to enter into the blockchain network however they are very difficult to hack if they have a very large network of nodes (Pimentel & Boulianne, 2020). Since the large network of nodes requires high number of miners to authenticate the new blocks. The permissioned blockchain are easy to hack since it works on the centralized system in which central authority is required to add nodes to the blockchain. Hence it is very easy to hack if the system used by the central authority is not secure (Wang et al., 2020).

On the basis of the permissioned and permissionless blockchain, there are three types of blockchain structure:

Public Blockchain

Public blockchain are part of the permissionless network in which anyone can join the blockchain network. In this blockchain, anyone can create the blocks on this blockchain and even validate the blocks in the network (Gaur, 2020). These types of blockchains are highly used in the exchange and mining of the cryptocurrency. The highly popular cryptocurrencies such as Bitcoin and Etherium used public blockchain in which the role of miners is to create blocks by solving the cryptographic equation (Nakamoto, 2008). In return they get the bitcoins as a reward of creating the blocks for the blockchains. The other miners validate the blocks created in the blockchain. Therefore, these miners were acting as the bank managers in this cryptocurrency era in which they get paid for their work in the form of cryptocurrency. The public blockchain encouraged new users to join the network and it works completely on the decentralized framework in which no person or organization has authority to control the access in the network.

The public blockchain consumes lot of power to maintain the distributed ledger and there are lot of trust issues in these types of blockchain (Queiroz et al., 2020). The blockchain uses proof-of-work which consumes lot of energy which can be handled by replacing it with more efficient algorithm such as Proof-of-Stake (PoS).

Moreover, these blockchain suffers from transactional speed as well. Sometimes the speed of the transaction is so slow that it takes around hours to authenticate the transactions. This is due the mathematical problems involved during the process of transactions. Hence it also leads to the problem of scalability. If the blockchain network has to be increased, then with the addition of new nodes, the network becomes very complex and slow.

Private Blockchain

Private blockchain works in an environment in which restrictions are imposed. It works in a closed environment and comes under permissioned blockchain ecosystem. These blockchains were highly used by the organizations who wants to have a restricted access to their blockchain network. Therefore, private blockchains allows only selected participants to access their network by setting up the parameters to securely enter the organizations. Hence, it is similar to the centralized architecture in which a single authority is controlling the network. These kind of blockchain networks were offered by various blockchain providers and they tend to offer unique features customized for various organizations.

Private blockchains are faster than public blockchain and does not have distributed ledger technology. There could be trust issues in these blockchain networks since these blockchain comes under the control of single authority, and if the topmost node is hacked then it is very easy to access the secondary nodes in this network. Moreover, due to the small size of the network, it becomes very easy to breach the trust by compromising the consensus method.

Federated Blockchain

Federated or consortium blockchain is different from public blockchain or private blockchain. In this network, some nodes are made public, while others remain as private, hence, offering the benefits of private and public blockchain in a single network. The advantage of this blockchain network is that it is restricted to lesser nodes, however still it follows the decentralized architecture for validation of the transactions. These blockchains are more secure and offers better scalability than public blockchains. Hence it provides a customized centralized architecture along with the benefits of the distributed ledger.

BLOCKCHAIN AND BITCOINS IN FINANCE AND BANKING

The banking sector was considering the use of blockchain based technologies to have an edge in this innovative technology. Established banks like BNP Paribas, Barclays, Swiss Investment Banks, Citigroup and stock exchanges like NASDAQ invested in their own blockchain based solutions to reduce the costs and introduce this new technology to their organizations. The fundamental use of blockchain in the financial sector is money transactions and payment systems. The blockchain provides an easy solution to the swift payments and money transactions system. The transaction is very less compared to the traditional banking system such as net banking and credit cards.

There is a huge difference between a blockchain and present banking system. Banks usually works between fixed hours, i.e. from 9AM to 5PM. However, the blockchain system has no fixed hours and works continuously for the whole year. Even the transaction fees also vary between the banks and blockchain technology. In the banking system, the transaction fees are decided by the banks, however in the blockchain and bitcoins, the fees for the transactions is provided by the miners and users. In terms of transaction speed, the bitcoin transactions usually vary between minutes to hours and moreover it also depends upon the network congestion. However, the banks have faster transaction systems, but usually the banks are not working on the weekends and therefore international transaction could be on hold if done on the weekends.

In the financial systems it is mandatory for the banks to get all the information about their customers before opening the account. In banking system, it is known as 'Know your customers' (KYC). However, there is lot of controversy regarding the Bitcoins. In Bitcoins, the identity of the customers is not known. Even an artificial intelligence program can participate in the Bitcoin network. Hence, it is the reason that government does not have control over the Bitcoin network, but can seize any account coming under the traditional banking and finance systems.

There is a lot of criticisms regarding the cryptocurrencies such as Bitcoins and Etherium, however the change has been observed in the recent years. The main reason is the fast transaction time and less expensive transactions as compared to the traditional banking systems.

Therefore, blockchain in the financial sector is acting as a disruptive force in terms of payments and banking. It exploits the banking sector by adding new technologies such as smart contracts, digital currencies and distributed ledgers. Hence, one of the critical challenges with the blockchain technology is the associated with regulatory issues. There is no law or rule in this technology that should be subject to the regulation, however the worldwide use of this technology in cryptocurrencies, blockchains and smart contracts demands regulation (Osmani et al., 2021). Hence the financial services using the blockchain technology demands regulatory mechanism. At the international level, global financial agencies are trying to regulate the cryptocurrencies to handle the taxation issues and criminal activities (Pimentel & Boulianne, 2020). However, Ji & Tia (2021) argue that the blockchain itself provides a secure and trustable architecture to the financial markets and is regulated through distributed ledger system. However, the collaborative governance is required to bring trust in the banking and finance sector. The absence of this system is responsible for the various cybercrimes and fraudulent transactions. Therefore, to get the societal benefits of the blockchain, there needs to be stringent governance and regulatory framework to handle the blockchain technology.

By looking at the perspective of infrastructure in the financial services, the blockchain brought a disruptive change in the banking and finance systems. The secure transactions using cryptographic algorithms across the globe was made possible with the blockchain technology. With the implementation of the blockchain, the process re-engineering and legacy system integration is a big challenge for the banks. Some of the critical challenges in the implementation of the blockchain technology are the clarity of authority, new technology and potential risks due to the lack of governance brought a disruption to the banking sector.

Cost reduction will play as an influencing factor in the implementation of blockchain technology. The financial solutions based on the blockchain technology will save $8 billion per annum (Accenture, 2017). Putting the blockchain process in the financial systems can save upto 30% of the infrastructure costs. Moreover, the cost cutting will also be done with the elimination of the intermediaries (Hillsberg, 2018; Marr, 2017). Blockchain also provides the secure environment with its decentralized system instead of the central database which is very vulnerable to the cyberattacks (Park & Park, 2017). Hence it was found that the benefits of the blockchain bringing revolution in the financial sector were related to the reduction in costs, secure and efficient financial transactional system (Osmani et al., 2021).

BLOCKCHAIN BASED TECHNOLOGY INITIATIVES IN VARIOUS COUNTRIES

Various countries have implemented the blockchain technology in their financial sector. Tunisia became the first country to start the cryptocurrency based on the blockchain technology. Tunisia tied up with Monetas for initiating the digital currency to do the monetary transactions (Yli-Huumo et al., 2016). Australian Reserve Bank taken the initiative of currency system named as "Developments in Financial System Architecture" (Alam et al., 2021). Palestinian government took the initiative of e-currency that became a central financial system for the digital payments and bank transactions (Alam et al., 2021). Canadian authorities staged a competition, "RegTech Hackathon" in which the idea was presented to simplify the process of Know Your Customer (KYC) while implementing the distributed ledger technology. The Chinese government is also working on the initiative, "Central Bank Digital Currency" to bring down the fraud cases, reduction in the transaction costs and accessibility to the financial services (Alam et al., 2021).

CONCLUDING REMARKS

The banking and financial sector is experiencing a tremendous change with the entry of blockchain technology. It is bringing the revolution in the banking and financial institution by providing various benefits in terms of cost, security and efficiency. On the contrary, it is also acting as a disruptor by bringing the new competition and innovative technologies in the financial sector with the entry of fintech firms and companies who are not previously dealing in financial services.

Therefore, in this chapter, the essentials to understand blockchain technology and the impact of this technology on the banking sector were discussed. The previous literature was considered to understand the blockchain in the banking domain. This chapter makes a novel contribution to the theory as well as in practice. The chapter explained the concepts and role of blockchain in the banking and finance domain. Secondly, the ongoing criticism of the blockchain as a disruptor in the banking domain is answered in this chapter. Third, the role of blockchain in the transformation of the banking sector is also discussed by explaining the blockchain process in the key banking services. Fourth, the relevant cases were discussed in which the established countries were initiating the blockchain process in their key financial services.

REFERENCES

Accenture. (2017). *Banking on Blockchain: a value analysis for investment banks*. Accenture. https://www.accenture.com/us-en/insight-banking-on-blockchain

Alam, S., Shuaib, M., Khan, W. Z., Garg, S., Kaddoum, G., Hossain, M. S., & Zikria, Y. (2021). Blockchain-based Initiatives: Current state and challenges. *Computer Networks*, *198*(March), 108395. doi:10.1016/j.comnet.2021.108395

Garg, P., Gupta, B., Chauhan, A. K., Sivarajah, U., Gupta, S., & Modgil, S. (2021). Measuring the perceived benefits of implementing blockchain technology in the banking sector. *Technological Forecasting and Social Change*, *163*(June), 120407. doi:10.1016/j.techfore.2020.120407

Gaur, N. (2020). Blockchain challenges in adoption. *Managerial Finance*, *46*(6), 849–858. doi:10.1108/MF-07-2019-0328

George, R. P., Peterson, B. L., Yaros, O., Beam, D. L., Dibbell, J. M., & Moore, R. C. (2019). Blockchain for business. *Journal of Investment Compliance*, *20*(1), 17–21. doi:10.1108/JOIC-01-2019-0001

Ghaemi Asl, M., Rashidi, M. M., & Hosseini Ebrahim Abad, S. A. (2021). Emerging digital economy companies and leading cryptocurrencies: Insights from blockchain-based technology companies. *Journal of Enterprise Information Management*, *34*(5), 1506–1550. Advance online publication. doi:10.1108/JEIM-08-2020-0348

Hillsberg, A. (2018). *Can Blockchain Technology Impact Banking? We Analyse this Important Trend*. https://www.comparethecloud.net/articles/can-blockchain-technology-impact-banking-we-analyse-this-important-trend/

Ji, F., & Tia, A. (2021). The effect of blockchain on business intelligence efficiency of banks. *Kybernetes*. Advance online publication. doi:10.1108/K-10-2020-0668

Liu, L., Zhang, J. Z., He, W., & Li, W. (2021). Mitigating information asymmetry in inventory pledge financing through the Internet of things and blockchain. *Journal of Enterprise Information Management*, *2013*(5), 1429–1451. Advance online publication. doi:10.1108/JEIM-12-2020-0510

Marr, B. (2017). Practical Examples Of How Blockchains Are Used In Banking And The Financial Services Sector. *Forbes*. https://www.forbes.com/sites/bernardmarr/2017/08/10/practical-examples-of-how-blockchains-are-used-in-banking-and-the-financial-services-sector/?sh=4c3b945b1a11

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. *Decentralized Business Review*, *21260*. Advance online publication. doi:10.1108/TG-06-2020-0114

Nam, K., Dutt, C. S., Chathoth, P., Khan, M. S., & Dutt, C. S. (2021). *Blockchain technology for smart city and smart tourism : Latest trends and challenges*. doi:10.1080/10941665.2019.1585376

Oh, J., & Shong, I. (2017). A case study on business model innovations using Blockchain: Focusing on financial institutions. *Asia Pacific Journal of Innovation and Entrepreneurship*, *11*(3), 335–344. doi:10.1108/APJIE-12-2017-038

Osmani, M., El-Haddadeh, R., Hindi, N., Janssen, M., & Weerakkody, V. (2021). Blockchain for next generation services in banking and finance: Cost, benefit, risk and opportunity analysis. *Journal of Enterprise Information Management*, *34*(3), 884–899. doi:10.1108/JEIM-02-2020-0044

Park, J. H., & Park, J. H. (2017). Blockchain security in cloud computing: Use cases, challenges, and solutions. *Symmetry*, *9*(8), 164. doi:10.3390ym9080164

Pimentel, E., & Boulianne, E. (2020). Blockchain in Accounting Research and Practice: Current Trends and Future Opportunities*. *Accounting Perspectives*, *19*(4), 325–361. doi:10.1111/1911-3838.12239

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2020). Blockchain and supply chain management integration: A systematic review of the literature. *Supply Chain Management*, *25*(2), 241–254. doi:10.1108/SCM-03-2018-0143

Rane, S. B., & Narvel, Y. A. M. (2019). Re-designing the business organization using disruptive innovations based on blockchain-IoT integrated architecture for improving agility in future Industry 4.0. *Benchmarking*, *28*(5), 1883–1908. doi:10.1108/BIJ-12-2018-0445

Tian, X., He, J. S., & Han, M. (2021). Data-driven approaches in FinTech: A survey. *Information Discovery and Delivery*, *49*(2), 123–135. doi:10.1108/IDD-06-2020-0062

Wang, H., Ma, S., Dai, H. N., Imran, M., & Wang, T. (2020). Blockchain-based data privacy management with Nudge theory in open banking. *Future Generation Computer Systems*, *110*, 812–823. doi:10.1016/j.future.2019.09.010

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where is current research on blockchain technology?—A systematic review. *PLoS One*, *11*(10), e0163477. doi:10.1371/journal.pone.0163477 PMID:27695049

Chapter 9
Blockchain Technology in the Insurance Industry

Sumit Oberoi
https://orcid.org/0000-0002-9989-2875
Symbiosis School of Economics, Symbiosis International University (Deemed), India

Pooja Kansra
Lovely Professional University, India

ABSTRACT

Application of blockchain technology is feasible in the insurance sector, thus authorising data transmission, preventing fraud, enabling automation, and safeguarding audit trails. The present study aims at understanding the use cases of blockchain in the insurance industry and examining the challenges and opportunities of blockchain technology in the insurance industry. This study is approached from a theoretical perspective, and literature search strategy was performed for all working and published research articles and book chapters indexed under different databanks (e.g., CEI, Google Scholar, IEEE, Research Gate, Web of Science, etc.). Only articles accessible in English and published between 2010 to 2021 are included in the study. Blockchain is gaining ever-increasing attention from various industries and research domains. A quantum leap in skills and technical know-how influences all segments of industries, and this revolution is absolutely necessary in the field of insurance. Thus, the implementation of blockchain in the insurance sector has turned out to be a default platform.

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INTRODUCTION

Blockchain is a technology that supports tamper-resistant and transparent transaction recording. A blockchain serves as a distributed database which maintains records secured by cryptography and governed by a consensus algorithm (Flovik et al., 2021)

Blockchain technology was first introduced in 2008 to document immutable and verifiable data records in the absence of intermediaries. According to Kar and Navin (2021), "*The first potential application of blockchain is its use in the transaction of bitcoin, the first-ever cryptocurrency*". The inquisitiveness and evolution of blockchain was majorly determined by the upsurge in cryptocurrency and huge investments in blockchain related start-ups. The potential application of blockchain technology was diffused to various areas such as health, insurance, finance, education, supply chain, etc. (Thake, 2018). Thus, the market share of blockchain technology is increasing significantly. Blockchain technology introduced modern and novel prospects for firms and companies to enhance their competitive edge and uplift economic progression.

Quantum leap in skills and technical know-how influence all segments of industries and this revolution is absolute necessary in the field of insurance industry. Protecting uncertainties has always been a complex and multidimensional obligation that is associated with numerous aspects of lives. Therefore, insurance industry is observed as a foremost player in handling present-day economies on their development pathway. Crawford et al. (2018), inferred "*In 2017, the gross premium of global insurance industry was amounted to be $ 4.8 trillion*". Hence, monetary investments, firm size, management possessions and protecting commercial risks exhibits the importance of insurance industry.

A significant development is witnessed in the area of research associated with blockchain technology in insurance sector, but a large proportion of research is majorly focused to key determinants and consequences of blockchain technology (Raikwar et al., 2018; Janssen et al., 2020). According to Oberoi and Kansra (2021), "*The espousal of blockchain in insurance industry is developing very quickly and it has been putative to become the default platform for complete insurance industry in coming future*". Blockchain technology possess the capacity to develop and enable insurance industry with new tools to redesign products and business models (Brophy, 2019). According to Tasca (2021),

Technology-related challenges in insurance industry are addressed by blockchain empowered solutions. If these new properties provided by blockchain can be combined together, it will be very beneficial for the insurance industry.

Therefore, this study aims at understanding the use cases of blockchain in Insurance industry? What are the challenges and opportunities of blockchain technology in Insurance?

MATERIAL AND METHODOLOGY

Literature Search

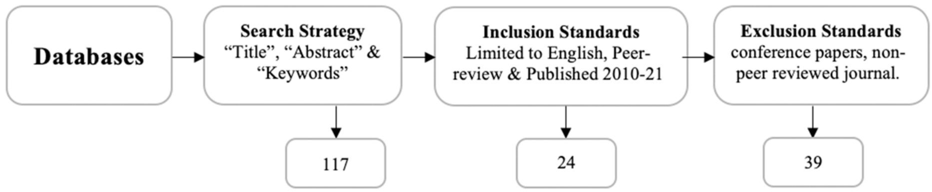
The literature search strategy was performed for all working and published research articles and book chapters indexed under different databases *viz.* Academia, EBSCO, Google Scholar, Research Gate and Web of Science. Moreover, for enhanced literature search available online libraries were searched such as "*Institute of Electrical and Electronics Engineers"* (IEEE) and "*Computerized Engineering Index*" (CEI). Supplementary articles were scrutinized and investigated by conducting backward referencing process.

The literature search strategy applied a combination of controlled vocabulary and keywords such as "Blockchain Technology", "Cryptocurrency", "Hash", "Nodes", "Indemnification", "Insurance", "Systematic Review" and "Decentralized Ledger". Both vocabulary and syntax were accustomed across various databases. A total of 117 articles were attained comprising duplicates by performing desk search criteria in various databases. Later, manuscripts were recognized to be duplicate and removed.

Inclusion and Exclusion Standards

Few articles managed to clear the inclusion standards based on the recommendations suggested by Oberoi and Kansra (2020). Results were limited to the English language, the publication year between 2010 to 2021, conclusions on insurance industry and journals to be peer-reviewed. Title and abstract of the remaining 63 papers were assessed to determine their significance. Therefore, the screening process helped in the selection of 24 articles as highlighted in figure 1. Finally, a large number of articles on blockchain technology were excluded if they (a) were conference papers or posters; (b) were published in non-peer reviewed journal and (c) were not available in English language.

Figure 1. Framework for the inclusion and exclusion of articles



BLOCKCHAIN IN INSURANCE

Rapid diffusion of blockchain technology is witnessed in several areas such as education, financial service, health services, public administration, real estate and supply chain (Hans et al., 2017; Johnson, 2017; Zhou et al., 2018; Demir et al., 2019). Thus, it's the need of an hour to develop and utilize blockchain technology in insurance industry for smoother and hassle free working.

Lack of infrastructural development and excessive intermediaries in insurance industry makes commercial operations expensive and burdensome. According to Grima et al. (2020), it was inferred that insurance sector is the most assuring and favorable domain for utilizing complex technology like blockchain. Oberoi and Kansra (2021), concluded that "*Blockchain technology could be used in distinctive areas of insurance industry, thereby, permitting for speedier and uninterrupted data transfer, automation progressions, prevention of frauds and lastly safeguarding audit trails*". Thereby, adding a value proposition in service and giving assistance to the consumers by attaining cost efficiency. With the use of blockchain technology subrogation and intercompany claim settlement will become less complicated and easy in insurance sector. PricewaterhouseCoopers (2016),

Work automation reduces the physical activity, confirms ineffaceable audit history and reports the acknowledgement of an agreement. This automation helps in removing barriers such as data duplication, up-to-date information, data to be accurate and accessible at all time.

Daley (2019), highlighted the application of blockchain technology in eight companies to revolutionize insurance sector.

The results concluded that utilization of blockchain technology benefit clients by highlighting an overview of insurance policy, notifying about premium due dates, *displaying history of policy, smart contracts, speeding up claim disputes and helps in removing inefficiencies.*

Bosisio et al. (2018), in the study concluded that insurance companies and firms are amongst the primary beneficiaries to get exclusive assistance and advantage from blockchain technology. With the utilization of blockchain in insurance firms and companies, industry will get cost advantage, innovation, data transparency, data upgradation and smart contract advantage (Insights, 2019). Therefore, this paper focusses to understand the use cases of blockchain in insurance industry. What are the challenges and opportunities of blockchain technology in insurance? Though, expectations are extraordinary, application of blockchain is still at nascent stages and not utilized to its fuller capacity (Pancetta, 2016; Olaf et al., 2017).

USE CASES OF BLOCKCHAIN IN INSURANCE INDUSTRY

Use cases of blockchain technology in insurance industry aims at enhancing operational functions with providers, agents and customers. Thereby, making customer experience better, improving product value, enhancing customer choice in the market, etc. Finally, the end result is to reduce cost burden, enhance operational efficiency and strengthen dealings with insured. The use cases of blockchain technology in insurance industry is exhibited in figure 2.

Operational Considerations

Blockchain technologies potential to bring decentralized individuals together while improving data security, exclusively positions blockchain technology in solving the most difficult problem insurance industry i.e. sharing imperative data among insurers, agents and customer (Woodside et al., 2017). Therefore, this use case also acts as foundation for various possible blockchain applications in insurance markets. Added data security and capability to develop trust among different individuals are the two major reasons were blockchain technology helps in solving interoperability issue and enabling operational priorities with cost advantage. With blockchain technology insurer could easily upload or share the desired information to a shared blockchain partner or other insurance company. Use of blockchain technology helps in solving trust issues and reduction of cost burden through automated data between different entities with no meddling of intermediaries and blockchain users do not need to connect.

Effective Fraud Prevention

According to Coalition Against Insurance Fraud (2016), "*Fraud is estimated to cost the insurance industry more than $80 billion annually*". Frauds in insurance industry varies from insurers proposing false claims for services that are never provided to over-charging services to obtain higher payments. Majority of life insurance frauds happens during application process, where applicants hide their medical history of chronic diseases such as diabetes, heart disease and etc. Submission of fraudulent data to an insurer through fabricated claims, false applications or other channels, smart contracts by blockchain technology could help in determining the claims to be valid or not. Blockchain can help in verifying whether the claim submitted by customer was actually seen for particular condition or insurer can compare applicant's prior electronic health record (EHR). Blockchain technologies competence to effortlessly and securely fetch diverse data sources, enable insurers' capability to identify, recognize and alleviate fraudulent activity.

Enhancing Provider's Directory Accuracy

Blockchain technology can offer a smart solution to the most vexing problems of health insurance customers by affirming which insurance provider is in-network. According to Deloitte (2016), "*the provider directory is the most-used function on health insurers websites, but it is too often filled with incorrect and out-of-date information*". Inaccurate or outdated data is a problematic situation for policy members to connect with their provider, such problems have impending impact on care because language disputes causes unanticipated cost burden in the absence of provider in same network. Insurers majorly depends upon providers to update directory data and might obtain information from unknown sources. Both these conditions make it difficult for insurer to keep the directory data accurate and generate correct billing for providers. Blockchain technology based provider's directory influence and allows insurers and providers to update information rapidly and effortlessly. For instance, if an insurer or provider identifies an error, one can easily initiate a correction, that could be accepted or rejected by smart contracts based on available data in blockchain.

Improving Customers Experience

The application process for getting insurance policy is a tedious and time consuming process. Gathering provider's data for underwriting and policy pricing is a challenging and complicated task. Thus, accessing accurate information at point of time is a difficult and biggest obstacle in delivering desired insurance policy (Blumenthal, 2016).

Blockchain technology provides an easier access to comprehensive set of data and records to both insurer and provider. This helps in more user-friendly application process, operational efficiency, fraud prevention and cost saving. According to Deloitte (2016),

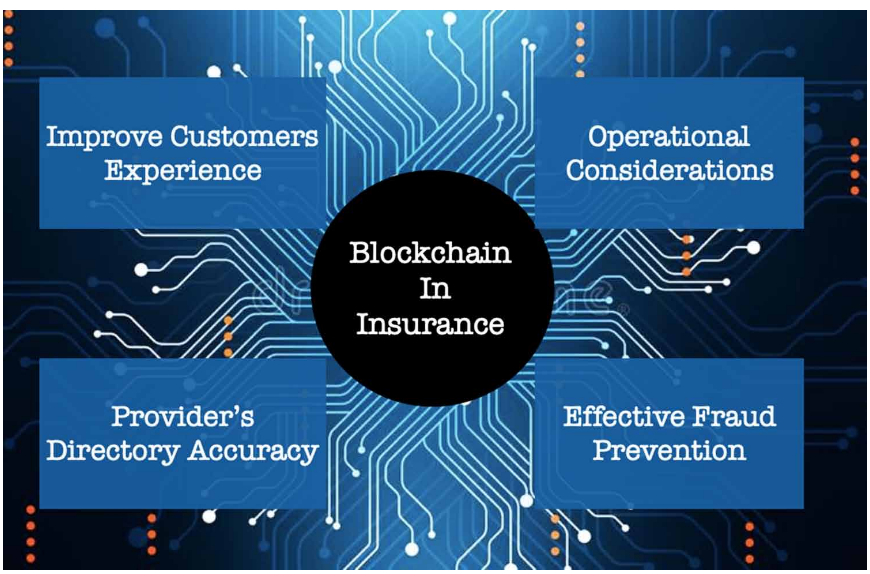
Blockchain could be deployed to accelerate the development of web-based insurance market coverage, centralized customer records, advanced analytics, telematics transmission of wellness data and third-party information to dynamically profile and recommend insurance products best suited to each consumer.

In a similar study by Gatteschi et al. (2018), discussed on several existing peer-to-peer insurances which enhances the customers experience. The study inferred that

In peer-to-peer insurance the blockchain could really become the key technology, from the insurance company's perspective it must be underlined that the objective of peer-to-peer insurance is the removal of intermediaries.

Hence, big insurance companies can recognize this threat and turn it into business opportunity.

Figure 2. Use cases of blockchain technology in insurance industry
Source: Authors compilation based on literature review.



OPPORTUNITIES AND CHALLENGES OF BLOCKCHAIN IN INSURANCE INDUSTRY

Understanding regarding opportunities and challenges of blockchain technology in insurance industry is significant for predicting profitability and achieving competitive edge. Therefore, an integrated conceptual model was developed by carrying out a meticulous examination of available literature on blockchain and insurance industry as shown in figure 3.

Opportunities of Blockchain Technology

Increasing application of blockchain technology highlights various benefits and opportunities that are not just consumer oriented, but also emphasize to add value proposition for insurance industry (Belousov and Shustrov, 2019). According to Oberoi and Kansra (2021),

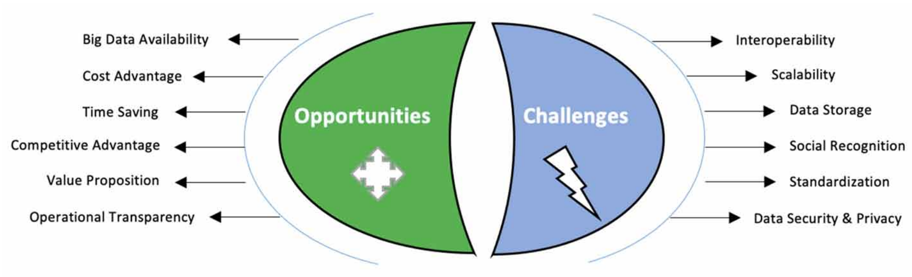
"Application of blockchain technology in the insurance industry will majorly benefit big companies with the availability of big data of customers by reformulating the policies, claim management criteria in accordance with peoples need.

Additionally, insurance industries are willing to use blockchain assistance and support to secure cost advantage, value proposition, big data availability and operational transparency (Tarr, 2018). Thus, utilization of blockchain technology in insurance industry is advantageous for insurers on several grounds such as validating the policy records authenticity, intercompany claims, saving time by removal of duplicate data, operational transparency, detection of fraudulent activity and easy transfer of policy ownership. According to Wright and Filippi (2015),

Blockchain facilitates the development and creation of smart contracts and has the potential to reduce costs, to accelerate the underwriting process and also to expedite claims handling processes — again leading to savings in administrative and operational costs.

Hence, utilization of smart contracts in insurance is a significant and novel innovation in the blockchain technology. Finally, it is a challenging and far beyond the articles scope to highlight the wide-ranging progressions and developments of blockchain technology within the insurance industry.

Figure 3. Opportunities and challenges of blockchain in insurance industry
Source: Authors compilation based on literature review



Challenges of Blockchain Technology

Blockchain technology is at nascent stage and its diffusion in various industries highlights numerous benefits and opportunities (Fernández-Caramés and Fraga-Lamas, 2018; Grima et al., 2020; Kar and Navin, 2021). Still, the use of blockchain technology in insurance industry involves set of challenges and restraints.

The primary and most critical challenge of blockchain technology in insurance industry is data security and privacy (Kuo et al., 2016; Tarr, 2018). Blockchain networks of both insurers and providers are most susceptible to any kind of security and privacy breach recognized as 51% attack (Frankenfield, 2021). According to Siyal et al., (2019),

51% attack involves a team of miners that own more than 50% of the blocks in a blockchain network. The miners get an authority of the network and could prevent any new transactions taking place by not providing them with the consent.

Additional major challenge discussed in literature is the responsibility of data management and storage. According to Tasca (2021), "*With time, as blockchain spread its wings into insurance domain, the data storage challenge becomes quite evident*". Moreover, with the rising size of data sets, a lag in data searching and retrieving becomes low. Therefore, blockchain technology needs to be scalable and resilient (McKinlay, 2016). Blockchain technology in insurance industry also suffered from interoperability snag that is the ability of blockchain network to exchange and make use of data in appropriate manner. Hence, this challenge of interoperability creates interferences and interruptions in data sharing. Since, blockchain is a developing and evolving technology, it requires a large number of licensed and authenticated certifications from highly acknowledged standardization authorities. Lastly, social recognition, acceptance and adoption of such complex technology in comparison to traditional work methods is very challenging process. Because of all discussed concerns and challenges, implementation of blockchain in insurance industry requires a meticulous attention.

CONCLUSION

Blockchain is considered as a major breakthrough and it is gaining an ever-increasing attention and focus from various industries and research domains. Quantum leap in skills and technical know-how influence all segments of industries and this revolution is absolute necessary in the field of insurance industry. Blockchain technology is at nascent stage and its diffusion could be applied in various spheres of insurance sector. The purpose of the present study is to examine the following research questions: to understand the use cases of blockchain in Insurance industry? What are the challenges and opportunities of blockchain technology in Insurance?

A systematic review was carried out to understand the use cases, challenges and opportunities of blockchain technology in insurance industry. Literature from various academic databases were reviewed, compared and included in the study. The systematic review of literature was especially commenced for insurance industry due to the less exploration of this industry and the review shows that opportunities are much greater than any other industry.

Addressing the question of the use cases of blockchain in insurance industry, the review identified four major use cases as operational consideration, effective fraud prevention, enhancing provider's directory accuracy and improving customers experience. Further, to address the second objective of the study it was inferred from the review that understanding regarding opportunities and challenges of blockchain in insurance industry is imperative for predicting profitability and achieving competitive edge. Thus, increasing application of blockchain technology highlights various benefits and opportunities that are not just consumer oriented, but also emphasize to add value proposition for insurance industry such as big data availability, cost advantage, time saving, smart contract benefit and transactional transparency. Still, the use of blockchain technology in insurance industry involves set of challenges and restraints. The primary and most critical challenge of blockchain technology in insurance industry is data security and privacy followed by data storage, scalability, interoperability snag, standardization and social recognition. Thus, the discussed challenges lead to the conclusion that blockchain technology need to work upon the challenges and restraints highlighted in the study, before attaining maturity in insurance sector.

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REFERENCES

Belousov, A. L., & Shustrov, A. A. (2019). Opportunities of using the blockchain technology in the insurance industry. *Finance and Credit*, *25*(1), 781. doi:10.24891/fc.25.1.196

Blumenthal, D. (2016). The biggest obstacle to the health-care revolution. *Wall Street Journal*.

Bosisio, R., Burchardi, K., Calvert, T., & Hauser, M. (2018). *The first all-blockchain insurer*. Boston Consulting Group.

Brophy, R. (2019). Blockchain and insurance: a review for operations and regulation. *Journal of Financial Regulation and Compliance*.

Coalition Against Insurance Fraud. (2016). *By the numbers: Fraud statistics*. https://insurancefraud.org

Crawford, S., Russignan, L., & Kumar, N. (2018). *Global insurance trends analysis 2018*. EY Report.

Daley, S. (2019). 8 companies using blockchain to revolutionize insurance. *Builtin*. https://builtin.com/blockchain/blockchain-insurance-companies

Deloitte. (2016). *Blockchain in insurance: Turning a buzzword into a breakthrough for health and life insurers.* Retrieved and accessed on 21st February 2021. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/financial-services/us-fsi-blockchain-in-insurance-ebook.pdf

Demir, M., Turetken, O., & Ferworn, A. (2019, June). Blockchain based transparent vehicle insurance management. In *2019 Sixth International Conference on Software Defined Systems (SDS)* (pp. 213-220). IEEE. 10.1109/SDS.2019.8768669

Fernández-Caramés, T. M., & Fraga-Lamas, P. (2018). A Review on the Use of Blockchain for the Internet of Things. *IEEE Access: Practical Innovations, Open Solutions*, *6*, 32979–33001. doi:10.1109/ACCESS.2018.2842685

Flovik, S., Moudnib, R. A., & Vassilakopoulou, P. (2021). Determinants of Blockchain Technology Introduction in Organizations: An Empirical Study among Experienced Practitioners. *Procedia Computer Science*, *181*, 664–670. doi:10.1016/j.procs.2021.01.216

Frankenfield, J. (2021). *51% Attack*. Accessed and retrieved on October 2021, https://www.investopedia.com/terms/1/51-attack.asp

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaría, V. (2018). Blockchain and smart contracts for insurance: Is the technology mature enough? *Future Internet*, *10*(2), 20. doi:10.3390/fi10020020

Grima, S., Spiteri, J., & Romānova, I. (2020). A STEEP framework analysis of the key factors impacting the use of blockchain technology in the insurance industry. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *45*(3), 1–28. doi:10.105741288-020-00162-x

Hans, R., Zuber, H., Rizk, A., & Steinmetz, R. (2017). *Blockchain and smart contracts: Disruptive technologies for the insurance market*. Academic Press.

Insights, C. (2019). *Blockchain and Insurance: New Technology*. New Opportunities.

Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analysing blockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, *50*, 302–309. doi:10.1016/j.ijinfomgt.2019.08.012

Johnson, G.L. (2017). Planning the future. Blockchain technology and the insurance industry. Insurance law. *In-House Defense Quarterly*, 73–78.

Kar, A. K., & Navin, L. (2021). Diffusion of blockchain in insurance industry: An analysis through the review of academic and trade literature. *Telematics and Informatics*, *58*, 101532. doi:10.1016/j.tele.2020.101532

Kuo, T. T., & Ohno-Machado, L. (2018). *Modelchain: Decentralized privacy-preserving healthcare predictive modeling framework on private blockchain networks.* arXiv preprint arXiv:1802.01746.

McKinlay, J., Pithouse, D., McGonagle, J., & Sanders, J. (2018). *Blockchain: background, challenges and legal issues*. DLA Piper Publications.

Oberoi, S., & Kansra, P. (2020). Economic menace of diabetes in India: A systematic review. *International Journal of Diabetes in Developing Countries*, *40*(4), 1–12. doi:10.100713410-020-00838-z PMID:32837090

Oberoi, S., & Kansra, P. (2021). Motivating Antecedents and Consequences of Blockchain Technology in the Insurance Industry. In *Blockchain Technology and Applications for Digital Marketing* (pp. 276–285). IGI Global. doi:10.4018/978-1-7998-8081-3.ch017

Olaf, A., Hagen, H., & Hajj, J. (2017). *2017 Technology trends*. PwC. Accessed on February 2021. https://www.strategyand.pwc.com/trend/2017-technology-trends

Pancetta, K. (2016). *Gartner's top 10 strategic technology trends for 2017*. Gartner. Accessed on June 2021, https://www.gartner.com/smarterwithgartner/gartners-top-10-technology-trends-2017

PricewaterhouseCoopers. (2016). *Blockchain in the insurance sector.* Accessed on May 2021, https://www.pwc.co.uk/financial-services/fintech/assets/blockchain-in-insurance.pdf

Raikwar, M., Mazumdar, S., Ruj, S., Gupta, S. S., Chattopadhyay, A., & Lam, K. Y. (2018, February). A blockchain framework for insurance processes. In *2018 9th IFIP International Conference on New Technologies, Mobility and Security (NTMS)* (pp. 1-4). IEEE. 10.1109/NTMS.2018.8328731

Siyal, A. A., Junejo, A. Z., Zawish, M., Ahmed, K., Khalil, A., & Soursou, G. (2019). Applications of blockchain technology in medicine and healthcare: Challenges and future perspectives. *Cryptography*, *3*(1), 3. doi:10.3390/cryptography3010003

Tarr, J. A. (2018). Distributed ledger technology, blockchain and insurance: Opportunities, risks and challenges. *Insurance Law Journal (Chicago, Ill.)*, *29*(3), 254–268.

Tasca, P. (2019). Insurance under the blockchain paradigm. In *Business Transformation through Blockchain* (pp. 273–285). Palgrave Macmillan. doi:10.1007/978-3-319-98911-2_9

Thake, M. (2018). *What's the difference between blockchain and DLT?* Nakamo. To.

Woodside, J. M., Augustine, F. K. Jr, & Giberson, W. (2017). Blockchain technology adoption status and strategies. *Journal of International Technology and Information Management*, *26*(2), 65–93.

WrightA.De FilippiP. (2015). Decentralized blockchain technology and the rise of lex cryptographia. Available at SSRN 2580664. doi:10.2139/ssrn.2580664

Zhou, L., Wang, L., & Sun, Y. (2018). MIStore: A blockchain-based medical insurance storage system. *Journal of Medical Systems*, *42*(8), 1–17. doi:10.100710916-018-0996-4 PMID:29968202

Chapter 10
Blockchain Technology:
The Way Forward Towards Transformation for the Banking and Insurance Sectors

Hesham Magd
Modern College of Business and Science, Oman

Ravi Thirumalaisamy
Modern College of Business and Science, Oman

Benson Ruzive
Modern College of Business and Science, Oman

ABSTRACT

Blockchain technology has received much attention from academicians and industry practitioners because they perceive that it can contribute to the bottom line of corporations. Current literature shows a significant need for adopting blockchain technology in the finance and banking sector to bring digital disruption. The main objective of this chapter will be to identify the principles of blockchain technology and how it impacts the performance of the financial and banking sector. The secondary aims of this chapter will be to examine the challenges faced by the banking and insurance sector and analyse the characteristics of blockchain technology to suggest a model that collaborates with the other ecosystems to overcome those challenges. The chapter identifies models that have been suggested by other researchers and finally proposes a framework for the adoption of blockchain technology in the finance and banking sector.

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INTRODUCTION

Blockchain is still in its infancy but lately has gained much attention from scholars and industry practitioners. The finance and banking sector has not been excluded from this exodus as it has emerged that Financial Technology (FinTech) and Blockchain have been topical issues in the sector (Chang, Bandier, Zhang, Xu, Zhang and Arami, 2020). Big data, machine learning, Artificial Intelligence, and the commercialization of technology were the first significant and remarkable trend in the evolution of FinTech, in addition to the risk-taking by some non-financial firms which invested in the financial business (Chang et al., 2017). Zetzsche et al. (2017) posit that a chemical reaction is presumed to occur when technology and finance are combined, which inherently creates a multiplier effect. Pilkington (2016) reiterates that the characteristics of blockchain technology, such as allowing trust to grow faster among the platform user, swift data transfer with reduced cost, etc. fascinate the end-users, and hence there is a need to adopt the technology.

Antonio and DiNizo (2018) state that Blockchain technology is growing very fast in the financial sector, thus revolutionizing how people handle their businesses. Nevertheless, the development of Blockchain technology has not yet fully grown as it is still facing some challenges in areas such as scalability, privacy, latency, and security (Chang et al., 2017). This chapter explores the current trends in the financial and banking sector in adopting blockchain and the barriers to its adoption, and possible ways to overcome those barriers. In addition, this chapter will demonstrate how Blockchain technology can leverage the sector by implementing principles of Blockchain technology. Varma (2019) defines blockchain as the decentralized reproduced ledger technology that motivates Bitcoin and other cryptocurrencies that offers possibly appealing complementary ways of managing modern finance. The blockchain is a decentralized, replicated, tamper-resistant append-only ledger of transactions. Challenges that are associated with Blockchain technology include scalability (Zheng et al., 2018; Marr, 2018, Biais et al., 2019), security (Werbach, 2018; Price, 2018), privacy leakage (Meiklejohn et al., 2013; Kosba et al., 2016; Cong & He, 2019) and energy consumption (Price, 2018).

SIGNIFICANCE OF THE STUDY – THE WAY FORWARD FOR THE BANKING AND INSURANCE SECTOR

The banking and insurance sector needs to redefine its existing business models by collaborating with other ecosystems to incorporate more secure, reliable, and efficient operational models into their systems. Because of security concerns, these two industries must adopt blockchain technology. Therefore, this chapter offers and explores the challenges of the banking and insurance sector like inefficient records maintenance, lack of consistent supervision, high operational costs, insecure payment facility, etc., and how blockchain technology can overcome those challenges. The decentralized trading activities have many supply chain stakeholders like sellers, buyers, financiers, etc., who perform the trade on mutual trust and confidence. However, there are instances of forgery, money laundering fraud, etc., which cause financial losses to the parties involved in the supply chain. Frauds associated with the Letter of Credit in international trade have been a significant cause of concern. Blockchain is a technology established to maintain real-time records of transactions among the parties involved in such trade at a reduced cost, with high transparency, and a mutual trust that enables to perform error-free transactions quickly. Digital disruptions are inevitable in five major industries due to the invention of blockchain technology which improves the core business services like recordkeeping, data transfer, document maintenance, supply chain management etc. The industries that reap digital disruption benefits by adopting blockchain technology are banking, insurance, healthcare, manufacturing, trading, and the public sector. The chapter concentrates on radical changes experienced by the banking and insurance sector and their future immunity to overcome the challenges of blockchain technology.

BLOCKCHAIN AND BANKING AND FINANCIAL SECTOR

The banking industry has already started establishing blockchain technology as one of the mandatory requirements. Banks have transformed their traditional security systems to modern tech-based security by experimenting with the blockchain where the current assets transactions are recorded, and digital assets are recorded and transferred at reduced cost and time. Anju Patwardhan (2014) rightly pointed out that blockchain technology can secure digital data and safely transfer such data to different parties involved in the supply chain. The Smart Contact Principle used in blockchain binds all the parties involved, so they all agree on what they intend to do. This principle allows banks to store any form of digital information, and it allows the parties to view or update the digital data within the limitations of the set of rules.

Blockchain allows banks to secure every customer's information and share it with others, avoiding data duplication. Further, banks can avoid the cost of retaining the customers' information. Intermediaries need not authorize the transactions in the blockchain, thus reducing the transactions' processing cost and time. For instance, the traditional money transfer takes a few days to transfer the amount, blockchain transfers instantaneously. Thus, the use of blockchain in the banking sector improves operational efficiency, provides a better security system, transparency to transactions, immutable records at reduced transaction time and cost. Blockchain technology ensures data privacy and secures data transfer, according to Popova and Butakova (2019). Blockchain technology is the safest way of executing transactions by avoiding financial fraud and money laundering. COVID-19 pandemic has brought about significant changes in the banking industry, where banks are losing their opportunities. For instance, Online payment systems like PayPal, Google Pay are predominantly handling money transfers. The innovation of cryptocurrencies like Bitcoin to cope with the current payment crisis has not reached all who need to use it. Many misunderstand that Bitcoin is the same as blockchain, but a lot more can be explored and made use of the blockchain.

THE CURRENT TREND OF BLOCKCHAIN TECHNOLOGY CONCERNING THE BANKING INDUSTRY

The banking and financial sector has experienced that blockchain technology has the potential to revamp local and international trade, as observed by Eyal (2017) while highlighting the outcomes of the adoption of blockchain technology in the banking and financial sector. The core banking system maintains records and distributes them locally and internationally. These decentralized records are technologically exposed to the possibility of being hacked or altered. Further, many global technology giants have started innovating their blockchain, which creates discrepancies among the applicability and creates a sense of untrustworthiness. Any international law or regulations do not govern the current form of blockchain technology. However, modernization of the current technological trend of blockchain can explore many potentials to address these issues. Bart Suichies (2016), Technology Lead at Philips Blockchain Lab, narrates that if developed with international collaboration, blockchain technology can benefit all industries and consumers and bring digital disruption in the business world, which will help withstand any emergency without diluting the features of international trade. The business world and the IT sector understand how blockchain technology operates differently, creating a gap between the users and the technology administrators. So, these stakeholders should bring the technology to reality without the core feature- the decentralized data maintenance and dissemination- being affected.

BLOCKCHAIN TECHNOLOGY- A GLOBAL PERSPECTIVE

With the hundreds of blockchain technology innovations over the years, many countries have initiated practicing digital transactions. Realizing the need for an international regulatory framework to structure the blockchain technology for providing an international scope is the core outcome of the G20 Summit, 2018, in Argentina. After the Summit, the international communities took a solid resolution for regulating the cryptocurrency transactions to counter money laundering and financing of terrorists. Table 1 describes the international perspective of blockchain technology in a nutshell. The UNESCO conference entitled "Blockchain: practices and perspectives" at UNESCO Headquarters on 17 May 2019 emphasized the significance of blockchain technology for social good globally. Blockchain has been the center of attraction globally as it offers opportunities to modernize many areas of government transactions, business transactions, and the regular walk of life of an ordinary person in society. Blockchain technology contributes to implementing the Trade Facilitation Agreement (TFA) and makes participation in international trade easier. The International Chamber of Commerce (ICC) estimates that the TFA could increase international exports considerably by some developing economies (International Chamber of Commerce, 2017b).

Table 1. Global perspective of blockchain technology

Countries	Application Area
Sweden	Real estate transactions
Singapore	Issuing invoicing
UK	Government grants distribution
Estonia	e-Citizens records, e-Payments key, medical records secured on Blockchain
Ghana	Recording land registry
Dubai	Government operations
USA	Supply Chain Management
Spain	Banking industry
China	Government Services
Japan	Legalizing Bitcoin changed the entire global financial system digitally
Australia	Sugar industry
Georgia	Mining or investing in the crypto space
Malta	Government Services
Cyprus	Cyprus is playing an excellent role in becoming a Blockchain hub
Gibraltar	Training young professionals and new generations on Blockchain
Thailand	Postal Service to ensure safety and security
Slovenia	Soon will be the Silicon Valley of Blockchain in the world
India	56% of Indian businesses are moving towards blockchain technology

Source: by Muhammad Ahsan Khan @mahsankhan. Blockchain Evangelist & Cryptocurrency Proponent.

ISSUES WITH THE CURRENT BANKING SYSTEMS

Banks and financial organizations perform numerous daily transactions involving massive transactional costs. For instance, JP Morgan, Bank of America Wells Fargo earned almost $6 billion from various services in 2015 (CNN Business, 14th January 2016). Another issue with the existing system is double spending. One of the primary causes for the financial crisis and financial depression in 2008 is that the financial institutions had lent out the money to all who could not afford to replay. Such lending decisions brought about the most devastating financial crisis for everyone associated with the banking system. These issues are due to the centralized power held by the central bank or any regulatory body in the monetary system. Further, the records are prone to hacks in the centralized banking system. Blockchain technology solves these issues by embedding the following features into the system:

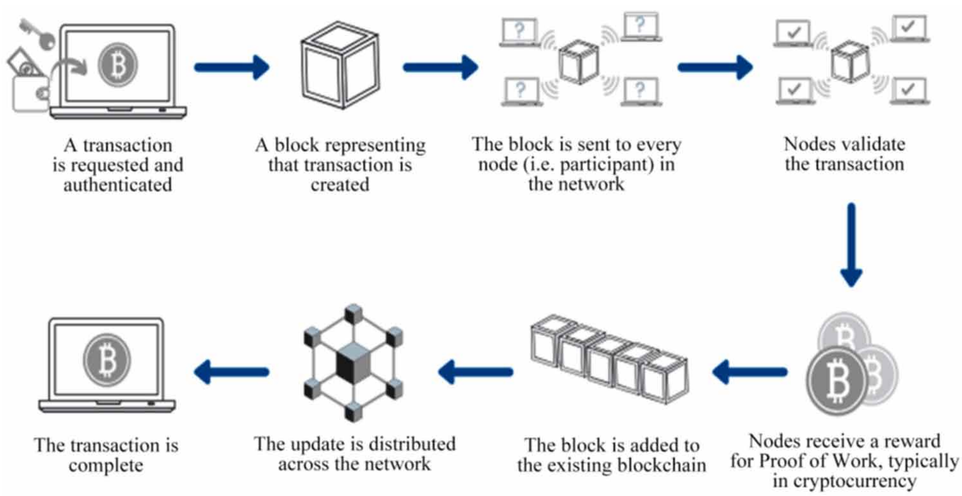
- **Decentralized power:** Blockchain allows the use of distributed ledger, meaning that anyone who becomes a part of the supply chain has the authority. So, the centralized authority gets distributed to everyone who joins the chain.
- **Public Ledgers:** In a blockchain network, the ledger becomes public against the current banking system where the ledger is private. Therefore, members of blockchain networks get an updated copy of their complete transactions immediately after signing up. Thus, the records are fully secure.
- **Immutable to Hacks:** The blockchain system has a structural format that prevents the transactions performed from being manipulated.
- **No Double spending:** The Blockchain system is structured to tackle double-spending.
- **No or minimal transaction cost**: Blockchain networks do not accommodate intermediaries to perform the transactions, resulting in zero transaction cost or a minimal fee.

Blockchain -Operational Roadmap

It's imperative to understand the way blockchain technology works which is the backbone of cryptocurrencies like Bitcoin (see Figure 1).

When a member of the blockchain network intends to execute a transaction, for instance, transferring a sum of money to another member of the same network, it creates the information of the transaction in a new block. There are miners in the network whose duty is to verify and validate the transactions. The validated transactions, that is, the blocks created, are distributed to all members on the blockchain. In this process, only the details of transactions are recorded and shared. No one can find the balance of amount in members' accounts explicitly. The transaction gets complete once validated by the miners. The system distributes the updated record of the transactions to all members. If the transaction information is wrong or altered, it does not match the records held by other members. Thus, validation will fail, and the transaction will not be processed.

Figure 1. Operational roadmap of |blockchain technology
Source: *https://doi.org/10.4236/jsea.2021.147018*



BLOCKCHAIN TECHNOLOGY IN INSURANCE: ADAPTABILITY

Blockchain technology has been introduced into the business sector to ease the trouble of entering data twice in most transactions (Kalsgonda and Kulkarni, 2020). For instance, in the insurance industry in India, it is common to find that the insured procures insurance through an agent who will, in turn, buy the policy from the Insurance firm, which means that the insured must keep the documents safe to be able to claim in the event of a mishap a process which gain involves the agent. Without the documents, claims will not be processed, and it usually takes a long time; in some cases, fraud is inevitable. The use of blockchain in these insurance transactions is expected to benefit society by keeping the documents intact and having claims processed quickly. Kalsgonda and Kulkarni (2020) claim that the technology aims to secure the documents process the claims at an accelerated speed and make the whole process cheaper, and more efficient. Mobile applications are being utilized for processing these claims, with as much as ninety-eight percent of life insurance policies being sold directly (Sangani n.d). Virtual branches are being set up taking advantage of artificial intelligence (AI), enabling agents to market the correct policies to the intended markets. Singh (nd) reports that an annual loss in the region of US$80 billion is suffered in the insurance industry, and a portion of that is a result of manual entry errors. A regulatory and legal framework for the operations of the blockchain is suggested by Afroz (nd), and this will give guidelines on all legal matters and the operational procedures of insurance from the point of buying a policy, during its life, and eventually the cession stages for life insurances.

Blockchain Insurance Industry Initiative (B3i) was launched in 2016 to improve and examine data exchange among insurance firms, including reinsurance companies (Amponsah et al., 2020). A blockchain application system that could detect fraudulent entries has been developed by Dhieb (nd) and can predict clients' future behaviors. There has been a recent development in which a proposal has been advanced to track vehicle insurance while identifying fake insurance proofs (Demir, nd). Amponsah, Adekoya and Weyori (2020) posit that it is a challenge in the insurance industry to identify counterfeit documents in a fight to eradicate bogus clients. Insurance assists people if they have faced unexpected mishaps to the assets they would have insured, and as such, they will receive some payment to soften their pain (Sharifinejad, Dorri and Rezazadeh, 2020). This process involves massive paperwork associated with inefficiencies and slow speed (Amponsah et al., 2020). The nature of business in insurance depends much on the principles of utmost good faith and trust, and as such, partners in the chain have no chance to examine again what would have been brought into their hands by upstream partners (Guo, Qi, Xian, Wu, Yang, Zhang & Wenyin).

GENERAL BLOCKCHAIN INSURANCE BENEFITS

Blockchain can adversely reduce the process of creating, accepting, and facilitating claims within the shortest possible time in an effortless manner which is evident to all (Mainelli and Manson, 2016; Huckstep, 2016; Nath, 2016; Xu et al., 2020; Liu et al., 2019). Transparency and visibility brought about by blockchain make it possible for partners to re-examine and audit claims. The Federal Burau Investigation (FBI) has noted that over $40 billion annually is lost through fraud (Lorenz et al., 2016; Tarr, 2018), resulting in increased costs for policyholders and insurance firms. This act involves insiders who manipulate the system for financial gains. The use of blockchain technology in insurance makes it difficult for fraudsters as the visibility to all partners allows them to trace and track the originality of statements whose entries are hard to alter (Nath, 2016; Wahlstrom, Skog and Handel, 2015). People's virtual identification is now in place to identify who they are and verify their true identities electronically (Lee, 2017; Lemieux, 2016). Correct identification of people is vital in insurance as lack of proper identification may open doors for fraudulent cases (Lamberti et al., 2018). With the blockchain technology in place in the insurance business, it becomes difficult for anyone who intends to defraud firms to alter any previously entered data related to beneficiaries. Blockchain technology increases data authenticity and integrity, thus preserving the image of the sector as well and at the same time creating confidence in the mind of those who already have registered with insurance companies as well as potential clients.

Data sharing has become the norm of the business in the 21st century, given the need to quickly respond to different needs and requests by both business partners and end-users of company products and services. Therefore, it is inevitable that this development is absorbed in the insurance industry. Nath (2016) posts that such intercompany connections are associated with deliberate attempts at siphoning its coffers' system. Deliberate attempts have been made in the insurance industry to make considerable investments to identify and inform stakeholders of any attempts to defraud the system (Amponsah et al., 2021). Insufficient and correct information coupled with visible and transparent procedures, including legal processes, has hampered the acceptance of digital technology in the insurance industry (Vakilinia et al., 2018; Lepoint, Ciocarlie and Eldefrawy, 2018).

The concept of Peer-to-peer is a widely accepted insurance model in which money is pooled together by members of a family, friends, or colleagues with the advantage of lower insurance premiums (Amith K.V., Prasad A. and Rajashekara M. S, 2019). At the end of a period, usually a year, money that would not have been used will be returned to the members. The emergence of peer-to-peer (P2P) insurance has brought some great relief and advantages to likeminded clients whose needs and interests can be grouped to manage these at once. A notable advantage that has been brought about by P2P insurance is the reduction in expenses associated with the management of policies, re-insuring policies, and processing payments using reserves (Amponsah et al., 2021). The use of blockchain technology has seen a massive reduction in paperwork related to these transactions (Pritzker, 2020), and all these gains have been achieved using a mobile application, facilitating filing claims and processing payments in less costly and fast methods (Amponsah et al., 2021). Amponsah et al. (2021) points out that the characteristics of P2P insurance are connected to the characteristics of blockchain technology, including the ability of an application to be decentralized, provision of speed, and ease of use.

PITFALLS OF THE CURRENT TRENDS IN THE INSURANCE SECTOR

The traditional approach in the insurance industry was to have a middleman who would provide several services, from the initial sale and promotion of insurance policies to timely and speedy processing of the required documentation for claim purposes. Even though the presence of the middlemen in these transactions offered value, bottlenecks such as the duration taken to process claims could not be underestimated. Blockchain technology's architecture has seen the elimination of the middlemen facilitated by including an algorithm that permits peers to share information among themselves. Claims approval time is extensively reduced by using such a blockchain application; nevertheless, much trust is required amongst users. Money laundering is prevented in the insurance industry by encouraging brokers, insurers, and reinsurers to know their clients thoroughly. A know-your-customer and anti-money-laundering mentality and approach are encouraged in the insurance sector.

Amith, Prasad, and Rajashekara (2019) point out that in vehicle insurance, two concepts have been introduced, namely Pay-As-You-Drive (PAYD) and Pay-How-You-Drive (PHYD). Telematics is fitted on the car, and they give real-time information on the driver's behavior as s/he maneuvers the vehicle. Blockchain technology is incorporated into these insurance concepts to facilitate efficiency, transparency, and security during the policy's tenure. Once data about the patterns of a vehicle has been stored using blockchain technology, it becomes problematic if not difficult for anyone to make some alterations to the insurance information. A number of benefits have been indicated by Amith, Prasad, and Rajashekana (2019), and these are listed below:

- Decentralization of the system ensures transparency and lack of control by one party
- Defaulters are eliminated as the system demands premiums promptly
- The repair of vehicles is fast as claims automatically trigger the process
- Owners automate premiums
- No single point of failure
- Optical character reader has replaced papers
- The implementation can be efficient
- Fraudulent companies are eliminated from the system

The Federal Advisory Committee on Insurance (FACI) on the 5th of January 2017, in its quarterly meeting, pointed ten things about blockchain technology:

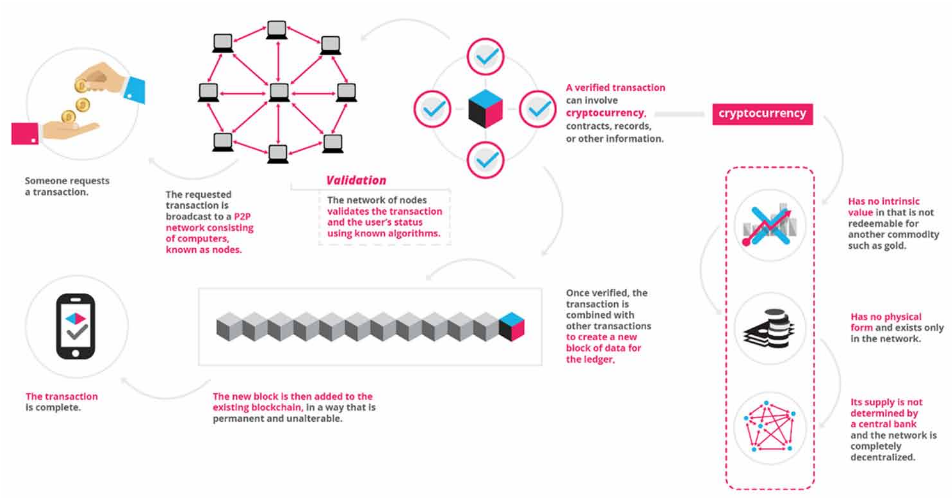
- Blockchain technology is an emerging and promising technology that has far-reaching consequences of efficiency and high security
- This technology is being applied across all industries even though it is still young
- Momentum is being gained in the investment towards blockchain technology
- Seventy percent of financial organizations are still in the experimentation stages of the use of the technology
- Collaboration of partners is vital for the success of the investment
- Value creation is possible even though the feasibility differs across the sector
- Blockchain is no silver bullet solution for all the pain points in the industry
- Collaboration, regulatory environment, and transparent business cases are crucial to justifying the move
- Full potential can be reached within five years if organizations are prepared to overcome these challenges
- Value can be unlocked through a five-step journey: Education, Strategy, Solution Design, Implementation, and Approach.

From Figure 2, it is understood that the term 'blockchain' in Blockchain Technology emanated from the concept of connected blocks using a hash of previous input of information. These blocks will be a chain of ledger distributed publicly and can be verified, shared in addition to possessing immutability characteristics. Blockchain technology facilitates the storage and tracing of transactions in the cooperate connection (Amponsah et al., 2021). Those who participate in chains can input new transactions, but they cannot in any way alter previously fed information into the system. Peer-to-peer connections are facilitated by a series of nodes that individually keep a copy of the chain at a local level. In insurance, the assets listed and covered include houses, cars, cellphones, bonds, title deeds and can be transferred from one peer to the other privately and securely.

A six-step approach as to how blockchain works suggested by McKinsey and Company is as follows:

- Creation of electronic messages
- The message is sent to distribution nodes with unique crypto signatures
- Economic race to validate the transaction
- Confirmation broadcast to the rest of the network
- Block is added to all the distributed ledger copies
- The network replicates record of verified transactions

Figure 2. Blockchain technology in insurance industry
Source: *(https://www.bing.com/images/search?q=clipart+of+blockchain+in+insurance&id)*



From Figure 3, one can understand that fraud is a phenomenon associated with traditional insurance because of several loopholes that may include the duration it takes to process claims. The length duration it takes usually disappoints the insured, who will connive with repair companies to inflate. However, the coming in of blockchain technology will disappoint the insured because verification is done by other people who are anonymous in the system. Policies are created quickly, and everything is decentralized to fast-track the process and streamline interactions among peers. Insurance that can be taken in blockchain include vehicles, houses, and other movable properties. The technology also permits re-insurance of these assets, thus allowing all valuable assets to be on the network (Atlam et al., 2018).

There are ten ways Blockchain will disrupt the insurance sector.

- Fraud Prevention
- Policy creation and claims processing
- Streamlining routine interactions
- Risk prevention
- On-demand Insurance
- Property and Casualty Insurance
- Reinsurance
- Microinsurance
- P2P Insurance
- Parametric Insurance

Figure 3. Ten ways blockchain will disrupt insurance
Source: *https://www.bing.com/images/search?q=clipart+of+blockchain+in+insurance&id*

CHALLENGES OF BLOCKCHAIN NETWORKS-ADOPTION BARRIER OF BLOCKCHAIN IN THE BANKING AND INSURANCE SECTOR

Blockchain technology is undoubtedly the future solution for the banking industry to sustain efficiently. However, the banking sector faces challenges while adopting blockchain technology on a large scale. Wide adoption of the technology needs to address some of the significant issues. The risk of international jurisdiction, scalability, protection of data privacy, and consumer rights protection are crucial. However, there are ways to overcome such barriers. Like any other technology to ease human tasks, blockchain has its shortcomings in its use in insurance services.

§ *Blockchain technology finds it difficult to scale with ease, and this challenge may lead to centralization as the number of connected nodes goes up (Atlam, Alenezi, Alassafi & Wills, 2018).*

§ *Hardware and software used by different peers in the chain are hardly the same, making compatibility difficult. Other algorithms apply to different hardware computers, and therefore it will be a complete fallacy and misinformation to expect the different nodes to work at the same speed (Torkaman & Seyyedi, 2016).*

§ *More space is required in the long run as nodes can only keep a sizable quantity of ledger, and when that takes place, even the speed of processing transactions will be affected adversely.*

§ *Skilling must know how the blockchain works, and educating the public is a challenge (Bafana, 2017).*

§ *Connections can be made possible from different countries, but that poses the challenge of which state will preside over a case in the event of a misunderstanding between the parties or which country's regulations should be followed if the rules are different (Asatryan, 2017).*

FRAMEWORK TO OVERCOME THE PITFALLS OF THE CURRENT TRENDS OF THE BANKING AND INSURANCE SECTOR

The chapter suggests possible ways to overcome the barriers of adopting the blockchain networks in the banking and insurance sector to reap the maximum benefits of digital disruption, considering the new challenges.

Blockchains should be used by partners in the same country or region with the same legal systems to avoid misunderstandings and have reasonable solutions to litigation cases, which calls for continued dialogue with regulators. This may also build on the law or regulation that partners must be within the same jurisdiction and practice the same legal systems in business transactions. There is a need to continue educating the public about how blockchain technology works and not neglecting employees of insurance companies. Further, the following suggestions are noteworthy:

- **Risk of international jurisdiction:** when there is no single universal law regulating the functions of blockchain as the spectrum of which is spread across international borders, the trustworthiness, privacy of data, and consumer protection are at high risk. Bringing the international tech giants involved in providing blockchain solutions, like IBM, to a consensus to frame an international regulatory body to govern the international adaptability can address the cross-border risk in blockchain technology. According to the decentralized financial technology company -RippleNet (2014), a vital nexus among the global financial solution providers is recommended to bring a technology disruption to many industries through blockchain.
- **Scalability:** There is no scope for broader adoption of blockchain technology in all services areas as it involves huge capital expenditure and the support of technical know-how, which is not affordable to many financial institutions. However, banks can facilitate E-identity to provide a broad scope of application. Further, maintenance of distributed ledgers of current assets by the central bank or the regulating authority offers an extended scope for blockchain technology.

- **Protection of data privacy:** Adoption of a single international law for regulating the spectrum of blockchain will protect the privacy of the parties' information.
- **Protection of consumer rights:** An international legal framework that governs cross-border transactions must protect consumer rights.

INTERNATIONAL REGULATORY FRAMEWORK

One can understand that every technology has challenges, either regulatory or software application for international transactions. Blockchain is not an excuse. Thus, the formation, innovation, and development of international standards for proving solutions to these challenges are essential. According to Marina and Koulouri (2018), a voluntary international legal framework is necessary to connect the international community in applying blockchain technology. The following principles or standards are suggested to be parts of the international framework to resolve the cross-border issues on the blockchain technology application.

1. Definition of Terms: Terms with multiple meanings involving the legal frameworks of different countries, legal rights, etc., need to be understood in the same way by all members and its applicability, and the impact should be well defined.
2. Clarity on the application framework: Clarity of the challenges, range of application, and the legal approach to resolve the issue are essential in applying the technology. So that members in the supply chain can understand the issue and how to resolve the issue.
3. Scope of applicable regulatory standards: the international framework should assist the application of national regulations when something illegal is found in the cross-border transaction in the Blockchain. For instance, if there is a fraud or misrepresentation of facts by any member in the chain, this should attract the local law governing such fraudulent acts as well.
4. The international jurisdiction of laws: It is essential to draw the jurisdiction to apply the international law of blockchain technology governing cross-border transactions.
5. Privacy and Security: The framework should accommodate specific principles for identifying public and private keys to provide the desired security and privacy framework.
6. Risk Mitigation: A mechanism for international dispute resolution is to be operational in the framework to mitigate the risk associated with international transactions, which helps to expand the universal application of the technology.

CONCLUSION

The chapter comprehends the adaptability of blockchain networks in the banking and insurance sector to understand and overcome the pitfalls of the current centralized financial system. Businesses, information, and financial solutions are inseparable elements. Thus, a foolproof nexus established by blockchain technology disrupts the banking and insurance sector worldwide. Blockchain technology assists the banking and insurance sector to bring about a significant digital transformation in their operational systems. Transactional security is a significant threat with the obsolete conventional systems, which forces the adoption of blockchain technology, reducing cost, time, and effort in the operational management of these industries by ensuring security and transparency. However, there are stills areas of concern like international regulation to govern the networks used by members across different countries to protect consumer rights, scalability in the adaptability of blockchain technology in the banking and insurance sector.

REFERENCES

Amponnsah, A. A., Adekoya, B. A., & Weyori, F. A. (2021). Blockchain in Insurance. Exploratory Analysis of Prospects and Threats. *International Journal of Advanced Computer Science and Applications*, *12*(1), 445–466. doi:10.14569/IJACSA.2021.0120153

Biais, B., Bisiere, C., Bouvard, M., & Casamatta, C. (2019). The Blockchain folk theorem. *Review of Financial Studies*, *32*(5), 1662–1715. doi:10.1093/rfs/hhy095

Blockchain: Practices and perspectives-Conference at UNESCO Headquarters. (2019). https://www.fmsh.fr/en/projects/blockchain-practices-and-perspectives

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*.

Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How blockchain can impact financial services. The overview, challenges and recommendations from expert interviews. Elsevier Public Health Emergency Collection. 1011016/j.techfore.2020.120166.

Chowdhury, M. U., Suchana, K., Alam, S. M. E., & Khan, M. M. (2021). Blockchain Application in Banking System. *Journal of Software Engineering and Applications*, *14*(07), 298–311. doi:10.4236/jsea.2021.147018

CNN Business Report. (2016). *ATM and overdraft fees top $6 billion at the big 3 banks*. Accessed from https://money.cnn.com/2016/01/14/investing/atm-overdraft-fees/index.html

Cong, L. W., & He, Z. (2019). Blockchain disruption and smart contracts. *Review of Financial Studies*, *32*(5), 1754–1797. doi:10.1093/rfs/hhz007

DiNizo Jr. (2018). *From Alice to Bob: The Patent Eligibility of Blockchain in a Post-CLS Bank World*. https://scholarlycommons.law.case.edu/jolti/vol9/iss1/29

Eyal, I. (2017). Blockchain Technology: Transforming Libertarian Cryptocurrency Dreams to Finance and Banking Realities. *Computer*, *50*(9), 38–49. doi:10.1109/MC.2017.3571042

Fyrigou-Koulouri. (2018). *Blockchain Technology: An Interconnected Legal Framework for an Interconnected System*. Available from: https://www.forbes.com/sites/bernardmarr/2018/02/19/the-5-big-problems-with-Blockchain-everyone-should-be-aware-of/#20420e951670

Guo, Y., Qi, Z., Xian, X., Wu, H., Yang, Z., Zhang, J., & Wenyin, L. (2019). WISChain: An Online Insurance System based on Blockchain and DengLu1 for Web Identity Security. *Proc. 2018 1st IEEE Int. Conf. Hot Information-Centric Networking, HotICN 2018*. https://101blockchains.com/blockchain-for-insurance/Alhamra

Huckstep, R. (2016). *What does the future hold for blockchain and insurance?* Available online at https://dailyfintech.com/2016/01/14/what-does-the-future-hold-for-blockchain-and insurance/unpublished

International Chamber of Commerce (ICC). (2017b). *ICC hails entry into force of WTO Trade Facilitation Agreement.* ICC News. Retrieved from https://iccwbo.org/mediawall/news-speeches/icc-hails-entry-force-wto-trade-facilitation-agreement-watershed-momentworld-trade/

Kalsgonda, V., & Kulkarni, R. (2020). Application of Blockchain in Insurance Industry: A Review. *PIMT Journal of Research*, *12*(4), 1–3.

KimH.MeharM. (2019) Blockchain in Commercial Insurance: Achieving and Learning Towards Insurance That Keeps Pace in a Digitally Transformed Business Landscape. SSRN Electron J. doi:10.2139/ssrn.3423382

Kosba, A., Miller, A., Shi, E., Wen, Z., & Papamanthou, C. (2016). Hawk: The Blockchain model of cryptography and privacy-preserving smart contracts. *Proceedings of the IEEE Symposium on Security and Privacy (SP)*, 839–858.

Lemieux, V. L. (2016). Trusting records: Is Blockchain technology the answer? *Records Management Journal*, *26*(2), 110–139. doi:10.1108/RMJ-12-2015-0042

Lepoint, T., Ciocarlie, G., & Eldefrawy, K. (2018). BlockCIS - A blockchain based cyber insurance system. *Proc. 2018 IEEE Int. Conf. Cloud Eng. IC2E*.

Li, Z., Xiao, Z., Xu, Q., Sotthiwat, E., Mong Goh, R. S., & Liang, X. (2018). Blockchain and IoT Data Analytics for Fine-Grained Transportation Insurance. *IEEE 24th International Conference on Parallel and Distributed Systems (ICPADS),* 1022-1027. 10.1109/PADSW.2018.8644599

Liu, J. L., Wu, X. Y., Yu, W. J., Wang, Z. C., Zhao, H. L., & Cang, N. M. (2019). Research and design of travel insurance system based on blockchain. *4th Int. Conf. Intell. Informatics Biomed. Sci.*

Lorenz, N., Münstermann, J. T., Higginson, B., Olesen, M., & Bohlken, P. B. (2016). *Blockchain in Insurance-Opportunity or Threat? McKinsey & Company*.

Lounds, M. (2020). *Blockchain and its Implications for the Insurance Industry*. Unpublished.

MainelliM.MansonB. (2016). *Chain reaction: How blockchain technology might transform wholesale insurance*. https://ssrn.com/abstract=3676290

Meiklejohn, S., Pomarole, M., Jordan, G., Levchenko, K., McCoy, D., Voelker, G. M., & Savage, S. (2013). A fistful of bitcoins: characterizing payments among men with no names. *Proceedings of the ACM IMC 2013*, 127–140. 10.1145/2504730.2504747

Nath, I. (2016). Data Exchange Platform to Fight Insurance Fraud on Blockchain. *IEEE Int. Conf. Data Min. Work. ICDMW*.

Patwardhan, A. (2014). *Blockchain – A disruptive force for good?* Available at: https://www.linkedin. com/pulse/blockchain-disruptive-force-good-anju-patwardhan?trk=mp-reader-card

Pilkington, M. (2016). *Blockchain technology: principles and applications*. *Research Handbook on Digital Transformations*. doi:10.4337/9781784717766

Popova, N. A., & Butakova, N. G. (2019). Research of a Possibility of Using Blockchain Technology without Tokens to Protect Banking Transactions. *2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus),* 1764-1768.

Price, D. (2018). *5 Big Blockchain Issues: Security, Privacy, Legal, Regulatory, and Ethical*. Available from: https://blocksdecoded.com/Blockchain-issues-security-privacy-legal-regulatory-ethical/

Pritzker, S. (2020). *Everything You Need To Know About Peer-To-Peer (P2P) Insurance*. Unpublished.

Raikwar, M., Mazumdar, S., Ruj, S., Sen Gupta, S., Chattopadhyay, A., & Lam, K. (2018). A Blockchain Framework for Insurance Processes. *2018 9th IFIP International Conference on New Technologies, Mobility and Security (NTMS),* 1-4. 10.1109/NTMS.2018.8328731

Ripple. (2014). *The Ripple protocol: A deep dive for finance professionals*. Available at: https://ripple.com/ files/ripple_deep_dive_for_financial_professionals.pdf

Sangani, P. (n.d.). *India's insurance industry is improving efficiency through the use of new-age technology*. https://economictimes.indiatimes.com/industry/banking/finance/insure/indias insurance-industry-is-improving-efficiency-through-the use-of-new-age technology/articleshow/70902516.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Sharifinejad, M., Dorri, A., & Rezazadeh, J. (2020). *BIS-A Blockchain-based Solution for the Insurance Industry in Smart Cities*. arXiv.

Singer, A. W. (2019). *Can Blockchain Improve Insurance? Risk Management Studies in Indian Place Names*. archives.tpnsindia.org

Suichies, B. (2016). *Why blockchain must die*. https://www.linkedin.com/pulse/whyblockchain- must-die-2016-bart-suichies?trk=prof-post

Tarr, J.A. (2018). Distributed ledger technology, blockchain and insurance: Opportunities, risks and challenges. *Insur. Law J.*

Vakilinia, I., Badsha, S., & Sengupta, S. (2018). Crowdfunding the Insurance of a Cyber-Product Using Blockchain. *9th IEEE Annu. Ubiquitous Comput. Electron. Mob. Commun. Conf. (UEMCON)*. 10.1109/UEMCON.2018.8796515

Varma, J. R. (2019). Blockchain in Finance. *The Journal for Decision Makers*, *44*(1), 1–11. doi:10.1177/0256090919839897

Werbach, K. (2018). Trust, but verify: Why the blockchain needs the law. *Berkeley Technology Law Journal*, *33*, 487–550. doi:10.15779/Z38H41JM9N

Xu, J., Wu, Y., Luo, X., & Yang, D. (2020). Improving the Efficiency of Blockchain Applications with Smart Contract based Cyber-insurance. *IEEE Int. Conf. Communication*. 10.1109/ICC40277.2020.9149301

Zetzsche, D. A., Buckley, R. P., Arner, D. W., & Barberis, J. N. (2017). From FinTech to TechFin: the regulatory challenges of data-driven finance. SSRN *Electron. J.*, (6), 1–36. doi:10.2139/ssrn.2959925

Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352–375. doi:10.1504/IJWGS.2018.095647

Chapter 11
Blockchain Technology in Digitizing Bancassurance:
A Theoretical Perspective of Prospects and Confronts in India

Diksha Verma
Chandigarh Group of Colleges, Landran, India

Pooja Kansra
Lovely Professional University, Jalandhar, India

ABSTRACT

Bancassurance was initiated as a supplementary medium for dispensing insurance-related products and services. The proposal was to make certain auxiliary profits for banks exclusive of the necessity to inculcate extra funds in a period when restrictions were under force and credit off take was unresponsive. Insurance firms thus had the time to amplify the market penetration for them. On the other hand, online and cybernetic intrusion in the banking sector and the inception of Bancassurance were nearly associated. The chapter will emphasize the need for a customer-centric approach and recognize the tactic desired for giving a boost to the Bancassurance business model through innovations and intensification of the digital infrastructure of banks. The recommendation is that rather than solely relying on digital, Bancassurance will benefit from the flawless amalgamation of omni channels (digital and physical) to contact customers.

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INTRODUCTION

Bancassurance simply refers to sale of insurance through bank. Both banks and insurance companies are in win-win condition under the scenario of Bancassurance. After having around 92,114 local offices in India, penetration level of life insurance in India was just approximately 2.82 percent and non life was too low around 0.92 percent according to a survey in 2019. The Indian insurance sector is a massive industry which is waiting for the potential prospect to exploit. In spite of the fact that India is second largest country in world in terms of population still the penetration and density of insurance is extremely low this is around 2 percent in total (Kumar & Senthil, 2017). The preamble of Bancassurance in banking sector was the leading contribution of the era in the financial industry. For satisfying the customer's needs, Bancassurance is adding its role by developing new insurance products according to customer's needs and intensifying the competitive atmosphere. Along with the phase that needs development in Bancassurance service, bankers are also intending to offer the products that include innovativeness for satisfying customer needs as well as aiding the customer for economic learning development and digitalization (Elda, 2018).

Indian insurance market is the fastest growing market in the financial industry. When the main bread earner is not able to hold up the responsibilities of the ancestors then the reparation which is provided is the foremost thought behind the concept of insurance and banks are the major contributors in this field nowadays. Bancassurance is the widespread model of dispersion of insurance among the customers. Along with this, insurance and banking industry is also adapting itself to the digitization part and trying to adopt artificial intelligence. Insurtech is the new term under the scope of Bancassurance in which the huge stand-alone digital startups especially for insurance gain seed funding from the potential financier and are simultaneously applauded outside India (Relan, 2020).

Block chain know-how as well as its progress in the financial zone are reliant on rules and regulations which basically influence how remote and how hasty the technology grows, and regulatory bodies will require to implement its novel courage beside the possibility of unintended general perils to the economic arrangement (Yeoh, 2017). Analysis of the development of Bitcoin and several crypto currencies has quietly led to superior center of attention on the theory of dispersed Block chain catalog (English et al., 2016).

Majority of the literatures have proven that block chain technology has the potential and prospective for various beneficial arrangements. Although various studies have not thoroughly explained about prospects and confronts of block chain technology especially in digitization era. Insurance itself needs a noteworthy management for its customers or policy holders, underwriters, regulatory bodies and alleges dispensation (Brophy, 2019). Many published works have innovatively focused on insurance perspective with block chain but till now no such work have been conducted so far for block chain and digitization of Bancassurance.

HISTORY OF BLOCKCHAIN TECHNOLOGY

Numerous literatures exist on Block chain technology as this concept is now not as such latest. Block chain technology was formerly originated to support its innovativeness in the fields of economics and crypto currency and now it is getting bigger and higher in various other sectors as well including the insurance and banking sectors. Through succession at global level and increase in prying for the concept, it becomes easy to presage the prospects and confronts of Block chain technology.

Block chain is a disseminated ledger know-how which is basically used for maintenance and preservance of number of transactions proficient in an organization (Lord, 2016). All digital or computer reliant transactions are can be authenticated by various peer systems working at the same level and also on the same network as they are connected with each other through internet and cloud computing; hence they have access of all the records (Hackett, 2016). The process of making a chain of prior block information with the new-fangled block information is called technology of block chain (Oberoi and Kansra, 2021).

Evolution of Bancassurance

The concept of Bancassurance was introduced in Europe for the very first time. When Government of India issued a notification under Banking Regulation Act, 1949 for allowing banks to sell insurance, it was launched in India as well. The basic idea behind ingression of this system was providing insurance services to the existing bank customers as well as potential customers without adding any extra capital. Bancassurance is explained as the indemnity creation deliverance model through which the insurance service is channelized through the bank's system to the customers of the bank (tinted by McGoldrick and Greenland, 1994).

In order to survive the tough competition and creating a dynamic environment, banks felt the need to opt new technological advancements so that needs of the customers could be satisfied as well as the market standing should not get affected. Therefore, the insurance organizations apprehended the call for generating cutthroat innovative associations that can escort them to devise diverse fresh canal in addition to compel technical modernization. The companies observed that for surviving in this spirited atmosphere there is a requirement to buckle up and cross the threshold into locked association and novel joint ventures. Consequently the ideas of alliances get nearer to execution (Relan, 2020).

Digitization of Bancassurance

Digitization of Bancassurance has made the possibilities for the customers to buy insurance products without taking in to consideration the cash transactions. Now the era of cashless and digitalized nation has made the insurance sellers and buyers to sell and buy the policy through this mode only. The purpose of modernization is to lessen the duty evasion, to battle in opposition to forged currency plus false annotations etc. Customers also feel safe as they have their details with bank and for availing insurance service they don't have to share their details with any third stranger party. This is essentially the foremost advantage of Bancassurance approach while other channels don't have this benefit with them (Kumar & Senthil, 2017).

Blockchain and Bancassurance

Block chain needs a united concord for the changes required. If a banker wants to change certain information of the customer then the changes made will be acknowledged by mass of the members of block chain. With this it would be possible to prevent majority of human errors as well as deceptions. With the facilitation of block chain it would turn out to be extremely effortless for the insurance sellers to surface the manner for safe, secure and translucent system as well as the pace for the dealings would also amplify. According to Deloitte, joining Bancassurance with block chain will lower the desired labors. Bancassurance has become very successful and popular in Asia. Most of the banks are making efforts to proffer several types of insurance products to their customers such as life insurance, home insurance, car insurance etc. In spite of its popularity, Bancassurance has been very slow in its processing. Keeping in mind this issue China Construction Bank has urbanized its first block chain facilitated Bancassurance model. By implementing block chain with Bancassurance, the exploitation time of policies have been lowered (Levdikova, 2020).

Looking behind the concept of crypto currency, it could be observed that the existence of block chain has only made it possible. By using cryptography in bitcoin there is less need for an outside party to record transactions as it could be possible by the automated system only by allowing ledgers to get synchronized after verification with the help of an algorithm. Some points which clarify the concept of block chain behind its execution along with insurance have been explained in various literatures. Due to its exclusive and constructive characteristics, it could be concluded that block chain with bancassurance has been working efficiently. Although block chain is a complicated technology yet its basic purpose is simply defined *i.e.* providing accurate and authentic records. With block chain technology, a copy of dynamically updated ledger could be created and the data in all the copies of the ledger would remain same, devoid of even an essential admistrator and master edition (Brophy, 2019).

Prospects of Block Chain in Digitizing Bancassurance

Digitization of bancassurance is a win-win strategy for banks as well as customers. It has the potential to diminish the mistakes that used to occur in spite of human hard efforts. With the introduction of Block Chain in Bancassurance, it has become much effortless for the parties to trust banks for insurance purposes. Various prospects of Block Chain technology has been discussed further.

Scam Discovery with Threat Avoidance

Block chain has the prospective to eradicate fault, carelessness and sense deception by giving a decentralized online depository to autonomously authenticate the genuineness of consumers, guidelines and claims (along with an absolute essential deal history). Due to this the role of third party is replaced, it also prevents fraud and double transaction for an authentic record of the transactions. Many insurers are already in practice to make block chain applicable in their premises for adopting public ledger and encrypted personal information of the customers as well as reduce the frauds.

Online Grievance Administration

Insurers are staring afar from algorithmic scam exposure to institute a claims model that is claims-centric and also customer focused. This claims administration is pedestal on belief, defeat anticipation, alleviation and reinstallation. For prevention of claims they are looking forward to combination of novel online technologies and also big data to augment the process of tasks including risks and analytics. By means of cellular phone cameras as substantiation to make data move more timely, trim down thrashing adjuster expenses and enlarge client pleasure. Along with this, employing mobile and internet technologies in the happening of natural disaster in remote area aids by recovery for every sufferer.

Authenticity for Decisions

Implementation of block chain in insurance sector assures sincerity; therefore conclusion can be made quicker and in complete assurance. The most important development in this area is the Telematics or the quantity of statistics engendered by M2M events developed from a multiplicity of distant piece of equipment. Motor insurance is one of the ways through which huge quantity of innovation data and opportunities are created. Block chain technology is to be expected strong innovations and inventions in micro-insurance and micro-finance. These types of line to line networks will be created for mobile payments for premiums, claims settlement, loans and some other dealings in the insurance sector. It will try to provide authenticated collaborations between customers and bankers. With this type of joining insurers are developing the concept of mobile wallets that are restrictive to their offering.

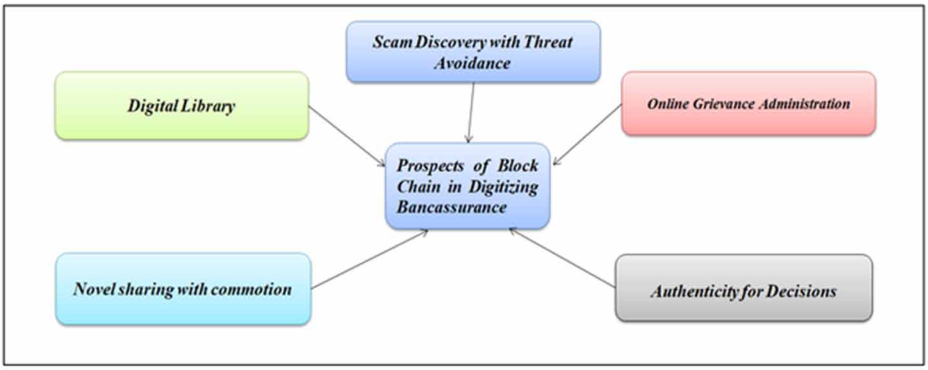
Novel Sharing with Commotion

Top global settled insurance companies are mounting treaties with different business payment models to attain competence with leaders situated at other places so that business could be expanded. Automation in banking and insurance sector facilitates various innovative avenues for upgrading the market knowledge, digital payments and avoids financial risk. Insurers are basically surveying various block chain competences in order to diminish fraud and disturbances. A large global insurer is trying out various experiments with block chain technologies adoption and its efficient uses in real estate, property management and intellectual property for administrating insurance services to their customers in promising and growing markets. Most important insurance adviser has shaped association through telecommunications organizations to frame novel insurance canals. These will hold up latest markets in addition to demographics and moreover impel innovative avenues in digital, virtual and assertions by implementing existent record-keeping.

Digital Library

Block chain has one more aspect for safety experts in which an association of digitally enabled assets and arrangement of data points, routers, knobs, binaries etc. will be carried out in order to provide a network that could be authenticated autonomously and in factual time period. There are numerous examples of existence of Bancassurance companies that has adopted block chain which are like Bitcoin waller service, BitGo, Coinbase, BTC Delta etc. There is expectation of novel gesture of investment into suitable products that would be modified to combat with quantifiable proposals to digitally enabled risk or threat.

Figure 1.
Source: Author's compiled model based on literature review



CONFRONTS OF BLOCK CHAIN IN DIGITIZING BANCASSURANCE

The execution of block chain ought to be measured beneath assured circumstances. The transactions that includes number of parties and also include mediators that deal needs precise and unchallengeable data of time and day and block chain is the one that propose this solution. Various issues such as retroactive exploitation of the data, different uses of same data, potential competent benefits etc. needs block chain very efficiently and it also results successfully. But there are certain cases where block chain is not an appropriate solution to the problems and it witness certain confront in its implementation with bancassurance. If there are no intermediaries in any transaction or only limited parties are involved in any transaction, insurers will not be able to implement block chain technology for their services. Ascend ability, safety and similarity and evenness are the major confront or the challenges that banking and insurance company has to face while implementing block chain with bancassurance.

Ascend Ability

Due to existence of harmony based support system and uninterrupted duplications and nonstop and ever growing data storage, ascend ability of block chain is a big challenge for the whole system. Although there are novel, fresh and innovative accomplishments of block chain that ultimately have very less presentation limitations, hasty speed and large quantity data transactions, concurrent information capture also collection of huge quantity data are not the required province of block chain technology especially with bancassurance.

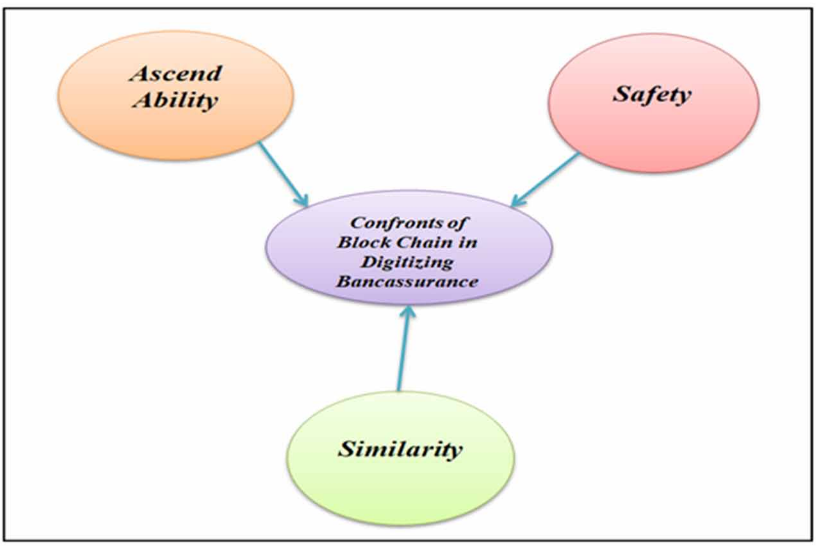
Safety

On the basis of latest researches it has been observed that new types of attacks are on their way in block chain system. These are very less implicit and less alleviate as these were happening in old type of data base infrastructure.

Similarity

In order to observe the regular and consistent benefits, communal with disseminated organization, similarity is enormously serious. The shortage of advantageously practical allusion executions prove that block chain technology in bancassurance is still at its infant stage. Therefore it becomes essential while practicing bancassurance digitally by banks that it should be used carefully.

Figure 2.
Source: Author's compiled model based on literature review



CONCLUSION

The banking sector in India has become difficult in period of progress and fiscal enlargement and also the integer of clients in the banking and insurance sector of the economy. Block chain technology in the coming time will play an important job in advance intensification of the banking and insurance sector. Now the innovative block chain technology is confident that the potential and prospect of banking will commence additional proposals to their customers with the logical banking creation and services. Banking sector has also amplified the convenience of an ordinary man to bank for his needs and requirements. Through digitalization, a novel sharing canal will be formed, therefore Bancassurance will have an augment and boost in the sales of insurance by providing various avenues to the customers of the bank. Various prospects and confronts of digitalization of bancassurance along with block chain have been shown in the chapter through two different models. Basically banks will be providing insurance to its customers in digital mode with more confidence and trust from the customers. Although digitalization of bancassurance has its own prospects but it still have some confronts that make it's counting in infant stage only. Banks are in a constant trial of adapting customers' requirements along with technological innovations.

REFERENCES

Beck, R., Avital, M., Rossi, M., & Thatcher, J. B. (2017). *Blockchain technology in business and information systems research*. Academic Press.

Beck, R., & Müller-Bloch, C. (2017, January). Blockchain as radical innovation: a framework for engaging with distributed ledgers as incumbent organization. *Proceedings of the 50th Hawaii International Conference on System Sciences*. 10.24251/HICSS.2017.653

Beck, R., Müller-Bloch, C., & King, J. L. (2018). Governance in the blockchain economy: A framework and research agenda. *Journal of the Association for Information Systems*, *19*(10), 1. doi:10.17705/1jais.00518

Bosisio, R., Burchardi, K., Calvert, T., & Hauser, M. (2018). *The first all-blockchain insurer.* Boston Consulting Group.

Crawford, S., Russignan, L., & Kumar, N. (2018). *Global insurance trends analysis 2018.* EY Report.

Daley, S. (2019). *Nine companies using blockchain to revolutionize insurance*. Builtin. Accessed on January 2021. https://builtin.com/blockchain/blockchain-insurance-companies

Flovik, S., Moudnib, R. A., & Vassilakopoulou, P. (2021). Determinants of Blockchain Technology Introduction in Organizations: An Empirical Study among Experienced Practitioners. *Procedia Computer Science*, *181*, 664–670. doi:10.1016/j.procs.2021.01.216

Glaser, F. (2017, January). Pervasive decentralisation of digital infrastructures: a framework for blockchain enabled system and use case analysis. *Proceedings of the 50th Hawaii international conference on system sciences*. 10.24251/HICSS.2017.186

Golosova, J., & Romanovs, A. (2018, November). The advantages and disadvantages of the blockchain technology. In *2018 IEEE 6th workshop on advances in information, electronic and electrical engineering (AIEEE)* (pp. 1-6). IEEE. 10.1109/AIEEE.2018.8592253

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems*, *35*(1), 220–265. doi:10.1080/07421222.2018.1440766

Grima, S., Spiteri, J., & Romānova, I. (2020). A STEEP framework analysis of the key factors impacting the use of blockchain technology in the insurance industry. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *45*(3), 1–28. doi:10.105741288-020-00162-x

Hackett, R. (2016). *Wait, what is Blockchain?* Accessed on February 2021, http://fortune.com/2016/05/23/block chain-definition/

Hans, R., Zuber, H., Rizk, A., & Steinmetz, R. (2017). *Blockchain and smart contracts: Disruptive technologies for the insurance market*. Academic Press.

Insights, C. (2019). *Blockchain and Insurance: New Technology*. New Opportunities.

Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analysing blockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, *50*, 302–309. doi:10.1016/j.ijinfomgt.2019.08.012

Johnson, G.L. (2017). Planning the future. Blockchain technology and the insurance industry. Insurance law. *In-House Defense Quarterly*, 73–78.

Lacity, M. C. (2018). Addressing key challenges to making enterprise blockchain applications a reality. *MIS Quarterly Executive*, *17*(3), 201–222.

Liedtke, P. M. (2007). What's insurance to a modern economy? *The Geneva Papers on Risk and Insurance. Issues and Practice*, *32*(2), 211–221. doi:10.1057/palgrave.gpp.2510128

Lord, S. (2016). Bankchain&itBit: Settling on the blockchain. *Modern Trader, 16*.

Oberoi, S., & Kansra, P. (2019). Factors Influencing Medical Tourism in India: A Critical Review. *SAMVAD*, *17*, 9-16.

Oberoi, S., & Kansra, P. (2020). Economic menace of diabetes in India: A systematic review. *International Journal of Diabetes in Developing Countries*, *40*(4), 464–475. doi:10.100713410-020-00838-z PMID:32837090

Oberoi, S., & Kansra, P. (2021). Motivating Antecedents and Consequences of Blockchain Technology in the Insurance Industry. In *Blockchain Technology and Applications for Digital Marketing* (pp. 276–285). IGI Global. doi:10.4018/978-1-7998-8081-3.ch017

Olaf, A., Hagen, H., & Hajj, J. (2017). *2017 Technology trends.* PwC. Accessed on February 2021. https://www.strategyand.pwc.com/ trend/2017-technology-trends

PricewaterhouseCoopers. (2016). *Blockchain in the insurance sector*. Accessed on January 2021, https://www.pwc.co.uk/financial-services/fintech/assets/blockchain-in-insurance.pdf

Relan, M. (2020). Digitalization in the Bancassurance Model of Distribution - Opportunities and Challenges. *Bimaquest, 20*(3). Accessed on December, 2021. http://www.bimaquest.niapune.org.in/index.php/bimaquest/article/view/79

Risius, M., & Spohrer, K. (2017). A Blockchain Research Framework: What We (don't) Know, Where We Go from Here, and How We Will Get There. *Business & Information Systems Engineering*, *59*(6), 385–409. doi:10.100712599-017-0506-0

Schweizer, A., Schlatt, V., Urbach, N., & Fridgen, G. (2017, December). Unchaining Social Businesses-Blockchain as the Basic Technology of a Crowdlending Platform. ICIS.

Siyal, A. A., Junejo, A. Z., Zawish, M., Ahmed, K., Khalil, A., & Soursou, G. (2019). Applications of blockchain technology in medicine and healthcare: Challenges and future perspectives. *Cryptography*, *3*(1), 3. doi:10.3390/cryptography3010003

Thake, M. (2018). *What's the difference between blockchain and DLT?* Nakamo. To.

Woodside, J. M., Augustine, F. K. Jr, & Giberson, W. (2017). Blockchain technology adoption status and strategies. *Journal of International Technology and Information Management*, *26*(2), 65–93.

Chapter 12
Blockchain Technology:
Principles, Applications, and Advantages of Blockchain Technology in the Digital Era

Satveer Kaur
Maharaj Agrasen University, India

Neeru Jaswal
Chandigarh Group of Colleges, India

Harvinder Singh
Maharaja Agrasen University, India

ABSTRACT

The objective of this chapter is to identify the applications of blockchain technology, to discuss the advantages of blockchain technology, and to identify the principles of blockchain technology. It was found from studies that in today's digital era, there are several applications of blockchain technology in the area of finance, voting, real estate, taxation, media, healthcare, food safety, data backup, data storage, and money transfer. Blockchain technology works on principles such as distribution database, transparency, peer-to-peer transmission, computational logic, etc. Moreover, blockchain technology provides several benefits over traditional technologies such as high speed, automation, reduced cost, innovation, enhancement of speed, and building trust, transparency, accuracy, traceability, etc.

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INTRODUCTION OF STUDY

In this digital era, with the advent of modernization of today's lives, Technology is the need of the hour. Now there is an addition to the list of technology as the blockchain technology that came into existence in 2009. First-time blockchain technology was introduced in the form of Bitcoin. Blockchain Technology is the recording of the digital recording of transactions in the public ledger that is transparent and authenticated to everyone through blocks arranged in chronological order. There is no single authority to control the transactions. Every transaction is secured with a digital signature to provide authenticity to transactions (Bogart & Rice 2015). There is also no extra fee for doing transactions through blockchain technology. Blockchain transactions cannot be altered or deleted by anyone unless with the consensus of the parties (Fanning & Centers 2016). There are several types of blockchains such as private, public, and consortium blockchains (He et al., 2016). Public blockchain ledgers can be assessed by anyone everywhere. Private blockchains can be assessed by trusted participants. Consortium blockchains are used by multiple organizations instead of single organizations.

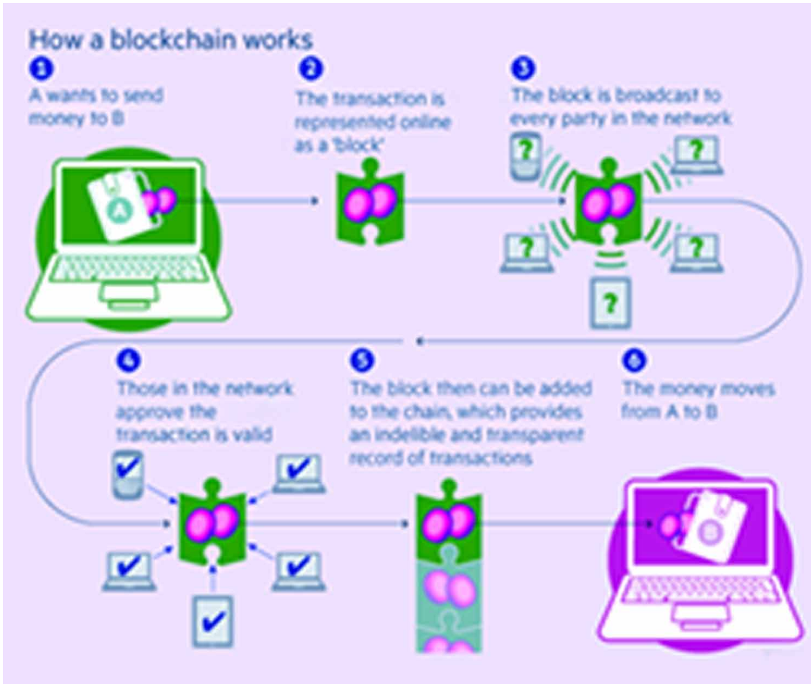
WORKING OF BLOCKCHAIN TECHNOLOGY

The working of block comprises of the following procedure. For example, A wants to send money to B. The transaction between A and B is represented as a block. The block is broadcast to other parties for approval of the transaction. The block added the transaction in the chain if it is a valid transaction and then Money moves from A to B. The working of blockchain technology is shown in Fig: 1.

REVIEW OF LITERATURE

Kitsantas et al. (2019) conducted a study on applications of blockchain technology and found that blockchain technology had applications in the area of Finance, Government, Banking, Business process management. Rawat et al. (2020) had done a study on Emerging Applications and Use Cases for Secure and Trustworthy Smart Systems and found that blockchain Technology had applications in the area of finance, banking, real estate, cyber security, and smart contacts. Kibet et al. (2019) conducted a study on applications and principles and unforeseen issues and found that blockchain technology had applications in the area of finance, cryptocurrency, private data storage, education, banking, taxation, health care, voting, internet of things, and blockchain technology works on principles such as decentralization,

Figure 1. Working of blockchain technology
Source: https://data-flair.training/blogs/working-of-blockchain/



openness, and transparency, independence and unforgeable. Pilkington studied the principles and applications of blockchain technology and found that blockchain technology had applications in the area of finance, voting rights, supply chains, and social inclusion.

OBJECTIVES OF THE STUDY

The study was conducted to fulfill the following objectives:

1. To identify the applications of blockchain technology.
2. To discuss the advantages of blockchain technology.
3. To identify the principles of blockchain technology.

RESEARCH METHODOLOGY

The descriptive research was conducted in this study. The secondary data was used for this study. The secondary data was collected from books, magazines, websites, and research papers related to the application, principles, and advantages of block technology.

APPLICATIONS OF BLOCKCHAIN TECHNOLOGY

In today's competitive scenario numbers of industries were affected by block chain. The impact of blockchain technology can be seen in Government sectors, banking & financial services, Health sectors, and various other business like real estate, supply chain, insurance, etc. Some of the big users of blockchain technologies are:

1. **Processing of payments, money transfer& international payments:** It is currently the most perfect use of blockchain technology. Blockchain technology has increased the pace of transferring funds from one party to another. Maximum transactions carried over by the application of this technology are settled in very little time as compared to banks. It can create a security system for sensitive activities which makes it best for international payments and money transfers.
2. **Supply Chains Monitoring:** With the advent of blockchain technology, paper-based trials have been eradicated enabling business houses to spot inefficiencies within their supply chain on time also detect items in real-time. It helps enterprises and consumers to get an insight into how the product performs from the quality control point of view while moving from producer of the product to retailer.
3. **Digital voting:** Blockchain technology has also changed the way voting is done. It has made it possible to vote digitally and the process is so transparent that every voter can see if some changes have been done with regard to the digital votes on the network. It makes every vote real and countable.
4. **Transfer of Real Estate, Land, and Auto Title:** Since blockchain technology is based on a paperless concept its objective is to do transactions without involving paper. So in transactions of buying or selling of property, land, car blockchain helps in getting titles on its network. This gives a crystal clear view of transfers and legal ownerships.
5. **Food Safety:** Another area where blockchain technology is successfully applied is providing food safety. With the help of this technology, we can easily track the transportation of food products from the place of production to actual consumption.

6. **Data Backup:** It is an ideal application for the storage and backup of data. Other sources like cloud storage systems are also used for the safekeeping of the data but they are insecure from a hacker's point of view and they may face infrastructural problems. Blockchain technology has very conveniently removed this issue.
7. **Impact on Capital Markets:** Blockchain technology has improved capital markets to a great extent and also has scope and potential to further improve capital markets. As per the McKinsey report, various benefits that have been offered to capital markets by blockchain technology are fast clearing and settlement, operational improvements, and consolidated audit reports.
8. **Trade Finance:** Under the traditional method of trade financing liquidity was hard to manage because of slow business processes. Also, cross-border trade was a very difficult and cumbersome process as it involved huge variables while communicating information such as country name, product details & high documentation. Blockchain technology has simplified the process across the border. It has made communication and transactions very easy across borders.
9. **Money Laundering Protection:** Blockchain technology is a record-keeping system that supports and promotes the "Know your Customer (KYC) process. KYC is a system that helps businesses to identify and verify their client's identities.
10. **Insurance:** Blockchain technology has made its place in the insurance sector also through the introduction of smart contracts. Through these contracts claims of customers and insurers against each other are managed in a transparent and secured way. These claims are validated by the network which would all together remove invalid claims
11. **Healthcare:** Blockchain technology is widely used in the health care sector. With the help of general information like age, gender, medical history is something which will not help to identify any particular patient thus making it secure and stored on the shared blockchain that has access to numerous individuals without any fear of privacy of individuals being tracked by someone else.
12. **Media:** Even the field of Media is not lagging behind in the use of blockchain technology. Media companies are using this technology to reduce fraud, reduce cost, protection of copyrights like music records.
13. **Record Management by Government:** Government -National, state and local are bound to maintain an individual's records. It is very difficult to manage huge data and still exists in paper only. Block chain technology can solve the problem of record keeping and making the records much safer than historical record.

14. **Taxes:** Blockchain tech could make the cumbersome process of filing taxes, which is prone to human error, much more efficient with enough information stored on the blockchain.

Principles of Blockchain Technology

1. **Distributed Database:** Blockchain technology offers distributed database, which means there is equal authority to all the members in the network. On one enjoys superior control over others. There is no need for middlemen in blockchain technology.
2. **Peer to Peer Transmission:** In blockchain Technology, no one is dependent upon the central authority for any type of communication. Every node in the network participated equally in the network with confidentiality and security.
3. **Transparency**: Blockchain technology facilitates the transparency during and storage of information. Every user has a unique key for participation in the network. When a user initiates to do the transaction in the network, the end-user responds to confirm it.
4. **Computational Logic:** Blockchain technology is based on computational logic. There is no need for manual calculations or repetitive tasks.

ADVANTAGES OF BLOCKCHAIN TECHNOLOGY

Blockchain technologies have various benefits over traditional technologies. Some of the very popular benefits gained by the adoption of blockchain technologies are:

Building Trust: One of the most important benefits derived from blockchain technologies is that it has helped big businesses to build trust between them which was earlier not present. This trust-building among entities has helped them to engage in transactions or share data that would not have been done if there were no blockchain technologies or would have required some intermediary to do the transaction. It facilitated transactions between the entities which were not have any direct relationship with each other yet they had to engage in transactions, share data or make payments. For example, cryptocurrencies or Bitcoin is building trust among sellers and buyers who are not familiar with each other

Decentralized Structure: Blockchain technologies work based on a decentralized structure that operates where nobody is in charge of anything. So this system works in an environment where no one is specially authorized. For example Suppliers, producers, distributors, transport companies require information or data from one another in that supply chain but still, no one is held responsible or authorized for providing that information. Such a problem of non-accountability of anyone can be easily solved with the use of blockchain technologies with the help of its decentralized structure.

Provides Improved Security and Privacy: Another most important benefit of blockchain technologies is the security provided by them. This security is another great leading benefit of this rising technology. Blockchain technology creates an unaltered record of transactions with end-to-end encryption which closes the door for fraud or any unauthorized activity. Also for enhancing the security services data on blockchain technologies is stored across a network of computers because of which it becomes difficult to do any hacking of the data. Apart from providing security it also helps in privacy concerns of the users by asking for permission to limit access.

Enhancing Speed

One of the most important features and benefits of blockchain technologies is the speed offered by the technology. Since in the use of this technology intermediaries are eliminated. There is no intermediary in the process thus enhancing the speed with which transactions take place. Blockchain technologies can handle transactions in a much faster way as compared to traditional methods. Though It helps in the speedy working of the transactions the time taken for each transaction depends on various factors like network traffic, how vast is the information or data to be shared. Even if in some cases it takes a slightly higher time but it will always win over the traditional technologies and processes used.

Visibility and Traceability: As per experts Blockchain technologies can help to track the origin of any problem or item. For example, it can be used on organic items to confirm if they are organic. By use of blockchain technology supply chain becomes more clear and transparent. It helps in creating a supply chain that will work with suppliers. Under traditional technologies, it was very difficult to locate or trace any item that can lead to multiple problems like theft, loss of goods, or counterfeit. It becomes easy to trace the items or goods ensuring that they are not misused or replaced.

Control of data: Blockchain technology enables a varied amount of control by an individual over his own digital data. Blockchain enables us to decide how much data we want to share, with whom we want to share; when we need to share, and for how long do we need to share. All these variables are controlled by an individual in blockchain technology with limits enforced by blockchain smart contracts.

Innovation: In today’s scenario big business players are using this technology to solve various problems which earlier were difficult to handle as solutions were not easily available. Industries today are using blockchain-based systems to find solutions to various problems. For example, verifying information provided by the applicant through resumes is a time-consuming task by recruiters so in order to minimize time wastage and make the process easy blockchain-based systems are used which allows educational institutions to put their data about their graduates on the blockchain which can be used by the recruiter thereby getting a solution to the problem in seconds and efficiently.

Transparent Transactions: The use of blockchain technologies provides transparency in the transactions as all the data & transactions are recorded in a number of locations and every user or participant can see the same information at the same time with permission access thus providing clear transparency. Thus any member can view the full transaction and the opportunity of any fraud is eliminated virtually

Automation: Smart Contracts are another important feature of blockchain-based systems which increase the efficiency and speed of the process. Smart Contracts remove human involvement to a great extent to verify the conditions of the contract. For example in the insurance business once the customer provides all information and documentation regarding the claim to the insurance company the claim will auto settled & paid.

Reduced Costs: Blockchain is very cost-effective for the organizations using it. Blockchain-based systems create efficiency in transactions; reduce manual tasks such as averaging data or correcting data. By eliminating suppliers vendors or distributors it helps in cutting the cost of the business

CONCLUSION

Thus it can be concluded that in today's digital era. There areseveral applications of blockchain technology in the area of finance, voting, real estate, taxation, media, health care, food safety, data backup, data storage, and money transfer. Blockchain technology works on principles such as distribution database, transparency, peer-to-peer transmission, computational Logic, etc. Moreover, blockchain technology provides several benefits over traditional technologies such as high speed, Automation, reduced cost, innovation, enhancement of speed, and building trust, etc.

REFERENCES

Bogart, S., & Rice, K. (2015). *The Blockchain Report: Welcome to the Internet of Value*. https://www.the-blockchain.com/docs/The%20Blockchain%20Report%20

Fanning, K., & Centers, D. P. (2016). Blockchain and Its Coming Impact on Financial Services. *Journal of Corporate Accounting & Finance*, *27*(5), 53–57. doi:10.1002/jcaf.22179

He, D., Habermeier, K., Leckow, R., Haksar, V., Almeida, Y., Kashima, M., Kyriakos-Saad, N., Oura, H., Sedik, T. S., Stetsenko, N., & Verdugo-Yepes, C. (2016). *Virtual Currencies and Beyond: Initial Considerations (No. 16/3)*. International Monetary Fund.

Kitsantas, H., Vazakidis, A., & Chytis, E. (n.d.). *A Review of Blockchain Technology and Its Applications in the Business Environment.* Academic Press.

Swan, M. (2015). *Blockchain: Blueprint for a new economy*. O'Reilly Media, Inc.

Rawat, D. B., Chaudhary, V., & Doku, R. (2020). Blockchain Technology: Emerging Applications and Use Cases for Secure and Trustworthy Smart Systems. Journal of Cyber Security and Privacy, 1-15.

Baiod. (2021). Blockchain Technology and its Applications across Multiple Domains. *Journal of International Technology and Information Management, 29*(4), 78-119.

Kibet, A. M., Bayyou, D. G., & Esquivel, R. A. (n.d.). Blockchain: Its Structure, Principles, Applications and Foreseen Issues. *Journal of Emerging Technologies and Innovative Research*, *6*(4), 515–526.

Pilkington, M. (n.d.). Blockchain Technology: Principles and Applications. *Journal of International Technology and Information Management*.

KEY TERMS AND DEFINITIONS

Consortium Blockchains: Consortium block chains means blockchains which can be assessed by multiple organisations.

Digital Ledger: Digital ledger refers to the data base distributed among multiple participants.

Peer-to-Peer Transmission: Peer to peer transmission means no one in the blockchain technology is dependent on central authority for any type of communication.

Private Blockchain: Private blockchain means blockchains which can be assessed by trusted participants only.

Public Blockchain: Public blockchain means blockchains which can be assessed by anyone.

Chapter 13
Integration of Blockchain Tokenisation in Real Estate:
A Review

Basit Ali Bhat
https://orcid.org/0000-0001-6381-6160
Lovely Professional University, India

Nitin Gupta
Lovely Professional University, India

ABSTRACT

Real estate is among the top reliable investments because it provides a reliable source of income through rent and leases. While there are many benefits, one of the main negatives of real estate investment is the lack of liquidity and transparency. Blockchain technology holds real potential to address this issue, making the market accessible for investors. Due to the utility and flexibility of constructing security tokens secured by real assets, real property can be liquidated through the use of special purpose vehicles. Blockchain tokenisation technology will revolutionize the real estate market across all aspects: ownership selling, managing, and investment. Tokenisation shifts physical real estate into the digital world and could lead to significant savings in the cost of the pre- and post-tokenisation phases. Policymakers and developers in India have started talking about shifting from the traditional investment towards new blockchain tokenisation. Tokenisation may prove to be a viable funding source for those relatively poorly capitalized financial markets.

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INTRODUCTION

The use of technology in real estate has changed how the sector based on pen-paper works. Virtual reality and automated homes have made significant impacts, but the Blockchain technology, or real-estate Tokenisation, has a bright future, and many industries benefit from Blockchain technology. Real estate Tokenisation is a digital asset that represents ownership rights to a physical or virtual asset, such as real estate or a fund, on a Blockchain-based platform. A ‘token-based economy’ might hasten the shift of corporate realty (Real Estate) ownership. It flips the equity and liquidity paradigms that have previously hampered investment. The token economy, for example, uses global capital markets to provide a liquidity alternative previously unavailable for privately owned real estate assets. Furthermore, security tokens may be used in conjunction with programmable algorithms (also known as “smart contracts”) to achieve a number of benefits (Uzair et al., 2022).

According to industry analysts, digitalizing real estate using Blockchain technology, tokenized real estate assets, and smart contracts based on digital ledger technology would provide unprecedented benefits to the real estate sector and the larger economy (Shin et al., 2021). The influence of real estate, on the other hand Tokenization should not be thought of in isolation. It must be studied in conjunction with continuing industrial trends. The Fourth Industrial Revolution (Industry 4.0), which fundamentally alters business paradigms, is driving disruptive transformation across all industries. This directly impacts corporate motivations regarding how much real estate ownership will be needed in the future. In addition, over the past two decades, there has been a shift toward privatization rather than public listing. This has consequences for how businesses access financial markets and recycle operating money in real estate asset portfolios.

With the advent of distributed ledger technology (also known as Blockchain technology in India), Indian real estate is changing. Although it’s still in its infancy and not yet fully developed, real estate Tokenisation has already had a major impact on India’s real estate industry. The real estate sector will account for almost 13% of India’s GDP by 2030. It has a market value close to USD 1 trillion. Blockchain is essentially a democratic market where property possession can be broken down into small ” tokens ” items. This makes it easier to sell your home, attracts investors with diverse backgrounds, and in real estate cases, liquidity. One of the world’s most populous countries, India has trillions of dollars worth of real estate assets. Property investment remains problematic due to high capital investment, difficulty in entry, and low liquidity. There is also a lack of an efficient trading marketplace. Real property investment trusts attempted to address these problems, but legal compliance and taxation are still concerns. The face of Indian real estate is changing with the advent of distributed ledger technology, also known as Blockchain technology, in

India. Even though it is still in its infancy, real estate Tokenisation has significantly impacted the Indian real-estate sector.

Indian markets are still relatively new to the concept of Real Estate Tokenisation. It has proven very successful in the USA, Hong Kong, Singapore, and Europe. Property is still the largest asset class globally, at $300 trillion. This is more than stock markets and gold. It is therefore well-suited for Tokenisation. Property investors can invest in any residential or commercial property they choose. Investors benefit from no entry barriers and greater transparency because every deal is done in the open market. Prices of crypto tokens can fluctuate according to market conditions and specific real estate values.

BACKGROUND

Real estate crowdfunding is a platform that allows investors and entrepreneurs to meet individuals or corporate funders who are looking for funding opportunities to purchase, construct or renovate the real property. Many crowdfunding options are available, including those that reward, donate, lend, or invoice. Real estate crowdfunding is an equity-based type of crowdfunding. (Cummings et al., 2018) The motivation of funders is to make a profit without the need for bureaucracy and buying the entire property. Funding campaigns specifically designed for real-estate acquisition typically necessitate a significant investment as well as a small share of the property.Investors who are unable to conduct proper research on real estate investments can join the online platform and review due diligence materials. They can then evaluate the potential benefits of the real estate investment, such as capital appreciation and rental income.

Real estate crowdfunding is a unique alternative to traditional real estate businesses. It provides numerous advantages to consumers, real estate owners, and the marketplace. The most important is fractional ownership. Investors on the crowdfunding platform have the option to purchase fractional ownership of the property. This is a great alternative to traditional real estate investments that require the purchase and maintenance of the entire property.

Large investments in one project can increase the risk for investors in traditional markets. This new platform allows you to build a portfolio of smaller investments in more projects. Real estate crowdfunding provides a unique answer to investors' lack of market expertise. These platforms collect and disseminate information on the property and its surroundings. They also provide appraisals. Crowdfunding enables investors to choose the proper degree of investment depending on a number of factors. By offering a simple point-and-click interface, fractional ownership makes the transaction more feasible. Customers may now invest in real estate, although traditional real estate markets require extensive documentation and bureaucracy.

Real estate crowdfunding also has the advantage of expanding the market and reducing structural inefficiencies. This financial model provides a more flexible funding environment than traditional real estate investments. Traditional real estate corporations have a small investor base, which increases the time it takes to sell real estate and decreases the pool of possible investors. The crowdfunding platform expands sales potential by making projects available globally. Real estate crowdfunding also helps to improve market efficiency by removing middlemen and linking investors with previously unavailable investment possibilities to economically privileged or clustering investors. It enables investors to identify real estate investments and register ownership online without the use of traditional institutions such as real estate brokers, attorneys, and notaries. Both parties save money and cut transaction expenses. According to (Taniyama, 2019), the speed with which real estate transactions are executed is critical to competing for business and creating a firm's reputation for professionalism and efficiency. This capability may enable [crowdfunding platforms for real estate] to continue developing and building on their existing pace. Because it is more stable than other solutions, crowdfunding provides investors with a greater opportunity to diversify. 2020; Gibilaro and Mattarocci). The. Even though crowdfunding platforms have made it easier to aggregate this information, "buyer beware!" remains a major problem.

LITERATURE REVIEW

According to (Chow and Tan 2021), Tokenisation in real estate is still a new market; platforms such as BrickX, KASA, and ADDX have launched successfully in Australia and South Korea. Tokenisation could prove to be a feseable funding source in some of the APAC's less well-capitalized financial markets. Tokenisation with Blockchain technology provides both opportunities and challenges for the real-estate sector. It may allow EU transactions, improve processes, and connect public administrations. This Blockchain must have special features to protect parties' rights, including the possibility of being modified (Garcia-Teruel, 2020). Tokenisation could allow investors to participate in the market, creating diversified portfolios using small amounts of money. Real estate is illiquid and lumpy. Two developments are required for the digital Tokenisation of single real property assets. (1) An expressed desire to fractionalize single real property assets (2) Market participants must be familiar with Blockchain, the digital underpinning to Tokenisation. In many land markets, fractionalization is required to establish an intermediate structure because land ownership cannot be shared between many people, which increases the cost of

TOKENISATION (Baum, 2021). However (Konashevych, 2020) stated that Private and permissioned DLT systems are not considered a major evolutionary step in government systems. Blockchain is an innovation in governance. It is distinct from the permission system as it is an immutable ledger technology that doesn't require authorities. This technology is not yet ready for use at the state level. Therefore, more research and further development are required. Blockchain requires an architecture that can support multiple technologies overlaid to address digital identity, privacy, legal compliance, the smart contracts enforceability, and scalability (Karamitsos et al., 2018).

THEORETICAL FRAMEWORK AND METHODOLOGY

This paper involves different sources such as research articles, opinion pieces, news articles, and outcomes of different workshops. This paper also involves the empirical experience of authors by acquiring knowledge throughout several years in the area of technology disruption in financial sectors (fintech, digital currency concepts, and other technological innovations in organization levels).

BLOCKCHAIN TECHNOLOGY AND TOKENISATION

Since the birth of Blockchain technology, it has gained traction in the financial industry as well as other areas such as pharmaceuticals and supply management (Nakamoto 2017). According to the report, technology like blockchain and its underlying distributed and decentralised technologies are "the primary technological enablers for recent breakthroughs in distributed transaction systems and ledger systems" (Lindman et al., 2017). Blockchain technology is a disruptive technology in traditional corporate operations because to its digital ledgers and transparency, redundancy, immutability, and disintermediation (Zhao et al., 2016).

Blockchain is revolutionising financial services including settlement, cross-border payment, remittances, and credit-information systems. It also addresses issues like as fraud, trust, transaction costs, and others (Guo and Liang, 2016). Blockchain technology has the potential to alleviate fund collection and administration concerns while also improving corporate governance. These characteristics establish a high level of faith in the ability of tiny, scattered shareholders to govern the organisation. Land conflicts might potentially be mitigated by blockchain (Yapicioglu and Leshinsky, 2020). The tokenization of scarce assets is perhaps the most significant benefit of Blockchain. This TOKENISATION serves as the foundation for pre-order crowdfunding platforms, as well as ownership shares in profit-sharing crowdfunding and other alternative fundraising strategies (Huang et al., 2018). Tokens, unlike cryptocurrency, are frequently managed via smart contracts. They are frequently governed by standards, depending on the Blockchain platform.. This enables Blockchain ecosystem players to readily recognise, trade, and exchange tokens. The underlying assets and services of a token determine its value in general. Tokens are also helpful and valuable since they contain a digital representation that stores contractual and physical information (Wouda and Opdenakker, 2019).

Funds can be raised by Entrepreneurs and innovators directly from investors without relying on financial institutions. Tokens also allow investors to invest in lucrative ventures or assets and provide instant liquidity. Technology and user-friendly platform design allow for continued development of offering initial coins, token offerings, or initial exchange offers.

There is a significant disparity between conventional security and Blockchain Tokenisation for managing rights of property. Tokens are manufactured using cryptographic procedures. The token owner can transfer it by producing a transaction message, signing it with their private keys, and submitting it to the Blockchain. Trading conventional securities, on the other hand, is impossible without the help of financial intermediaries. Tokenisation allows for partial ownership of a certain asset. This might be regarded as numerous individuals sharing an asset, which could be actual property (Graglia and Mellon, 2018). Customers can invest in high-value assets that fractional ownership cannot. Customers might partake in ownership rewards such as capital appreciation and rental revenue, or they could own simply a fraction of the property. The intermediary may absorb or reflect all of the costs incurred by investors.

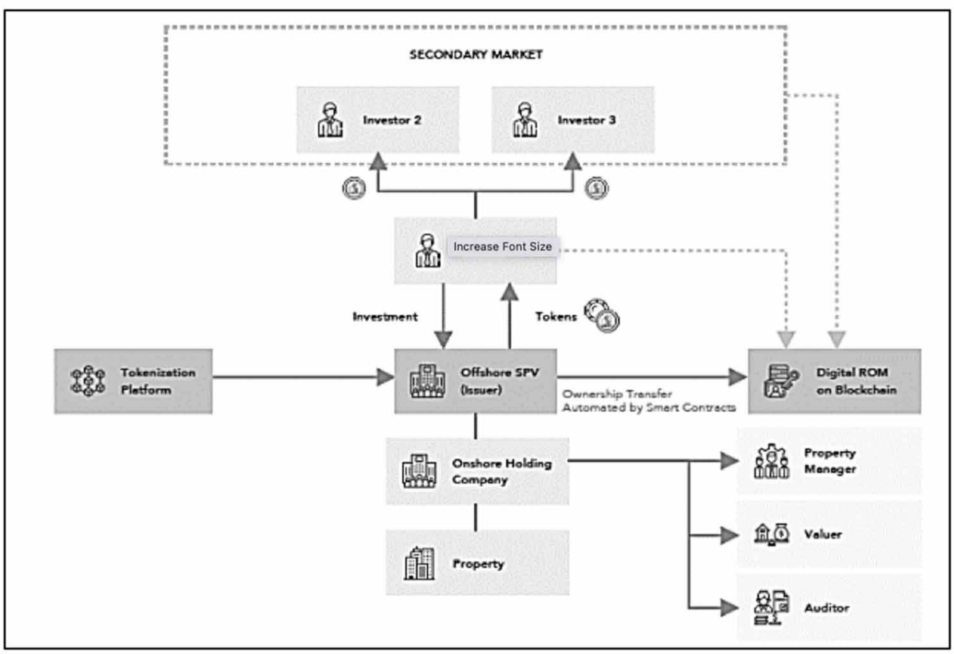
While many real estate crowdfunding platforms have been regulated and trusted by the public, central platforms might be vulnerable to fraud and information asymmetry (Konashevych, 2020), which is a key barrier to equity crowdfunding. Tokens make third-party verification more easier, while Blockchain eliminates security and asymmetrical information problemsA crowdfunding method that uses Blockchain technology protects investors by reducing information inconsistencies, increasing market stability, and, eventually, reducing market manipulation and systemic risks. Blockchain technology allows for the transparent recording of information about the shares of investors. It also ensures trust between money seekers and fundraisers, resulting in more secure and safe contracts.. Blockchain technology allows digital registration and confirmation of investors' shares regardless of their location (Zhu and Zhou, 2016). These platforms may also be required to meet regulatory burdens such as minimum capital requirements, corporate governance, internal controls, compliance infrastructure, trust accounts, and internal controls.

Tokenisation would refer to converting any object into tokens in its most basic meaning. Tokenisation is a key concept in natural language processing (NLP), even though it may have applications in credit card security. Tokenisation is essential to break down the text in natural-language processing and improve learning. In the Blockchain context, TOKENISATION refers to converting real-world assets into tokens.

A token can be described as a digital Blockchain share of an asset. The underlying asset of real estate Tokenisation is property. A holding company holds the property through which property managers and valuers, auditors, and others can access it. The holding company also manages the net operating income. A special purpose vehicle is used to control the holding company. This was created by the original company that acquired the property. The special purpose vehicle is the tokenized underlying asset.

To tokenize and partition the special purpose vehicle, a tokenisation platform is utilised (Colliers International et al., 2020). The property can then be liquidated on the secondary market by selling tokens. If the tokenized asset is published on an exchange, the tokens can be traded openly. Dividends and token ownership are distributed, transferred, and stored in read-only memory (ROM) smart contracts and Blockchain. Figure 4 depicts the lifecycle of a tokenized property.

Figure 1. Lifecycle of tokenized property (Colliers International et al., 2020)



Real estate Tokenisation is a broad term that can be used in many ways. This could be used to represent shares in a trust for real estate investments with tokens or to use a token to signify debt against a single property. Or to convert a single property into 500,000 tokens. A security token can digitally represent a real-world financial asset such as a loan, share certificate, or land title. They are made with Blockchain-based technology and can be highly secured digital assets. Security tokens significantly improve the security and accessibility of digital assets. They also make it easier to raise funds and lower the cost of compliance and cross-border transfers. Security tokens are growing in popularity all over the globe - because of their potential to improve capital markets, financial inclusion, and increase capital markets.

EXISTING SYSTEM

Real estate encompasses both tangible and intangible property, such as land, natural resources, buildings, plants, and wildlife. Real estate is divided into three types: residential, commercial, and industrial. Buying land or property through a broker is a traditional method of investing in real estate (Xie, 2017). Real estate investments provide several benefits, including high physical asset value and competitive risk-adjusted return, consistent income returns and rent, and leasing fees.

Traditional real estate investing has many drawbacks. The first is the high initial cost of property purchase. Many investors cannot afford this amount, so they cannot invest in real estate. A lack of liquidity is another problem in the system. Real estate investments can be very volatile. The owner must find suitable tenants to continue earning rental income from their underlying property. You cannot sell just a portion of your asset. It would help if you sold the whole asset. There are frequently several intermediates, such as attorneys, brokers, and so on. The mechanism is intricate. Real estate transactions are expensive and time-consuming. Because of these characteristics, regular investors find the system complex and unavailable.

Real Estate Investment Trusts are another way to invest in real estate. Das and his associates (2013) A real estate investment trust (REIT) is a trust, business, or organisation that invests in rental real estate. It might be either publicly traded or privately held. A REIT generates money through collecting rent from assets, receiving interest from financing real estate assets, or selling assets under management (Arora, 2011).

Crowdfunding is a combination of loan and equity that may be invested in various projects through an online platform that creates possibilities by combining sponsors and lenders. Real estate crowdfunding funds are used to Buy or refurbish a Real Estate asset for subsequent usage or trades. Crowdfunding for real estate has been stagnant for a many reasons. One of the primary reasons is the high quality of homes offered on the sites. Another concern with crowdfunding is the extended lock-in time necessary for assets that cannot receive funds using standard financing techniques. The crowdfunding platform secures investor funds, while platforms that offer secondary marketplaces for these investments reduce total liquidity. Although these secondary markets are restricted, several platforms allow investors to sell their shares within a year. Because of these factors, crowdsourcing and REITs are inappropriate for regular investors (Arora, 2011).

REAL ESTATE IN INDIA

The government has taken various initiatives to boost the expansion of the real estate industry, including the liberalization of FDI rules in 2005, the introduction of the SEZ Act, and allowing PE funds to invest in the industry. The government is also aided by a growing economy, favorable demographics, a better lifestyle, and the development of new sources of financing and financing, among other things (Gaikwad et al., 2022). However, the sector has recently seen an evolving profile due to shifts in consumers' preferences and growing interest. Development companies are now more organized and transparent in leveraging opportunities on the market. Due to the large capital requirements, the sector's interest rates depend on the number of purchases financed by borrowed financing.

In addition, there have been increased prices by RBI many times. India is experiencing high urban population growth (Das et al., 2013). However, India's per-capita investment in urban infrastructure is quite low, thus hindering real estate development. Although there is an increasing demand for commercial and housing projects in India, the inaccessibility of land within the city limits and the increasing construction costs and land prices are increasing the overall cost of projects. This makes the projects impossible to finance. There is no coordination between state and central ministries. The Indian real estate sector faces numerous challenges. Poor rental yields, inadequate rental contract implementation, trust deficiency between tenants and owners, and easy access to properties are just some of the primary problems that plague the real estate sector (Gaikwad et al., 2022). Recently the loan-to-value (LTV) ratio, which is the amount of loan available to a home with the market value of a specific amount, is now limited by 70% as it was previously ranging between 80% to 90% of property's value.

FINANCIAL SIDE OF REAL ESTATE IN INDIA

Credit Restrictions

Currently, the financing options favor personal loans compared to developers' financing. Many housing finance companies focus on people in the upper-income bracket and guaranteed creditworthiness. About 5-7 percent of loans issued by these firms for housing finance go-to builders and institutional developers. The high default rates among developers are the main reasons financial institutions deal with housing finance from investing in this industry. The legal mechanism for recovery takes a long time. The absence of a code of conduct for the business is the second reason that prevents investors from investing. At present, developers have been corporatized to get financial institution funding. This leads developers and builders to pursue private financing sources with higher interest rates, which leads to higher prices for real estate.

Sources of Financing

In industrialised countries, the primary investors in the housing market are real estate mutual funds, insurance firms, and pension funds. Pension funds in the United States invest 5% of their reserves in mortgages, real estate equity, and mortgages (Ullah and Al-Turjman, 2021). At the same time, developers in India have limited access to financial help through these resources (Chung and Lee, 2020). Companies in India that finance housing must also have pension, provident, and insurance funds. Because real estate projects might take more than five years to complete, developers must access these long-term finance sources.

Securitization

Another source of funding for housing businesses is the development of secondary markets for mortgages converting mortgages into tradeable debt or financial instruments. Securitization is an increasingly popular process for housing finance firms in the West, where the home loan assets are packaged into securities and then sold to investors. These securities are referred to as mortgage-backed securities. They assist finance firms in converting their loan assets to cash to fund loan repayments, thereby ensuring a steady flow of cash from lenders. They also help finance companies reduce their risk when investing and the risk of receiving lower returns on cash flows through the prepayment of home loans.

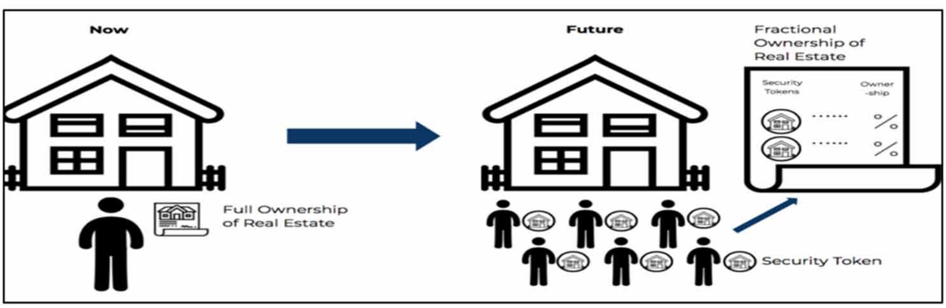
Foreign Direct Investment

Small companies currently dominate the market for real estate. The local developers do not have a national presence, and big companies aren't yet fully engaged in real estate development. The current players do not are financially able enough to fund large-scale projects. The creation of new cities and towns would require massive investment and the technical expertise that local players cannot offer on their own (Law, 2022). One method to overcome this issue is to raise funds via the FDI method. But, at present, the FDI route within the property market is only permitted to develop integrated townships.

BLOCKCHAIN TOKENISATION IN INDIAN REAL ESTATE

The real estate industry in India is one of the most well-known sectors. It comprises four sub-sectors: Housing and hospitality, retail, and commercial. The expansion of this industry is accompanied by an expansion of the corporate sector and the increasing demand for office space, as also semi-urban and urban accommodation (Bureau, 2022). The construction industry is third in the 14 main sectors regarding direct or indirect effects across all areas that make up the economic system.

Figure 2.



TOKENISATION technology has the potential to transform the Indian real estate market. It gives issuers and investors many advantages over existing alternatives to investing and opens the doors for many investors to enter the market (Baum, 2021). In the public eye, the real estate market in India contains a significant amount of black money, and it is difficult for political leaders to deal with it. Tokenisation will bring a great amount of transparency with the advancement of Blockchain technology. It is evident that the real estate sector was resistant to change for a long time and is now catching up to other industries (X, 2020). The real estate sector in India has yet to realize how Tokenisation based on the Blockchain can bring a significant revolution in real estate by solving all the major problems related to liquidity, transparency, investment security, accessibility, and management.

The real estate market in India deals with delays, approval, and procedural difficulties in projects. Tokenisation is a solution to the disadvantages that traditional real estate has that comes with high upfront costs for investment and inefficient processes that involve costly intermediaries, paper-based documentation, and loan qualification

Tokenisation makes use of fractionalization to cut down on the costs associated with traditional real property. When investors buy the entire property using conventional real estate investment, Tokenisation permits individuals the opportunity to buy smaller pieces within the same building, making it easier to invest at a lower cost. For example, the TOKENISATION of the most expensive Antilla (Mukesh Ambani house), which costs 12000 crores, can be divided into 10000 pieces, worth 1.2 lakh each. The Tokenisation process drastically cut down on the investment costs and made it accessible to a wider range of investors. Furthermore, Tokenisation eases the process by enabling digitization. In contrast to traditional real estate, which is restricted to investors in regional areas in the local hours of opening, Real estate tokens can be exchanged at any moment across boundaries (Forum, 2022).

According to the broker discovery and platform for comparison Broker Chooser, India has the biggest amount of crypto-owners around the globe at 10.07 crore. Fully adopting Tokenisation in real estate would bring phenomenal results for property owners and developers.

Benefits of Real Estate Tokenisation

Liquidity

The real estate industry has always been a low-liquidity investment or illiquid asset. It is primarily due to the multiple stakeholders are involved. It is necessary to have substantial capital. There are more private players in contrast to public companies. With the Tokenisation of real estate, investors can easily access the market, and assets are fractionalized, increasing the value of tokens (Real Estate Commercial Cafe, 2022). Thus, real estate could become more than purchasing homes and become one of the leading industries in revenue generation.

More Access to the Market

Investment in real estate is typically seen as a sport for the elite. But, the Tokenisation of real estate changes this perception and expands the investment pool. Anyone with enough money with an internet connection can trade, buy, or invest in real property assets from anywhere in the world, of the globe. Because the assets (or those) are divided, selling the entire token unit is unnecessary.

Transparency and Inexpensive

Each piece of information is encoded into a secure, digital token from contract clauses and transaction details to your preferences and due dates for interest. Thus, there is complete communication between the investor as well as the buyer (Huh and Kim, 2020). Additionally, fewer intermediaries and fewer administrative burdens will make buying and selling houses inexpensively.

Ownership

The real estate business has often seen intense legal battles for ownership and rights. They are financially draining, but they can affect the brand's value. Blockchain technology eliminates the potential cause of fraud. The information stored in the Blockchain ledgers can't be altered. So when the ownership of fractional or full ownership is disclosed, you can review transactions from the past or present.

Property Management

Delayed rent payments or leases renewals frequently pose problems for the property owner and tenants. (Kothari et al., 2020) Blockchain-based smart contracts, also known as tokens, could speed up the process. You can record documents in an online database by utilizing real estate TOKENISATION, collecting timely rent payments from tenants, syndicating loans, and speeding up your due diligence procedure (Ullah and Al-Turjman, 2021).

Challenges

Legal Challenges

In many countries, including India, there aren't many laws that govern the legality or invalidity of smart contract technology. Numerous top real estate firms and investors, contractors, and contractors do not engage in Real Estate Tokenisation to stay clear of any legal disputes that could arise from a legal framework for technology that is not yet established.

Tax Implication

As a truly global phenomenon, Real estate Tokenisation is a magnet for investors from all over the globe. But, tax laws associated with it are not clearly defined or implemented in all countries. These results in which make understanding the legal frameworks a little difficult.

Digital Infrastructure

There is a deficiency of infrastructure that can facilitate real estate Tokenisation, which is the case across many countries, including India. Since it is a new technology, there is a lack of understanding of how these coins could be utilized, their benefits, and how various technical issues can be resolved.

Cyber Threat

While having assets held through cryptography technology is considered secure, the security of digital tokens is still unsettling. In the absence of a well-established law regarding cybersecurity, the possibility of hacking is a concern.

Energy

Blockchain networks consume a huge quantity of electricity. In July of 2019, an online tool of the University of Cambridge determined that the energy utilized for the Bitcoin network is close to that used by the entire nation of Switzerland. This could be a financial burden for startups.

CONCLUSION

The process of investing in real estate is a lengthy process of administrative processing as well as heavy capital infusions and numerous commitments. Tokenisation is a solution to these issues and is beneficial to all parties. Tokenisation provides fractionalized ownership and a simple entry point for investors with small amounts in the property industry. Alongside fractionalized ownership, it allows portfolio rebalancing and management for those with high net worth. With regard to token issuers, digitalization and automation improve efficiency, decreases operating costs, and allow the opportunity for a broad range of investors. For intermediaries such as brokers, agents, and lawyers, automation stores information, improves precision, reduces costs, and protects the data.

India is one of the leading real estate markets, with an urban population of more than 35% of the total population. Integration of Tokenisation will open new doors for the real estate sector as well as investors and developers. The housing crisis in India's cities has increased by 54 percent in the last year to reach 29 million in 2018 from 18.78 million in 2012. According to the paper of ICRIER entitled housing for the poorest urban households in India. The floor area per capita of congestion-ridden households decreased from 111 sq feet between 2012 and 83 sq feet in 2018, highlighting the need for urgent action to tackle the issue of congestion. Early adoption of the Blockchain Tokenisation concept in India will bring a pool of small investments in the shape of tokens in real estate, particularly in the housing sector.

The future of Tokenisation for real estate is deemed and supported by a number of promising researchers. Certain researchers predict massive changes in the business world due to the rising popularity of Tokenisation because of the adage "The most profitable investment on Earth is the Earth itself" that can be available to all people by using fractional ownership. Land prices are always increasing, and technology is constantly evolving.

REFERENCES

Arora, R. (2011). Real Estate Investment Trusts (REITs): Development in India. *Indian Journal of Applied Research*, *1*(10), 102–103. https://doi.org/10.15373/2249555x/jul2012/33

Baum, A. (2021). TOKENISATION—The Future of Real Estate Investment? *Journal of Portfolio Management*, *47*(10), 41–61. https://doi.org/10.3905/jpm.2021.1.260

Bureau, B. (2022). India's Urban Housing Shortage Rises 54% To 29 Million In 2018: Report. *BW Businessworld*. Retrieved 10 March 2022, from https://www.businessworld.in/article/India-s-Urban-Housing-Shortage-Rises-54-To-29-Million-In-2018-Report/23-12-2020-357300/

Chow, Y., & Tan, K. (2021). Is TOKENISATION of real estate ready for lift-off in APAC? *Journal Of Property Investment and Finance*. doi:10.1108/jpif-10-2021-0087

Chung, J., & Lee, C. (2020). Theoretical Approach to Blockchain-based Real Estate Transaction System. *Korea Real Estate Academy, 81*, 21-35. doi:10.31303/krear.2020.81.21

Colliers International, KPMG, Liquefy, & Sidley. (2020). *Real Estate TOKENISATION*. https://www.colliers.com/en-hk/research/real-estate-TOKENISATION

Cummings, M., Rawhouser, H., Vismara, S., & Hamilton, E. (2019). An equity crowdfunding research agenda: Evidence from stakeholder participation in the rulemaking process. *Small Business Economics*, *54*(4), 907–932. https://doi.org/10.1007/s11187-018-00134-5

Das, P., Sah, V., Sharma, D., Singh, V., & Galuppo, L. (2013). Real Estate Development Process in India. *Journal of Real Estate Literature*, *21*(2), 271–292. https://doi.org/10.1080/10835547.2013.12090362

Forum, I. (2022). *Real Estate TOKENISATION, The Next Big Thing In India*. Retrieved 10 March 2022, from https://www.openpr.com/news/2088565/real-estate-TOKENISATION-the-next-big-thing-in-india

Gaikwad, D., Hambir, A., Chavan, H., Khedkar, G., & Athawale, D. (2022). Real Estate Land Transaction System Using Blockchain. *International Journal For Research In Applied Science And Engineering Technology, 10*(3), 307-311. doi:10.22214/ijraset.2022.40633

Garcia-Teruel, R. (2020). Legal challenges and opportunities of Blockchain technology in the real estate sector. Journal Of Property, Planning And. *Environmental Law (Northwestern School of Law)*, *12*(2), 129–145. https://doi.org/10.1108/jppel-07-2019-0039

Gibilaro, L., & Mattarocci, G. (2020). Crowdfunding REITs: A new asset class for the real estate industry? *Journal of Property Investment & Finance*, *39*(2), 84–96. https://doi.org/10.1108/jpif-08-2019-0112

Graglia, J., & Mellon, C. (2018). Blockchain and Property in 2018: At the End of the Beginning. *Innovations: Technology, Governance, Globalization*, *12*(1-2), 90–116. https://doi.org/10.1162/inov_a_00270

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation, 2*(1). doi:10.1186/s40854-016-0034-9

Huang, Z., Chiu, C., Mo, S., & Marjerison, R. (2018). The nature of crowdfunding in China: initial evidence. *Asia Pacific Journal Of Innovation And Entrepreneurship, 12*(3), 300-322. doi:10.1108/apjie-08-2018-0046

Huh, J., & Kim, S. (2020). Verification Plan Using Neural Algorithm Blockchain Smart Contract for Secure P2P RealEstate Transactions. *Electronics (Basel)*, *9*(6), 1052. https://doi.org/10.3390/electronics9061052

Karamitsos, I., Papadaki, M., & Barghuthi, N. (2018). Design of the Blockchain Smart Contract: A Use Case for Real Estate. *Journal Of Information Security*, *09*(03), 177–190. https://doi.org/10.4236/jis.2018.93013

Konashevych, O. (2020). Constraints and benefits of the Blockchain use for real estate and property rights. Journal Of Property, Planning And. *Environmental Law (Northwestern School of Law)*, *12*(2), 109–127. https://doi.org/10.1108/jppel-12-2019-0061

Kothari, P., Bharambe, A., Motwani, R., & Rathi, A. (2020). Smart Contract for Real Estate Using Blockchain. *SSRN Electronic Journal*. doi:10.2139/ssrn.3565497

Law, I. (2022). *Crowdfunding, Tokenisation And Reits - Technology - India*. Retrieved 10 March 2022, from https://www.mondaq.com/india/fin-tech/1025628/crowdfunding-Tokenisation-and-reits

Lindman, J., Tuunainen, V., & Rossi, M. (2017). Opportunities and Risks of Blockchain Technologies: A Research Agenda. *Proceedings Of The 50Th Hawaii International Conference On System Sciences*. doi:10.24251/hicss.2017.185

Nakamoto, N. (2017). Centralized Bitcoin: A Secure and High-Performance Electronic Cash System. *SSRN Electronic Journal*. doi:10.2139/ssrn.3065723

Real Estate TOKENISATION: Pros, Cons, and Challenges. (2022). Retrieved 10 March 2022, from https://www.commercialcafe.com/blog/real-estate-TOKENISATION/

Shin, G., Kim, J., & Kim, G. (2021). Real Estate Transactions in the Post-Corona Era: Introduction of Smart Contracts and Legal Issues. *Korea Association Of Real Estate Law, 25*(2), 1-28. doi:10.32989/rel.2021.25.2.1

Taniyama, T. (2019). Real Estate Crowdfunding: The Fusion of Real Estate, Finance, and Technology. *The Japanese Journal Of Real Estate Sciences, 32*(4), 54-59. doi:10.5736/jares.32.4_54

Ullah, F., & Al-Turjman, F. (2021). A conceptual framework for Blockchain smart contract adoption to manage real estate deals in smart cities. *Neural Computing And Applications*. doi:10.1007/s00521-021-05800-6

Uzair, M., Karim, E., Sultan, S., & Ahmad, S. (2022). *The Impact of Blockchain Technology on the Real Estate Sector Using Smart Contracts*. Greenwich University, Karachi.

Wouda, H., & Opdenakker, R. (2019). Blockchain technology in commercial real estate transactions. *Journal of Property Investment & Finance*, *37*(6), 570–579. https://doi.org/10.1108/jpif-06-2019-0085

X, C. (2020). *Upgrading Real Estate TOKENISATION to the Next Level*. Finextra Research. Retrieved 10 March 2022, from https://www.finextra.com/blogposting/21252/upgrading-real-estate-TOKENISATION-to-the-next-level

Xie, J. (2017). Who Is "Misleading" Whom in Real Estate Transactions? *Real Estate Economics*, *46*(3), 527–558. https://doi.org/10.1111/1540-6229.12196

Yapicioglu, B., & Leshinsky, R. (2020). Blockchain as a tool for land rights: Ownership of land in Cyprus. Journal Of Property, Planning And. *Environmental Law (Northwestern School of Law)*, *12*(2), 171–182. https://doi.org/10.1108/jppel-02-2020-0010

Zhao, J., Fan, S., & Yan, J. (2016). Overview of business innovations and research opportunities in Blockchain and introduction to the special issue. *Financial Innovation, 2*(1). doi:10.1186/s40854-016-0049-2

Zhu, H., & Zhou, Z. (2016). Analysis and outlook of applications of Blockchain technology to equity crowdfunding in China. *Financial Innovation, 2*(1). doi:10.1186/s40854-016-0044-7

Chapter 14
Cryptocurrency:
A New Investment Avenue in India

Pitresh Kaushik
Doon Business School, India

Neha Kukrety
Doon Business School, India

ABSTRACT

Cryptocurrencies started gaining popularity in 2017 because of the exponential returns despite their introduction in the year 2009. Cryptocurrency is now also seen as an investment opportunity by many especially after various cryptocurrencies have given unimaginable returns. Favourite investment avenues for investors were mutual funds, stock market, bonds, fixed deposits, etc., but cryptocurrencies have made their presence felt in recent times as an investment option and have seen a lot of inflow. Various start-ups are facilitating the investment in cryptocurrencies, making it feasible and reachable for every household to invest in in the hope of high returns. This chapter tries to analyse the returns that various cryptocurrencies have given since inception and compare the same with global benchmarks like NASDAQ, Nikkei, Sensex, etc. It is observed that despite very high volatility, cryptocurrencies were able to achieve very high returns as compared to stocks. The study also found a high positive correlation between the returns given by global indices and cryptocurrencies.

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INTRODUCTION

As a futurist, one of the things we try and do is not just look at what's going to happen in the future, analogies for what might happen based on what's happened in the past have to be looked at. "You have to be a good 'pastist,'". The isolated technologies like blockchain and digitizing which are being noticed because of consumers' low friction and immediacy can scale up to more rapidly in the global system. A decade runs at a faster pace. Within the last 10 years, technology has changed the way people bank and invest. From the era of the first currency being minted to digital banking, there is an amalgamation of the banking business and digital technology.

Traditionally, financial deals were cracked between two parties using fiat money which is now been replaced by an authentic chain of private networks through cryptography. For transferring digital money from one source to another, puzzle-solving techniques are rewarded in terms of cryptocurrencies. This is known as mining through blockchain technology. Satoshi Nakamoto conceptualized an accounting system post-financial crisis 2008 mooting an idea for transactions and value of money digitally on public availability. The same was mentioned on open ledgers (blockchain) containing all the transactions ever made through anonymous and encrypted forms. Cryptocurrency, a medium of exchange in a digital format uses encryption techniques to create monetary units and verify the exchange of money. Bitcoin topping the chart followed by Ethereum according to market capitalization. There have been voices calling for stable coins as an alternative to volatile cryptocurrencies. Recent cryptocurrencies have become a popular choice of alternative investment. These are digital currencies like Bitcoin (BTC), Ethereum (ETH), and many more. Alternative investments beyond usual stocks and bonds can be non-traditional assets like private equity, private debt, and other collectibles or can be exotic derivative investments like credit default swaps or mortgaged-backed securities.

The adoption of cryptocurrency proved to be most advanced in North America and Europe, covering other emerging countries like Asia, Latin America, Africa, and the Middle East. The concentration of merchants observed in North America and especially Europe covers P2P exchange platforms in almost 249 countries. The user database obtained from incorporated wallets providers exchanges payment platforms linked to the securities had covered 40% of cryptocurrency users based out of the Asia Pacific region. (Hileman et al, 2017). The role of exchange and trust attached to each of such exchange platforms hold significance in the cryptocurrency economy offering confident investment plans from the marketplace.

The market-specific factors which are predictive tools of returns dependent on cryptocurrency network factors and independent of production and cost of production of cryptocurrency devised strongly through the time-series momentum effect forecasting the returns (Liu & Tsyvinski, 2021).

The social sentiments of the investors during bulls and bears market situations have been drifted by the crypto market shift because of heterogeneity patterns of market behaviors. The trend was seen that a positive response was based on the bulls effect and the bears' effect was more evident with a downward trend.(Kim et al,.2021)

The common risk factor in cryptocurrency can be linked to the cryptocurrency market, its size, and momentum of returns listing market-related factors in the stock market and constructing their cryptocurrency counterparts. Crypto long-short strategy under three-fold model constructs fit sizable and statistically significant returns (Liu et al., 2019).

The existence of Bitcoin, Litecoin, Ripple, and Dash over half a decade indicated the endurance of setting up a correlation between its past and future values. (Caporale et al, 2018). Primecoin being the first cryptocurrency in the market dearth of hashcash proof-of-work is used therein Bitcoin these days. Thus, proof-of-work in cryptocurrency helped in advanced transition providing both security and scientific computing values to maintain dominance in the long term. (King, 2013)

Digital currencies globally known for their volatility have bounced backed strongly in 2020. Post the crash of bitcoin in 2018 the digital currency has squirt roughly 800 percent. The popularity of cryptocurrencies was racked in 2018 turning dormant for the most part of 2019. The virtual currencies evolution over the past decades proved to be a virtue for economic growth. The global investment portfolios clasping the digital coin as an alternative asset to equity, gold, mutual funds, and real estate. The start-ups in the world looking forward to venturing into capital financing have diluted their preference from stock sales-based investment to cryptocurrencies in the apprehension of high returns.

A smart contract is a piece of code signed as a solidity agreement between multiple people agreeing upon certain conditions when successfully met. Investment in cryptocurrency surged along with that of NFT because of smart contracts as these contracts are immutable and are distributed. This helps to control bugs, as these contracts cannot be changed and only new contracts can be created mentioning not to use the old ones. This happens very often and the contract doesn't carry any discrepancies as it's used to avoid human errors. Thus, financial agreements are done under codes that cannot be changed. Smart contracts are capable of giving rise to the next generation of super entrepreneurs. These contracts render transactions that are traceable, transparent, and irreversible. (Mell et al.,2017)

The wallet holders as creditors and debtors of a smart contract automatically enter the multilateral agreements as participants. (Geiregat, 2018).

Blockchain technology entices the ecosystem ensuring enhanced security in the context of cryptocurrency dominance through the Internet of Things (IoT). Proof of work in the digital ledger usage has become least incorruptible using a public key (PK) as a distinctive identity maintaining the privacy of individuals. (Miraz & Ali, 2018).

The introduction of Nano grid architecture cryptocurrency in which accounts have their blockchain with unlimited scalability, making the transaction faster through direct networks. Transactions keep track of account balances rather than transaction amounts, concentrating on serious data mining without hampering the security of users becoming feeless in a brief moment. (LeMahieu, 2018).

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Blockchain analysis mentions crypto in India has grown 200 times in the past year, from $200 million to nearly $40 billion. About 15 million cryptocurrencies are been traded in India i.e more than 65 percent of that US numbers. The reason behind the trust factor for this new era investment can be Encryption algorithms which are allowing secure payments online, that cannot be counterfeited and maintained as" tokens" or ledger entries. Although, Pump-and-dump schemes (P&Ds) are penetrating the cryptocurrency market leading to short-term increases in price, volume, and volatility. Price brow and trough being noticed within minutes implies significant wealth transfers between insiders and outsiders. (Li et al., 2021).

Post-April 2021, the Ethereum (ETH) market cap grew to over $250 billion. Companies like JP Morgan, AWS (Amazon Web Service), Microsoft Azure, etc started adopting Ethereum-based applications. Polkadot Crypto (DOT) is being offered by financial institutions like Goldman Sachs, JPMorgan, ICAP, and UBS have bought the first ETP (Exchange-Traded Product). Cardano (ADA) plans to rehabilitate the education system in Ethiopia through its blockchain technology. Dogecoin gained popularity post-Elon Musk tweet referring to two brothers who fight out of Jealousy slanting to DogeCoin and Shiba Inu. Companies like NBA's Dallas Mavericks, Kessler Collection (luxury hotels), AirBaltic (Latvian Airlines), Such list, Strange Donuts, STEEM, Burger Bear, All Gamer, etc. planned to adopt DogeCoin as means of payment. Binance Coin the world's largest cryptocurrency exchange became the first to trade other cryptocurrencies. The exceptional performance of other asset classes can enhance potential returns while reducing overall portfolio risk.

The Creation of Credence in Cryptocurrencies

Cryptocurrencies have become immensely popular since the introduction of bitcoin in 2009. The market speculation on cryptocurrencies is negatively associated with returns after controlling for a variety of factors, such as supply growth and liquidity. The weekly positive returns are associated with the supply prior to market research, predicting the industry rather than speculating the market. (Wang & Vergne, 2017).

Most cryptocurrencies are decentralized networks based on blockchain technology, which is a distributed ledger spread over a wide network of computers. The oldest amongst the whole lot is Bitcoin, with thousands of other alternatives offering differentiated risk and return characteristics. The new field of cryptographic currencies and consensus ledgers: blockchains, has become popular almost in all different communities. "These diverse Communities include technical enthusiasts, activist groups, researchers from various disciplines, start-ups, large enterprises, public authorities, banks, financial regulators, businessmen, investors, and also criminals". The adaption though slow for quite a while has reached a hype with the only resource available i.e Bitcoin. Excogitation in this new age of development has brought in fast free software development introducing various other cryptocurrencies for acceptance. There exists a gap that can be structured with a technical viewpoint The paradigm for modern cryptographic currencies i.e Bitcoin verifies the authenticity through the combination of the proof-of-work via the peer-to-peer network (Nakamoto consensus). (Judmayer et al., 2017).

Due to the steaming profits, the digital currency has become popular amongst new-age investors. The platform for digital currencies investment using digital wallets stood incompetent in explaining the functioning of the financial markets using an efficient market hypothesis The comparison between Bitcoin, Ethereum and Litecoin was drawn to estimate the volatility in investments for different cryptocurrencies. The Hurst exponent methodology used for application to examine long-range memory in some of the cryptocurrency's markets led to conclusions like (i) Long memory exists in the selected cryptocurrencies; (ii) Ethereum market is more persistent than Bitcoin and Litecoin as its Hurst exponent is more than the other cryptocurrencies. The findings helped the policymakers and investors while making prudent decisions regarding investment in the emerging cryptocurrencies market. (Hameed et al, 2021).

Over 30 years of coincident crises have collectively cost the world's economies $30 trillion with the emergence of the internet resulting in an exponential stream of online sales evolving into cryptocurrencies. "The mysterious Satoshi Nakamoto (2008) created Bitcoin as a purely peer-to-peer electronic cash system, removing trusted third parties (bitcoin serves as a digital unit of account of Bitcoin network)". The psycho love for those exponential returns can also lead to swipe fall or collapse of Bitcoin (Kindleberger, 1978).

Some who advocate the dominance of Bitcoin in the future mentioning it as a global reserve currency believe in “this time is different” (Reinhart & Rogoff, 2008). “Financial turmoil in the new millennium together with the United States’ abuse of sanction power since the 2008 global financial crisis have re-emerged the interest in the search for a viable alternative to the U.S. dollar”. The price of Bitcoin is expected to grow exponentially higher hitting $1 million by 2040 (John, 2018).

The cryptocurrency market transcended the roadblock of $100 billion market capitalization in June 2017. The informative basis lacked because of unawareness of other cryptocurrencies than Bitcoin. From 2013 to 2017 multiple cryptocurrencies reached out to super-exponential market growth though disappeared abruptly. Ecological adoption and meeting out the empirical observation’s assumptions on one over other cryptocurrency created a spark of growing market research studying 1469 cryptocurrencies, of which around 600 were active by that time.

Adopting an ecological perspective, studies show that the so-called neutral model of evolution can reproduce several key empirical observations, despite its simplicity and the assumption of no selective advantage of one cryptocurrency over another. “The results shed light on the properties of the cryptocurrency market and establish the first formal link between ecological modeling and the growing system. The anticipation will spark further research in this direction”. (Abeer et al, 2017).

Popular tokens of 2018 like Bitcoin, DASH, Litecoin, Monero, Ripple, and Stellar with a market capitalization above $0.5 billion, uncovering surprising results. The historical currencies are analyzed inefficiently without any opposition over the analyzed period mentioning the efficiency and ranking being dependent on the denomination (the US dollar or Bitcoin). Major coins especially DASH became efficient from 2017 to 2018 except for the least efficient coins i.e Ethereum and Litecoin (Kristoufek and Vosvrda, 2019). The Ethereum (ETH) had 2nd market capitalization after Bitcoin. Taking time series analysis Bitcoin gained more attention than Ether based on log returns on daily volatility. Using the Vector Machine algorithm for testing the marginal predictability level Ether mediated triangular arbitrage between six major fiat currencies which stated an increase in the Ether market over the period. (Pichl et al, 2020).

Cryptocurrencies are likely to offer more rigorous regulations than some other types of unorthodox investments. The Covid-19 pandemic thrashed economies around the globe leading to strict lockdowns imposing devastating consequences on world economies and mainstream investments. An amplifying number of global investors are looking thoughtfully for a longer period of time in digital coins instead of gold. This article tries to identify the effects of coronavirus on blockchain and cryptocurrency. The benefits and drawbacks of adopting cryptocurrency and the future of bitcoin after the pandemic are also being analyzed. The assay of the future of cryptocurrency in the coming years will be floated on the NASDAQ adding credibility to blockchain-backed by the exchange-traded fund.

Coeval cryptocurrencies lack the legal, monetary, and institutional assistance that traditional financial services employ. After the Industry revolution, 5.0 technology reinforced cryptocurrency's trust in the economy. The reliability constructs a users' trust in technology post blockchain development making a significant trust in Bitcoin amongst investors. The transforming phenomenon brought radical changes in the digital markets globally. Banking and financial institutions' revolution post industry 5.0 introduction cater to the market with cryptocurrencies (Woodford, 2019).

Cryptocurrency: Paving the Way for Future of Start-Ups

Chain analysis working hard to build up trust across the ecosystem providing banks, financial institutions, government agencies, etc. artificial intelligence awareness for blockchain acceptance worldwide. Digital Portfolio being brought and sold by the users either through coin base or cryptocurrency are breaking down the barriers of acceptance forming a nationwide network of cryptocurrency Kiosks, accepting cash investment, and storing investment via Coinme application. IBM the tech giant, integrating hyper ledgers helped more than 200 businesses develop applications and data governance tools that run on the blockchain. FinTech has brought blockchain-powered investment platforms for users to invest in start-ups, real estate, crypto, and gaming associations becoming angel investors and building up a robust portfolio. The information transfer is faster but secure between businesses using transparency and real-time data ledger technology. Companies providing platforms allowing users cash loan facilities based on the leverage of their cryptocurrency like bitcoin, ether dogecoin, etc for short-term ranging up to 36 months have made start-up investment seamless. Digital assets exchanges on other hand have helped the ecosystem, allowing individuals and institutional investors to trade everything from Bitcoin to Litecoin and Ether. When public blockchain ledger and various solutions to trustless speculate institutional permissions of blockchain, crypto trading will then increase the industrial strength. Security token offerings & Initial token offerings will pave the way to a direct electronic IPO market (Low & Marsh, 2019).

CONTEXT AND DISCUSSION

Cryptocurrency as an Investment Option

When it comes to investment, people in India generally opt for instruments that guarantee returns with minimum risk. Though there are investments options like stocks, FDs, forex, bonds, etc. but people are slowly taking up the idea of investing in cryptocurrency looking at the huge returns provided to them in recent years. Table 1 below summarises the annual returns comparing the indicators of the share market i.e, Sensex and Nifty with the two largest cryptocurrencies in terms of volume which are Bitcoin and Ethereum.

Table 1. Summary of annual returns given by cryptocurrencies and indicators of stock market

Period		**Annual Returns**			
From	**To**	**Sensex**	**Nifty**	**Bitcoin**	**Ethereum**
Jan-21	Dec-21	20.05%	22.12%	96.51%	529.01%
Jan-20	Jan-21	15.56%	14.70%	302.31%	469.51%
Jan-19	Jan-20	14.35%	12.13%	94.00%	-2.04%
Jan-18	Jan-19	6.17%	3.32%	-73.22%	-82.10%
Jan-17	Jan-18	27.51%	28.28%	1337.67%	8917.99%
Jan-16	Jan-17	2.34%	3.42%	124.05%	-
Jan-15	Jan-16	-5.04%	-4.04%	35.14%	-
Jan-14	Jan-15	29.51%	30.82%	-60.52%	-
Jan-13	Jan-14	8.76%	6.50%	5869.63%	-
Jan-12	Jan-13	25.61%	27.96%	187.23%	-
Jan-11	Jan-12	-24.67%	-24.88%	1466.67%	-
Average Returns		**10.92%**	**10.94%**	**852.68%**	**1966.48%**

Source: Official Website of “Bombay Stock Exchange” (BSE) and “National Stock Exchange” (NSE) and Investing.com

It clearly shows that the annual returns in the past decade were higher in the case of cryptocurrencies except for two instances. Incomparable returns can be seen between stock market indices and cryptocurrencies where Sensex and Nifty had given returns averaging 10.92% and 10.94%, Bitcoin was able to give 852.68% average returns. Ethereum started late and was able to register average annualized returns of 1966.48%. These figures are evident enough to draw the attention of Indian investors and the investment volumes saw an increase by leaps and bounds. The market capitalization of Bitcoin amounted to $893.77 Billion whereas Ethereum clocked a $ 451.69 Billion market capitalization as per the last data available in December 2021.

Stocks and cryptocurrency both are volatile but data suggests that cryptocurrency is very volatile. Stocks have different kinds of risks like business risk, financial risk, government regulations, volatility risk; while cryptocurrency is a decentralized structure that is not yet backed by the government in India as the government does not have any control over cryptocurrency and the same can be used for illegal purposes as well.

Comparison of Global Benchmarks with Cryptocurrencies

Table 2 below analyses the monthly returns are given by six-global indices as they represent the most reliable companies in the world. These returns are compared with the returns given by the top five cryptocurrencies in terms of volume according to the latest data. The analysis not only compares the returns of indices with cryptocurrencies but also compares the volatility of returns.

Looking globally, the biggest indices of the world like NASDAQ, FTSE, Shanghai, Euronext, Nikkei, and DAX are compared with the top five cryptocurrencies in terms of volume. In Table 2, it can be observed that the monthly returns of global indices are looking weaker against the monthly returns given by cryptocurrencies. NASDAQ was able to manage a maximum mean of monthly returns of 1.47% which is much weaker as compared to 16.88% by Bitcoin, 16.20% by Ethereum, 24.37% by Binance, and 61.72% by Solana. Tether was the only exception which has given lower returns of 0.14%.

But at the same time, observing the volatility of returns, returns of cryptocurrencies are very much volatile as compared to that of global indices. Where the global indices have a standard deviation ranging from 3.54% to 5.4%, cryptocurrencies have a much higher standard deviation ranging from 44.86% to 105.81% Tether again remaining an exception with 2.07%. Variance also strengthens the conclusion with respect to volatility and global indices shows a very low variance ranging from 0.13% to 0.36% whereas cryptocurrencies show a very high variance ranging from 20.12% to 111.95% with Tether as an exception at 0.04%. This is evident enough to prove that the cryptocurrencies had given a higher return as compared to global indices but with higher volatility as well.

Table 2. Descriptive stats of monthly returns of global indices and cryptocurrencies

	NASDAQ	***FTSE***	***Shangahai***	***Euronext***	***Nikkei***	***DAX***	***Bitcoin***	***Ethereum***	***Binance***	***Tether***	***Solana***
Mean	1.47%	0.21%	0.37%	0.56%	0.90%	0.73%	16.88%	16.20%	24.37%	0.14%	61.72%
Standard Deviation	4.64%	3.54%	6.03%	4.49%	5.13%	5.40%	59.03%	44.86%	75.75%	2.07%	105.81%
Sample Variance	0.22%	0.13%	0.36%	0.20%	0.26%	0.29%	34.84%	20.12%	57.38%	0.04%	111.95%
Kurtosis	165.55%	215.30%	267.84%	386.09%	30.63%	255.34%	3319.72%	549.09%	1493.70%	3226.79%	72.68%
Skewness	-40.82%	-43.82%	2.77%	-67.12%	-29.11%	-74.08%	505.84%	182.38%	369.97%	467.92%	129.85%
Range	30.31%	26.16%	43.84%	37.00%	28.35%	35.39%	509.75%	267.26%	420.18%	18.09%	362.08%
Minimum	-13.93%	-13.81%	-22.78%	-19.89%	-13.14%	-20.14%	-38.87%	-53.77%	-46.15%	-4.72%	-46.52%
Maximum	16.38%	12.35%	21.06%	17.11%	15.20%	15.24%	470.88%	213.49%	374.02%	13.37%	315.56%
Count	130	130	130	130	130	130	130	68	48	55	16

Source: Investing.com

Cryptocurrency as an Investment Option in India

Post comparing the returns of Bitcoin and Ethereum with Sensex and Nifty, it was clearly seen that there is a huge difference in the returns which has certainly made cryptocurrencies a very appealing option for investors. From January 2011 to December 2011, Sensex and Nifty were able to give only 178.17% and 176.67% returns respectively. On the other hand, during the same period, Bitcoin has given 18963800% returns as its price was only $ 0.3 in January 2011. Since its introduction in April 2016, Ethereum has given 40467% returns as compared to 13586% return of bitcoin and 126.72% and 121.45% of Sensex and Nifty respectively.

Table 3. Descriptive stats of monthly return of Indian indices mean differences

	Sensex Return	Nifty Return	Bitcoin Return	Ethereum Return	Tether Return	Binance Return	Solana Return
Mean	0.91%	0.91%	17.26%	16.20%	0.14%	24.37%	61.72%
Standard Deviation	4.91%	5.03%	58.96%	44.86%	2.07%	75.75%	105.81%
Sample Variance	0.24%	0.25%	34.76%	20.12%	0.04%	57.38%	111.95%
Kurtosis	420.38%	409.57%	3293.95%	549.09%	3226.79%	1493.70%	72.68%
Skewness	-90.22%	-87.17%	502.11%	182.38%	467.92%	369.97%	129.85%
Range (%)	35.59%	36.64%	509.75%	267.26%	18.09%	420.18%	362.08%
Minimum (%)	-24.17%	-24.62%	-38.87%	-53.77%	-4.72%	-46.15%	-46.52%
Maximum (%)	11.42%	12.02%	470.88%	213.49%	13.37%	374.02%	315.56%
Count	131	131	131	68	55	48	16

Source: Investing.com and official website “Bombay Stock Exchange” (BSE) and “National Stock Exchange” (NSE)

As mentioned in Table 3, it is clearly seen that the mean return of Bitcoin, Ethereum, Binance, and Solona is much higher as compared to Nifty and Sensex. The mean return of sensex and nifty stood at 0.91% which is higher than other global indices except for NASDAQ which has given a 1.47% mean return. On the other hand, mean returns given by cryptocurrencies range from 44.86% by Ethereum to 105.81% by Solana which are much higher than that of nifty and sensex. Although, Tether was the only cryptocurrency that had not given higher returns and had a mean monthly return of only 2.07%.

At the same time, it is imperative to note that the Standard Deviation and Variance of Bitcoin, Ethereum Binance, and Solona is much higher as compared to Sensex and Nifty. Where the standard deviation for sensex and nifty is 4.91% and 5.03%, the standard deviation for bitcoin records 58.96%, ethereum records 44.86%, binance records 75.75% and solona records the highest standard deviation of 105.81%. Variance also indicates the same story and points that cryptocurrencies are much more volatile as compared to stock market indices. Sensex and nifty records only 0.24% and 0.25% variance as compared to 34.76%, 20.12% 57.38%, and 111.95% variance of bitcoin, ethereum, binance and Solana respectively.

There is not much significant difference observed in kurtosis between sensex, nifty and ethereum which were 420.38%, 409.57% and 549.09% respectively. Binance observes kurtosis of 1493.70% whereas bitcoin and tether records a higher kurtosis of 3293.95% and 3226.79% indicating that investors had experienced extreme returns at times. Solana shows a kurtosis of only 72.68% indicating less extreme returns but the same has less observation as compared to others in the table due to its late introduction.

After observing the minimum and maximum percentage of monthly returns, it was found that sensex and nifty had not shown very high monthly returns during the period. Maximum returns were 11.42% for sensex and 12.02% for nifty which were much lower than the highest monthly returns of cryptocurrencies. The maximum returns of bitcoin were 470.88%, Ethereum was 213.49%, 374.02% for Binance, and 315.56% for Solana but there is not much difference between the minimum returns. Although the minimum returns for bitcoin were -38.87% ethereum was -53.77%, binance was -46.15% and Solana was -46.52% but they were very much comparable with sensex at -24.17% returns and nifty at -24.62% returns.

Tether has been an exception in the above analysis. It had given mean returns of only 0.14% which was lower than the mean returns of sensex and nifty. Its standard deviation and variance is lower than other cryptocurrencies as well as share market indices which makes it less volatile. It had given much fewer returns as compared to other currencies as well as indices and does not fall in line with the analysis of other cryptocurrencies.

Impact of Returns by Indices on Returns by Cryptocurrencies

When looking at cryptocurrencies as an investment avenue, then analysis of an existing correlation between the returns given by various indices and cryptocurrencies can be established. Table 4 attempts to take out the correlation of monthly returns of all the cryptocurrencies with the monthly returns given by global indices.

Table 4. Correlation of returns given by cryptocurrencies and indices

	Global Indices								
Cryptocurrencies	**NASDAQ**	**FTSE**	**Shangahai**	**Euronext**	**Nikkei**	**DAX**	**Sensex**	**Nifty**	**Average**
Bitcoin	0.883	0.248	0.442	0.708	0.724	0.694	0.832	0.825	**0.669**
Ethereum	0.824	0.071	0.646	0.813	0.783	0.811	0.848	0.867	**0.708**
Binance	0.823	0.038	0.634	0.803	0.791	0.807	0.859	0.868	**0.703**
Tether	-0.004	0.677	0.551	0.705	0.421	0.606	0.801	0.798	**0.569**
Solana	0.776	0.677	0.551	0.705	0.421	0.606	0.801	0.798	**0.667**
Average	**0.660**	**0.342**	**0.565**	**0.747**	**0.628**	**0.705**	**0.828**	**0.831**	**0.663**

Source: Investing.com and official website "Bombay Stock Exchange" (BSE) and "National Stock Exchange" (NSE)

It can be observed in Table 4 that there is a highly positive correlation between the monthly returns given by cryptocurrencies and global indices. Returns given by Sensex and Nifty have a very high average correlation of +0.828 and +0.831 with the cryptocurrencies followed by Euronext and DAX with +0.747 and +0.705 respectively. FTSE is having the lowest average correlation with cryptocurrencies reaching only +0.342. There is just one negative correlation by a very nominal margin which is between NASDAQ and Tether of -0.004. It can be concluded reasonably that there is a higher positive correlation between the returns given by global indices and cryptocurrencies.

CONCLUSION

There is no second opinion to the fact that Indian investors had now started looking at cryptocurrencies as an investment option. Cryptocurrencies have become an increasingly popular choice of investment for investors as a diversification strategy. Crypto has made investing easily attainable to far-flung people filling the gap between alternative as well as traditional investments. Four out of five largest cryptocurrencies had given significantly higher returns as compared to share market indices. At the same time, much higher volatility is also seen in the cryptocurrencies as compared to stock market indices, and sensex and nifty are giving less but consistent returns. It was also found that there is a high positive correlation between the returns given by global benchmarks like NASDAQ, Nikkei, Sensex, and cryptocurrencies. Although, these are early days for cryptocurrencies to establish themselves as an investment option, especially under uncertainty that looms in the absence of a regulatory framework it is also true that due to significantly higher returns, they were successful in luring a great chunk of investors towards them.

REFERENCES

Caporale, G. M., Gil-Alana, L., & Plastun, A. (2018). Persistence in the cryptocurrency market. *Research in International Business and Finance*, *46*, 141–148. doi:10.1016/j.ribaf.2018.01.002

ElBahrawy, A., Alessandretti, L., Kandler, A., Pastor-Satorras, R., & Baronchelli, A. (2017). Evolutionary dynamics of the cryptocurrency market. *Royal Society Open Science*, *4*(11), 170623. doi:10.1098/rsos.170623 PMID:29291057

Geiregat, S. (2018). Cryptocurrencies are (smart) contracts. *Computer Law & Security Review*, *34*(5), 1144–1149.

Hameed, Z., Shafi, K., & Nawab, S. (2021). Long Term Memory Effect in Selected Cryptocurrencies. *Research Journal of Social Sciences and Economics Review*, *2*(2), 255–263.

Hileman, G., & Rauchs, M. (2017). *Global cryptocurrency benchmarking study*.

Judmayer, A., Stifter, N., Krombholz, K., & Weippl, E. (2017). Blocks and chains: Introduction to bitcoin, cryptocurrencies, and their consensus mechanisms. Synthesis Lectures on Information Security, Privacy, &. *Trust*, *9*(1), 1–123.

Kim, K., Lee, S. Y. T., & Assar, S. (2021). The dynamics of cryptocurrency market behavior: Sentiment analysis using Markov chains. *Industrial Management & Data Systems*.

King, S. (2013). Primecoin: Cryptocurrency with prime number proof-of-work. *July 7th, 1*(6).

Kristoufek, L., & Vosvrda, M. (2019). Cryptocurrencies market efficiency ranking: Not so straightforward. *Physica A*, *531*, 120853. doi:10.1016/j.physa.2019.04.089

LeMahieu, C. (2018). *Nano: A feeless distributed cryptocurrency network*. Nano. https://nano. Org/en/whitepaper

LiT.ShinD.WangB. (2021). Cryptocurrency pump-and-dump schemes. SSRN, 1-58.

Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. *Review of Financial Studies*, *34*(6), 2689–2727. doi:10.1093/rfs/hhaa113

Liu, Y., Tsyvinski, A., & Wu, X. (2019). Common risk factors in cryptocurrency (No. w25882). National Bureau of Economic Research.

Low, R., & Marsh, T. (2019). Cryptocurrency and blockchains: Retail to institutional. *Journal of Investing*, *29*(1), 18–30.

Mell, P., Kelsey, J., & Shook, J. (2017). Cryptocurrency Smart Contracts for Distributed Consensus of Public Randomness. In P. Spirakis & P. Tsigas (Eds.), Lecture Notes in Computer Science: Vol. 10616. *Stabilization, Safety, and Security of Distributed Systems. SSS 2017*. Springer.

Miraz, M. H., & Ali, M. (2018). *Applications of blockchain technology beyond cryptocurrency*. arXiv preprint arXiv:1801.03528.

Mukhopadhyay, U., Skjellum, A., Hambolu, O., Oakley, J., Yu, L., & Brooks, R. (2016, December). A brief survey of cryptocurrency systems. In *2016 14th annual conference on privacy, security and trust (PST)* (pp. 745-752). IEEE.

Pichl, L., Nan, Z., & Kaizoji, T. (2020). Time series analysis of ether cryptocurrency prices: Efficiency, predictability, and arbitrage on exchange rates. In *Advanced studies of financial technologies and cryptocurrency markets* (pp. 183–196). Springer.

Taskinsoy, J. (2018). *Bitcoin Mania: An End to the US Dollar's Hegemony or another Cryptocurrency Experiment Destined to Fail?* Available at SSRN 3311989.

Wang, S., & Vergne, J. P. (2017). Buzz factor or innovation potential: What explains cryptocurrencies' returns? *PLoS One*, *12*(1), e0169556.

Chapter 15
Blockchain Application in Retirement Planning Investment:
Improving Transparency and Viability

Anup Sharma
https://orcid.org/0000-0002-4065-3319
Lovely Professional University, India

Nitin Gupta
Lovely Professional University, India

ABSTRACT

Retirement planning is a crucial step in any individual's life, yet many complain of dissatisfaction with the plan they made before retirement. Many variables, the uncertainty of life, and socio-economic shocks make this planning difficult. At times, an action plan needs some adjustments, which can be made through financial institutions. Any loan or scheme offered to an individual involves risk calculation. Transparency in records and the complete history of an individual's financial transactions can help institutions access risk correctly. Linking transactions and other details with blockchain technology can improve transparency and can make retirement saving plans viable for individuals. This chapter explains the relevance of blockchain technology in context to retirement planning investment. This chapter also suggests a blockchain model that can be implemented by financial institutions to make their products favorable.

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INTRODUCTION

Blockchains are digital ledgers that are considered to be tamper-evident and tamper-resistant. These ledgers are without any central repository and are implemented in a distributed fashion. This system enables users to record transactions but at the same time, restrict restricts any change post-publication. This concept of blockchain is applied in many areas and improvement in transparency and security is reported (Arshadi, 2019).

Systems can be made autonomous by implementing blockchain technology (Antonopoulos, 2014). Such systems can work without too much of human intervention and thus mathematical calculations can be trusted over people.

This concept can be applied in areas other than financial transactions and cryptocurrencies (Lamberti et al., 2017; Oberoi & Kansra, 2021). Any organization can implement blockchain technology and can store data with it. Such data can be updated, and new blocks can be created with updated information. Though updating of data is done the history of such actions will be available to users. These transactions, including deletion or addition, can be validated by participants by reaching a consensus.

Organizations may choose from two different approaches: permissionless network and permissioned network. The permissionless network is open to the public where no authorization is required for reading or writing to the blockchain. Under permissioned networks, permission is granted to certain individuals or organizations. The authority granting these permissions are difficult to identify and thus present design issues. Both approaches have their advantage and organization may choose based on their requirements.

ISSUES FACED BY FINANCIAL INSTITUTIONS

Financial institutions face the following issues while giving loans to individuals:

The Authenticity of Applicant: Any applicant may have to furnish identity by officially verified documents. If these documents are not linked to each other than different loan accounts may not be mapped correctly. It is also possible that certain details might be updated in documents. Through blockchain, updates in details of an individual will be recorded. Thus, documents available with institutions will be always updated and validated.

Transparency in Financial History: Financial transactions done with financial institutions can be recorded as information mapped against an individual. This information can be saved in blockchain (Lee D., 2016). Any further transaction adds more information and thus, more blocks into the system. It will be impossible to hide any transaction. Institutions can get the complete history of an individual and can thus calculate risk appropriately.

Product Viability: Financial products are designed to address a larger customer base. These products consider associated risk with the customer. Institutions face problems in getting the complete financial history of an individual. Actions taken by an Individual, with other institutions, may also reflect attitude. This helps institutions to compute associated risk accurately, rather than taking conservative numbers. Such actions can reduce overall risk and the same may be reflected as lesser interest on loans. Better offerings can make products viable for the larger population.

Thus, the use of Blockchain technology is expected to give good results and may make the retirement planning industry more lucrative. In the following section, relevant blockchain components are explained in our context. The further section will use these ideas, to frame a blockchain model, suitable for investment and insurance aspects of retirement planning.

BLOCKCHAIN COMPONENTS

Multiple components of Blockchain can be utilized for the model. These components are:

1. Cryptographic Hash Functions

Hashing is a process where any data can be converted to its "digest". This hash function can be applied to a file, text, or even to an image. This is believed to generate a digest that is unique for data but can't be the same for any other data. Any small change in data will generate a different digest. Thus, data integrity can be confirmed by comparing their digest (National Institute of Standards and Technology, 2015).

Hash functions are secure as it is infeasible to compute input values from a digest. Additionally, it is impossible to find another input that can give a similar digest. Even searching two input values that can give the same digest is computationally infeasible (National Institute of Standards and Technology, 2015).

Thus, following functions hold true:

If, f (Hash (I_1)) = Digest (D_1) and f (Hash (I_2)) = Digest (D_2),
Then, f^{-1} (D_1): Impossible to calculate
And, If ($D_1 = D_2$), Then, $I_1 = I_2$;
And, If ($D_1 \,^{1}\, D_2$), Then, $I_1 \,^{1}\, I_2$

A Secured Hash Algorithm (SHA) is used in the implementation of various blockchains. This algorithm has an output size of 256 bits (SHA-256).

256 bits = 32 bytes = 2^{256} (= 10^{77}) possible digest values

Though this size of possible output values looks finite but to get any repetition, it would require 10^{13} years of computation for the blockchain network. Thus, the output can fairly be considered infinite and the chances of any collision in output are almost impossible.

The above discussion supports the fact that any new data will always generate a different digest and thus, uniqueness of data is ensured. An arbitrary but unique number ("nounce") is added to the data before calculating the digest. Same data will have the same nounce and thus same digest but similar data will get different nounce and thus different digest (National Institute of Standards and Technology, 2015).

2. Transactions

Transactions in blockchain refer to any interaction between two or more involved parties. This transaction need not be only of cryptocurrency. In a business, activities may occur on physical or digital assets. Transactions may be the recording of such activities (Lamport, 1998).

Every blockchain may have different data comprising of transactions. In our case, a user may send account details, digital signatures or keys, transaction input and output. Attributes of an individual may change with any event and such change may be recorded (Nakamoto, 2008). Expenses, income and investments information can be recorded as transactions. All such information is unique for an individual and thus validation through an individual's private key can be verified by an associated public key.

3. Key Cryptography

There exist two types of key cryptography: asymmetric and symmetric. Asymmetric key cryptography is used in blockchain technology.

Asymmetric Key Cryptography

There exist two types of keys: private and public keys. These keys are related to each other mathematically. A private key is kept secret and can be used to retain the safety of information. The public key can be made available to the public without risking security. Even though a public key is available, generating a private key from it is almost not possible. Encryption and decryption are done as followed:

Document => Encrypt (Private key) => Encrypted Document=> Decrypt (Public key) => Document

Or

Document => Encrypt (Public key) => Encrypted Document=> Decrypt (Private key) => Document

In the case of a public transaction, a digital signature is done through a private key. Only a linked public key can decrypt the document. It will ensure that only the concerned user can decrypt it with the private key. Similarly, any document may be submitted with public-key encryption. Only users with access to the linked private key can decrypt the document.

This method is used when parties have trust and authenticity issues.

Symmetric Key Cryptography

This method is adopted where both parties have trust or both have already shared a common private key. In this case, encryption and decryption are done by a common private key. Encryption and decryption are done as:

Document => Encrypt (Private key) => Encrypted Document=> Decrypt (Private key) => Document

This process is faster but finding trusted parties are difficult.

Asymmetric - Symmetric Mix Key Cryptography

This method uses the benefits of both Asymmetric and Symmetric key cryptography (Narayanan et al., 2016). Encryption and decryption are done through Symmetric key cryptography. The private key used in the process is encrypted and decrypted using Asymmetric key cryptography. The process is:

Step 1:

Document => Encrypt (Private key) => Encrypted Document=> Decrypt (Private key) => Document

And, Step 2:

Private Key => Encrypt (Private key 2) => Encrypted Key=> Decrypt (Public key 2) => Private Key

4. User Address and Private Key

In a blockchain, any transaction is linked with Input and Output. Thus, both parties need to be identified for recording a transaction. Multiple methods are used to create the address, but the private key is used widely to create an address (National Institute of Standards and Technology (NIST), Digital Signature Standard). A private key can be generated which is unique for a party. The cryptographic hash function can be applied to this private key. Digest generated in this process will be unique for a private key and thus for a party. This digest can be taken as an address of a party. The process is as followed:

Party 1: Private key => hash function (Private key) = Digest => Digest = Address (Party 1)

In any system, private keys may be distributed through Asymmetric - Symmetric mix key cryptography. Any transaction information can be mapped to an individual address by mapping private keys to records.

In this process, private key storage becomes crucial. Digital assets linked with this key are lost if the key itself is lost by the user. If any hacker gets access to this key, the transaction can be done and it will be recorded in the blockchain. Reverting is impossible as transactions can't be undone in a blockchain.

5. Ledgers

In accounting, a ledger is used to record the exchange of goods and services. These transactions can be stored digitally in large databases. In a blockchain network, multiple copies of this ledger are created. These copies can update and sync data among peers. Blockchain works on a heterogeneous network of software and hardware and thus, if one node is attacked, other nodes may be safe. These distributed ledgers are across the globe (Lamport, 1978). This ensures that data loss, due to any geographical event in a region, is prevented. Any malicious node can be easily identified and can be avoided from propagation. Thus, any invalid transaction will be ignored in the blockchain. A new node always takes a reference to the previous node. It ensures that blockchain is expanded over valid transactions. As the transactions in the ledger are encrypted, users can be sure that data was never tempered (Peter & Panayi, 2016). This distributed network provides publicly available information on multiple points. Attacking multiple points becomes impossible and damage may be limited to an unpatched individual node.

According to Swanson (2015), a state of ledger is validated by majority of validators in the network. This coherence across multiple nodes is done through set of rules and procedures. Any transaction is held for certain duration for validation and then transferred to the node for integration.

6. Blocks

In a blockchain, any transaction is transferred to the network through software or web applications. This transaction is sent to the node and propagated to other nodes. This pending transaction is then added to the blockchain through the publishing node (Peck, 2017).

When a block is published then a transaction can be assumed to be added to the blockchain. In any block, block data and block header are present. Block data contains a list of validated transactions while the block header has metadata of the block. Block header consists of block number (also called block height), the hash value of the previous block, the hash value of the block, timestamp, size of a block, and the nounce. Block data may include other ledger events and some miscellaneous information, in addition to the list of transactions. Validation of each block of data is done by ensuring that it is properly formatted and is digitally signed by the provider. The same validation is done across the other full nodes. Once validation is done and the authenticity of data is confirmed, the block is accepted in the blockchain.

7. Block-Chaining

Block consists of a block header and block data. The digest of a block is used as one of the components of the next block. This process keeps repeating to link all blocks into a blockchain. It works as followed:

For any Nth block,

$$\text{Block, B (n)} = [\text{Block Header, BH (n)} + \text{Block Data, BD (n)}]$$

Where,

$$\text{BH (n)} = \text{Hash [BH(n-1)]} + \text{Hash [BD (n)]} + \text{Timestamp (n)} + \text{Nounce (n)}$$

This system also ensures that data is not tempered in any previous block. Any change in data will change the digest of that block and thus of the entire chain. Such change can be easily noticed and such blocks can be rejected by the system.

8. Smart Contract

Smart contracts are protocols that are followed for computerized transactions as per the terms of the contract. Such a design ensures that all the contractual conditions are satisfied while minimizing malicious exceptions. A contract consists of data and a code which uses cryptographic validation for deployment. These contracts are executed at each node and all of them are expected to generate the same results after execution (Szabo, 1994).

Codes used in the smart contract are tamper-proof and thus can be assumed safe by all users. These contracts can execute any calculation, store some information or can expose any property to the public. It is not limited to financial transactions but can be used for other information. It can also deal with transactions between multiple parties (Ethereum Team).

PROPOSED MODEL

Retirement planning deals with a long time frame and multiple factors determine successful planning of the same. During pre and post-retirement life, multiple transactions are done by any individual. These transactions are done with other individuals or financial institutions. Thus, on financial transaction grounds, the following players are involved:

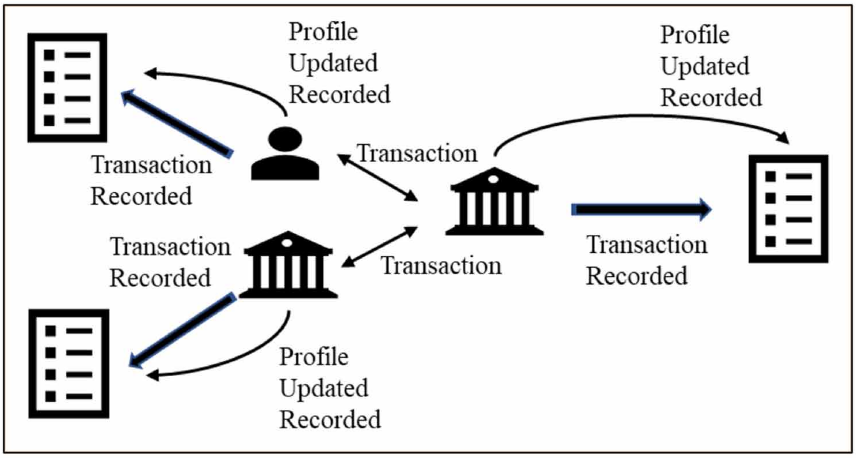
Individuals: $I_1, I_2, I_3, I_4, \ldots\ldots I_n$
Financial Institutions: $F_1, F_2, F_3, F_4, \ldots\ldots F_m$

Transactions may be between individuals, between institutions and between individuals and institutions.

In addition to financial transactions, information related to an individual's credentials, transaction history, attributes etc. may change. Similarly, information linked with financial institutions (like performance, investor details, investment details etc.) may also change (Figure-1). Thus we can get the following set of information in the system:

For Individuals:
financial transactions:: $I_1(f_1, f_2, f_3, f_4, \ldots\ldots f_a) \ldots\ldots I_n(f_1, f_2, f_3, f_4, \ldots\ldots f_b)$
Information:: $I_1(i_1, i_2, i_3, i_4, \ldots\ldots i_j) \ldots\ldots I_n(i_1, i_2, i_3, i_4, \ldots\ldots i_j)$
For Financial institutions:
financial transactions:: $F_1(f_1, f_2, f_3, f_4, \ldots\ldots f_c) \ldots\ldots F_m(f_1, f_2, f_3, f_4, \ldots\ldots f_d)$
Information:: $F_1(i_1, i_2, i_3, i_4, \ldots\ldots i_k) \ldots\ldots F_m(i_1, i_2, i_3, i_4, \ldots\ldots i_l)$

Figure 1. Record update in ledger (Source: Author's own)



All the users who want to get associated with the network and need a reliable and efficient system may need the private key. Digest of these private keys will be the respective addresses of the users. Thus, we have:

Key $(I_1) = KI_1$; And Address (I_1), AI_1 = Digest (KI_1)

Similarly, we can have keys for other individuals (KI_1, KI_2, KI_3, KI_4, …… KI_n) and financial institutions (KF_1, KF_2, KF_3, KF_4, …… KF_m). For these private keys, the linked address will be AI_1, AI_2, AI_3, AI_4, …… AI_n for individuals and AF_1, AF_2, AF_3, AF_4, …… AF_m.

Every time a transaction is done by an individual or financial institution, these addresses will be used along with the encryption through the respective private key. The information generated in the process may also be added to the data. This data will be clubbed with a block header to generate a block (Figure-2).

Financial institutions need to define smart contracts for all the possible transactions with individuals or within financial institutions. Any transaction, involving financial institutions, needs to be executed through these smart contracts. This smart contract information should be made publicly available and can be decrypted by a public key of any user.

Figure 2. Block creation flowchart (Source: Author's own)

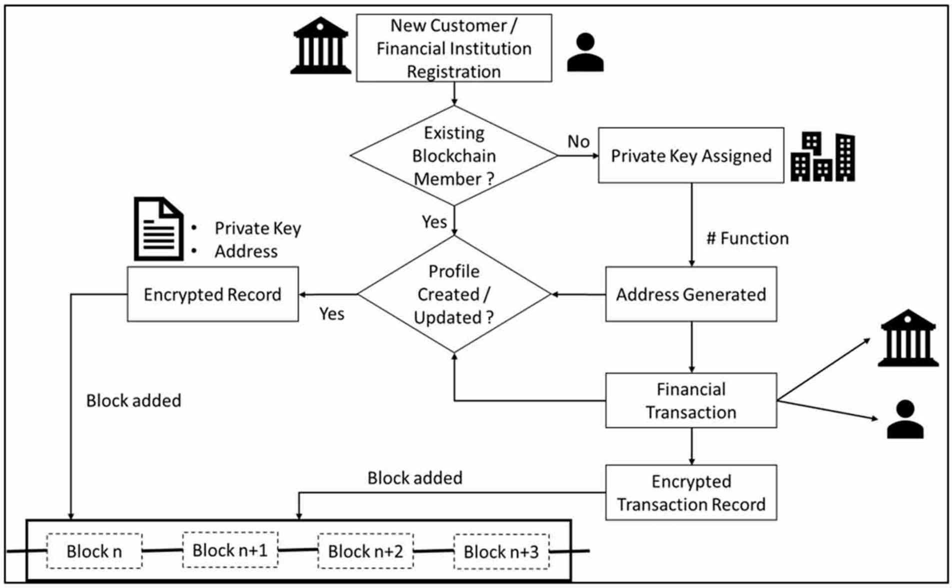
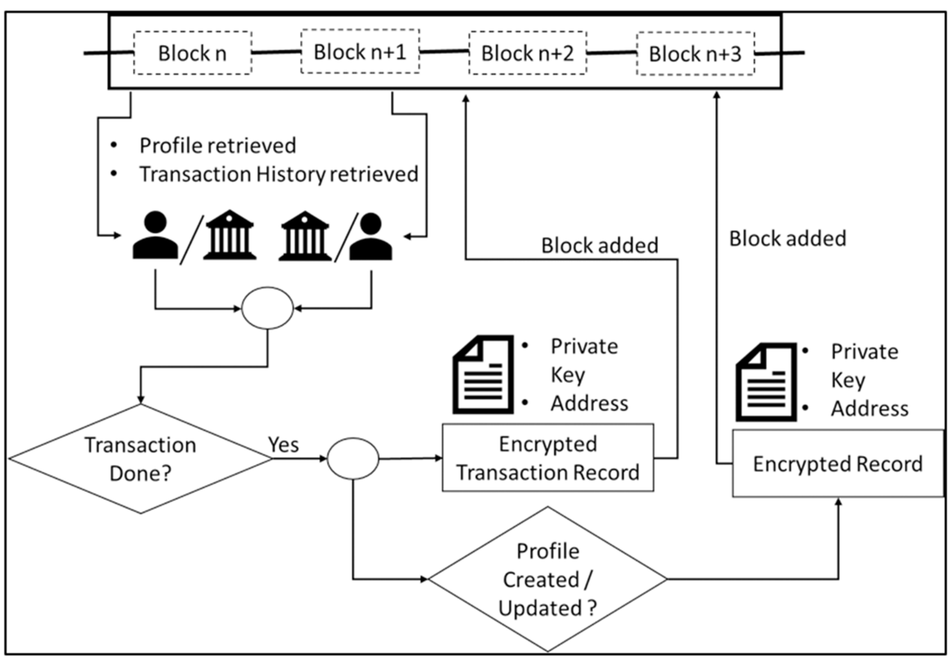


Figure 3. Information retrieval for Smart Contract creation (Source: Author's own)



In addition to the financial transaction, any change in the institution's information should be encrypted and added to the block. This will ensure transparency at institutions' end. Whenever any interaction happens between an individual and institutions, information related to the individual needs to be verified. Any update in an individual's information needs to be validated and added to the block. This will ensure that financial institutions know the complete history of an Individual (Figure-3).

Different combinations were explained above. These processes can run simultaneously between multiple institutions and individuals. Further studies may suggest improvement to this model where processing efficiencies can be increased.

CONCLUSION

The blockchain model proposed for retirement planning is in a very nascent stage but can be a stepping stone for further research. This model conceptualizes users and the type of transactions they might be involved in. This model further suggests the ways through which blocks can be generated and added to the blockchain network. This system is expected to bring all financial institutions and linked transactions on common ground. It is also expected to build confidence in financial institutions resulting in more reliability for financial planning. Access to the full history of an individual enables institutions to calculate risk more efficiently. Individuals are also expected to get the benefit of a lower interest rate as a result of this transparency.

REFERENCES

Antonopoulos, A. (2014). Bitcoin security model: trust by computation. *Forbes.*

Arshadi, N. (2019). Application of Blockchain Protocol to Wealth Management. *The Journal of Wealth Management*, *21*(4), 122–129. doi:10.3905/jwm.2019.21.4.122

Ethereum Team. (n.d.). *Ethereum White Paper—A Next-Generation Smart Contract and Decentralized Application Platform*. https://github.com/ethereum/wiki/wiki/White-Paper

Lamberti, F., Gatteschi, V., Demartini, C., Pranteda, C., & Santamaria, V. (2017). Blockchain or not blockchain, that is the question of the insurance and other sectors. *IT Professional*. Advance online publication. doi:10.1109/MITP.2018.021921652

Lamport, L. (1978). Time, Clocks, and the Ordering of Events in a Distributed System. *Communications of the ACM*, *21*(7), 558–565. doi:10.1145/359545.359563

Lamport, L. (1998). The Part-Time Parliament. *ACM Transactions on Computer Systems*, *16*(2), 133–169. doi:10.1145/279227.279229

Lee, D. (2016). *Arachneum: Blockchain meets Distributed Web*. arXiv.

Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*. Retrieved from https://bitcoin.org/bitcoin.pdf

Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). *Bitcoin and cryptocurrency technologies: A comprehensive introduction*. Princeton University Press. Retrieved from https://lccn.loc.gov/2016014802

National Institute of Standards and Technology, Secure Hash Standard (SHS). (2015). Federal Information Processing Standards (FIPS) Publication.

Oberoi, S., & Kansra, P. (2021). Motivating Antecedents and Consequences of Blockchain Technology in the Insurance Industry. In *Blockchain Technology and Applications for Digital Marketing* (pp. 276–285). IGI Global. doi:10.4018/978-1-7998-8081-3.ch017

Panetta, K. (2017). *Gartner Top 10 strategic technology trends for 2018*. Retrieved from Gartner: https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2018/

Peck, M. E. (2017). Blockchains: How they work and why they'll change the world. *IEEE Spectrum*, *54*(10), 26–35. doi:10.1109/MSPEC.2017.8048836

Peters, G., & Panayi, E. (2016). Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money. *Banking Beyond Banks and Money,* 239-278.

Swanson, T. (2015). *Consensus-as-a-service: a brief report on the emergence of permissioned, distributed ledger systems.* Report.

Szabo, N. (1994). *Smart Contracts*. http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/ LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html

Chapter 16
Blockchain Technology:
Present and Future Perspectives

Tanya Kumar
Maharaja Agrasen University, India

Satveer Kaur
Maharaja Agrasen University, India

ABSTRACT

Blockchain technology is the digital network of storing the relevant information regarding cryptocurrencies and is growing its importance day by day. Advanced blockchain technology is being used in various cases for the creation of digital currency. Bitcoin is one of the famous cryptocurrencies and it was the main reason for the creation of blockchain technology with various computer networks. The security concerns of blockchain technology are quite high which results in overall protection of crypto information through proper verification. Blockchain technology increases the working capacity as well as profitability of various business concerns. Blockchain infrastructure is designed as per the needs and requirements of the organization and the focus of the organization is to keep the information secured as well as private, and blockchain technology is responsible in doing this commendable job in handling the mechanisms in an appropriate manner.

INTRODUCTION

The thought regarding Bit coin was turned up in 2008 and that thought was turned up into reality in 2009 which further resulted in birth of block chain technology as well as crypto currency as they work on mutual programmed framework. (Copigneaux,

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Vlasov, & Bani, 2020) Crypto currency is the digitally mechanized money as like Bit coin and is one of the buzz words as everybody is familiar with and it has gaining its importance day by day in various countries because people are becoming wacky to gain the in-depth knowledge regarding bit coin as well as block chain technology. (Faisal, 2020)

Block chain technology as the name suggests, it is the chain of blocks which contain the relevant data regarding transactions of crypto currency, which firstly confide and verify the records which cannot be removed or changed. (Makridakis & Christodoulou, 2019) Block chain Technology is one of dispersed form of technology which is used to form appropriated ledger of the transactions which take place regarding crypto currency. Block chain is a fiction which is inclusive of classified summary regarding prior concerns with a block is the original document of day-to-day transactions. (Chiu & Koeppl, 2018) It is the register which is used to record encoded as well as encrypted record of digital affairs which is known as block.

This provides the protection from intervention of third party because it results in direct transmission regarding block of data which is approved and sequentially structured with the use of cryptography. Cryptography is one of the mechanisms which are used to transfigure the data into tangled form which provides the protection against third party. (Kitsantas, Vazakidis, & Chytis, 2019) Block chains are generally confined on cryptography in order to safeguard the surveillance of data which is reserved. It is quite important to store the data with evident accuracy and irreversibility.

Block chain technology regulates the inter-change process between the parties who regulate to protect their interest on secured basis as well as the transactions are to be signed by the parties without any intermediary through digital mode. (Makridakis & Christodoulou, 2019) There are generally three types of Block Chains such as Pubic Block Chains, Private Block Chains, and Hybrid Block Chains. Public Block Chains which are open as well as provide read and write permissions to everyone and on the other hand, Private Block Chains which are also known as permissioned Block Chains are restricted to some. Hybrid Block Chains are the consortium of both Public and Private Block Chain technology where reading permissions are opened for everyone and writing permissions are subject to various restrictions. (Copigneaux, Vlasov, & Bani, 2020) It is only because of block chain technology crypto currencies are gaining the trust of the people as well as is one of the reason for positive attitude and attraction of the people towards crypto currencies and various business organisations are adopting them in order to ensure dynamism in their working which further result in growth and development of the economy as a whole.

Currently, there are three emerging generations of Block Chain Technology such as Digital Currency (Block Chain 1.0), Digital Finance (Block Chain 2.0), and Digital Society (Block Chain 3.0). (Fabian Knirsch & Engel, 2019) Persistency as well as auditability is the unique characteristic of block chain technology. (Ramana, M.V.Rajesh, & Devi, 2018) Crypto currency can be stored and protected by the users in the form of wallets and the wallets used for crypto currencies are of two types, the one which is used for online storing is known as hot wallet, whereas on the other hand, cold wallet is used to store the crypto in offline mode.

OBJECTIVES OF THE STUDY

The research in the area of Block Chain Technology is quite vast so it is important to limit the study and in order to reach the specific goal it is important to sub-divide the goal into further objectives. The research is conducted to concisely achieve the objectives which are as follows:

1. To study the working of Block chain Technology
2. To explore the companies using Block chain Technology
3. To estimate the future requirements of Block chain Technology

WORKING OF BLOCK CHAIN TECHNOLOGY

Block chains are responsible for handling the crypto related tasks which involve monitoring, storing as well as validating each and every transaction in systematic and chronological manner ensuring greater level of dependence as well as security because the information stored in block chain is automatically saved and can never be deleted or even modified at any cost. (Copigneaux, Vlasov, & Bani, 2020) There are two methods of verification of crypto transactions i.e. Proof of Work Method and Proof of Stake Method and the difference between both the methods is computing power, on one side proof of work method requires high power of computing and on the other side proof stake method requires lesser computing power. (Kashyap & Chand, 2018)

There is a requirement of authoritative verification in case of bock chain technology in order to handle the transaction for recording and maintaining its confidentiality that is why approximately ten minutes are required for successful confirmation of the transaction because bundle of nodes are working to handle and manage the transactions in appropriate manner. (Fabian Knirsch & Engel, 2019) The processing of each and every transaction is intimated to even a single node and this is one of the reasons of longer time duration of handling the transaction (Faisal, 2020). But the cost of handling as well as storing the transaction is quite lower as it does not have any physical existence and is one of the logic behind minimal transaction cost.

The mechanism of asymmetric cryptography as which is generally used in digital signatures is the essence of block chain technology which is used to handle the validation as well as authenticity of the transactions which require confidentiality. (Ramana, M.V.Rajesh, & Devi, 2018) Block chain technology follows the systematic process of transaction recording in appropriate manner which begins with transaction identification and definition. After this, the next step is communication and transmission of transaction to nodes of network. After this transmission, block is created and then it is also transmitted to the network. The last but not the least is block is recorded in the chain and in this way block chain technology works (Copigneaux, Vlasov, & Bani, 2020)

COMPANIES USING BLOCKCHAIN TECHNOLOGY

Block chain can help in transforming the areas of accounting and finance, entertainment, banking, law, insurance, e-governance, medical, real estate, international trade, and e-commerce and so on. (Kitsantas, Vazakidis, & Chytis, 2019) Block Chain Technology can be also be used in supply chain as well as logistics management. Various companies are in the race of exploring applications of block chain network to meet the future needs and requirements of the economy.

In 2014, only two companies were there who engaged in block chain networking i.e. Walt Disney and PayPal but if we talk about the current scenario, there are almost 81 out of top 100 companies are applying and are on the path of application of block chain technology. If we discuss in detail, out of these 81companies, 16 companies are engaged in research process regarding block chain technology which include famous companies such as Apple, Loreal, Adobe, P & G, QualComm, Johnsons and Johnsons etc. 14 companies are in pilot testing and companies like Nike, Tesla, Pepsico, Nestle, United Health Group etc. are the part of it. 24 companies are on development stage like Facebook, Pfizer, Reliance, Coca Cola, Starbucks, Cisco, Citi etc. companies play major role. The rest of 27 companies are successfully using the block chain technology like Amazon, Walmart, Visa, Intel, Alibaba Group, MasterCard, and J.P. Morgan etc.

Block chain technology is one of the updated technology and one of area of focus of those companies who were sitting aside and were showing the negative attitude block chain technology as with the dynamism of business environment, it is important for all the companies to adopt the changes as soon as possible in most effective way through which they can improve their efficiency as well as profitability in the long-run which is not only beneficial for individual business organisations but for the economy as a whole. (LIM, 2021) The companies which are the early and timely adopters of block chain technology are at the safer side in updated and dynamic ecosystem. (Iredale, 2020)

FUTURE REQUIREMENTS OF BLOCKCHAIN TECHNOLOGY

Crypto currency is the responsible in reshaping the payment and currency system and Bit coin is one of the steps taken to initiate the innovation in digital payment system. The community dealing with crypto currencies is trying to adopt the better ways to manage and handle the block chain in integrated market economies. New digital coin can be created as extracting gold from earth by the miners. Crypto currency and block chain technology are the prospect to qualify the broadening with social as well as economic perspective all round the world which is inclusive in evolving economies by contributing accessibility to financial services as well as capital.

The pace at which crypto currency is evolving in crucial manner and it is be proved by ultimate acceptors who turn out wealthy in lasting one night because they find the moment in order to cultivate financially. The organisations in which there is requirement of integrity, honesty as well as reliability are required to adopt block chain technology to handle their operations in desired manner. Therefore, it is beneficial for underdeveloped as well as developing countries to adopt it in order to reach the developed stage. Evidence can be seen that block chain technology has bright future and is remarkable in changing the industry forever. (Sahu, 2020) Central Bank will adopt crypto currency very soon in near future and which offer better opportunities to banks in order to handle the transactions efficiently. (Ramana, M.V.Rajesh, & Devi, 2018) Reserve Bank of India will launch India's crypto currency known as 'Lakshmi'.

Hence, it is proved that in India, there is bright and strong hope of block chain technology to regulate and handle the crypto currencies in effective and promising manner. (James & Parashar, 2018) It all dependents upon the change in order to handle the boredom of life as in exchange and regulation, we have seen the changes from time to time as like from barter exchange to gold exchange, then gold is transformed in to fiat money, but in future trends, crypto currency will be the major players in the market.

CONCLUSION

The general people, researchers and policy makers are feeling attracted towards crypto currency and block chain technology plays the major role in implementation and execution of block chain technology in appropriate and systematic manner

(Perkins, 2020). Crypto currency does not have any physical existence and is electronically established by encryption which ensures transparency in its mechanism. The working can be balanced and handled in scientific form through the network known as Block chain Technology which includes creation of nodes which work in storing and verifying the transaction to ensure transparency and security without any intermediary (Kashyap & Chand, 2018).

The combination of artificial intelligence with block chain technology can proved to be highly superfluous for the economy as a whole and will lead towards bright future outcomes in the form of digital infrastructure and can also improve the living standards of the people which further results in social and economic development of the economy as a whole. (Makridakis & Christodoulou, 2019) Economic transactions can be conducted in better and advanced manner which reduces the cost and increases the speed with trust and security could further result in development of the economy as a whole.

Various e-commerce companies are joining their hands with block chain technology networks by providing wallet for storing crypto currencies to their customers. Proper authenticity of block chain technology provides protection against cyber risks. The government can use this technology to handle the Tax evasion process in the economy as well as businesses can use this technology to keep the records of their customers. (Sahu, 2020) The use of block chain technology is not just confined to these areas only but is pervasive in nature and can be used everywhere as per the suitability and requirements. Various startups are also looking at the block chain technologies to grow and survive with smart work which could provide them support and existence and their survival for longer period of time in the economy.

DISCUSSION AND RECOMMENDATIONS

In today's world block chain technology has sky-high potential as well as upright anticipation in data handling issues by ensuring straightforwardness, developing more clarity, reliability boosting, elimination of embezzlement, and foundation of confidence as well as trust too. (Kitsantas, Vazakidis, & Chytis, 2019) Block chains can proved to be helpful in affixing additional degree of monitoring, detectability as well as clarity to business and commerce and can also helpful for the organisations for developing their intellectual property rights, trademarks, terms and conditions in order to assist the market with affixed information. (Copigneaux, Vlasov, & Bani, 2020)

Block chain technology can be used to handle the day-to-day affairs which are value-driven may be in the form of goods, money, medical record keeping, ownership of property as well as in elections too. (Kitsantas, Vazakidis, & Chytis, 2019) It is essential to create proper awareness among the people regarding crypto currency in order to safeguard their interest because education as well as time both plays a major role for the business organisations as well as individual level also in order to handle the innovative practices to fulfill the needs and requirements in near future. (Xu, Chen, & Kou, 2019) Social welfare will also take place through adoption of block chain technology as it would also help in eliminating corruption, hoarding, and black money and so on.

The people living in remote areas can also have a financial access through growth and development of block chain technology in order to regulate and maintain crypto currency. It would be easy for the government to keep the details of each and every individual in significant manner which further that information can be used by experts in framing accurate policies which can be the base for new innovations and development of new and updated technology. Block chain technology will be helpful for the developing country like India in order to reach the desired heights.

REFERENCES

Chiu, J., & Koeppl, T. V. (2018, September). *The Economics of Cryptocurrencies - Bitcoin and Beyond.* Academic Press.

Copigneaux, B., Vlasov, N., & Bani, E. (2020, May). *Blockchain for Supply Chains and International Trade.* Scientific Foresight Unit of European Parliamentary Research Service.

Fabian Knirsch, A. U., & Engel, D. (2019, March). Implementing a Blockchain from Scratch: Why, How, and What We Learned. *Eurasip Journal on Information Security*.

Faisal, S. (2020, April). *Application and Impact of Crypto Economic Variable for Organizational Blockchain*. Academic Press.

Iredale, G. (2020, December). *List Of Top 50 Companies Using Blockchain Technology*. Academic Press.

James, P. B., & Parashar, P. M. (2018, April 2). Cryptocurrency: An Overview on its Impact on Indian Economy. *International Journal of Creative Research Thoughts*, *6*(2), 695–698.

Kashyap, S., & Chand, D. K. (2018, December). Impact of Cryptocurrency in India. *International Journal of Law Management & Humanities*, *2*(1), 1–10.

Kitsantas, T., Vazakidis, A., & Chytis, E. (2019). A Review of Blockchain Technology and Its Applications in the Business Environment. *International Conference on Enterprise, Systems, Accounting, Logistics & Management.*

Lim, M. (2021, September). *81 of top 100 companies use Blockchain technology, Blockdata research shows*. Academic Press.

Makridakis, S., & Christodoulou, K. (2019, December). Blockchain: Current Challenges and Future Prospects/Applications. *Future Internet, 11*(12).

Perkins, D. W. (2020). *Cryptocurrency: The Economics of Money and Selected Policy Issues*. Congressional Research Service.

Ramana, C., Rajesh, M. V., & Devi, B. (2018). A Future Perspective of Blockchain Technology, It's Design and Implementations. *International Journal of Scientific Research and Review*, *7*(5), 357–364.

Sahu, M. (2020, March). Why is Blockchain the Future? *Future Prospects, Expectations & Current Scenario*.

Xu, M., Chen, X., & Kou, G. (2019, July). A systematic review of Blockchain. *Financial Innovation, 27*(5).

Zhao, J. L., Fan, S., & Yan, J. (2016, December). Overview of Business Innovations and Research Opportunities in Blockchain and Introduction to the Special Issue. *Financial Innovation, 28*(2).

Compilation of References

Accenture. (2017). *Banking on Blockchain: a value analysis for investment banks*. Accenture. https://www.accenture.com/us-en/insight-banking-on-blockchain

Alammary, A., Alhazmi, S., Almasri, M., & Gillani, S. (2019). Blockchain-Based Applications in Education: A Systematic Review. *Applied Sciences (Basel, Switzerland)*, *9*(12), 2400. doi:10.3390/app9122400

Alam, S., Shuaib, M., Khan, W. Z., Garg, S., Kaddoum, G., Hossain, M. S., & Zikria, Y. B. (2021). Blockchain-based initiatives: Current state and challenges. *Computer Networks*, *198*, 1–20. doi:10.1016/j.comnet.2021.108395

Alharby, M., & van Moorsel, A. (2017). *Blockchain Based Smart Contracts : A Systematic Mapping Study. Computer Science & Information Technology*. doi:10.5121/csit.2017.71011

Amponnsah, A. A., Adekoya, B. A., & Weyori, F. A. (2021). Blockchain in Insurance. Exploratory Analysis of Prospects and Threats. *International Journal of Advanced Computer Science and Applications*, *12*(1), 445–466. doi:10.14569/IJACSA.2021.0120153

Andrikos, J. (2021). *Blockchain-based land registry in Honduras.* The Borgen Project. Retrieved from https://borgenproject.org/blockchain-based-land-registry/

Ante, L., Sandner, P., & Fiedler, I. (2018). Blockchain-based ICOs: Pure hype or the dawn of a new era of startup financing? *Journal of Risk and Financial Management, 11*(4), 1-19. doi:10.3390/jrfm11040080

Antonopoulos, A. (2014). Bitcoin security model: trust by computation. *Forbes.*

Appaya, S. (2021). *On fintech and financial inclusion*. Retrieved from https://blogs.worldbank.org/psd/fintech-and-financial-inclusion

Aramonte, S., Wenqian, H. & Schrimpf, A. (2021, Dec.). DeFi risks and the decentralisation illusion. *BIS Quarterly Review*.

Arora, R. (2011). Real Estate Investment Trusts (REITs): Development in India. *Indian Journal of Applied Research*, *1*(10), 102–103. https://doi.org/10.15373/2249555x/jul2012/33

Arshadi, N. (2019). Application of Blockchain Protocol to Wealth Management. *The Journal of Wealth Management*, *21*(4), 122–129. doi:10.3905/jwm.2019.21.4.122

Arslanian & Fischer. (2019). *The Future of Finance.* Retrieved from https://link.springer.com/book/10.1007/978-3-030-14533-0

Asian Development Bank Institute. (2019). *SME Finance in Asia: Recent Innovations in Fintech Credit, Trade Finance, and Beyond.* Retrieved from https://www.adb.org/sites/default/files/publication/535836/adbi-wp1027.pdf

Attri, R., Ashishpal, N.A., Khan, No. Z., Siddiquee, A. N., & Khan, Z. A. (2020). ISM-MICMAC approach for evaluating the critical success factors of 5S implementation in manufacturing organisations. *International Journal of Business Excellence, 20*(4), 521–548.

Attri. (2013). Interpretive Structural Modelling (ISM) approach: An Overview. *Research Journal of Management Science*, *2*(2), 3–8.

Baiod. (2021). Blockchain Technology and its Applications across Multiple Domains. *Journal of International Technology and Information Management, 29*(4), 78-119.

Banha, F., Almeida, H., Rebelo, E. & Orgambídez-Ramos, A. (2017). The main barriers of Portuguese entrepreneurship ecosystem: Interpretive Structural Modeling (ISM) approach. *Tourism & Management Studies, 13*(2), 60-70.

Bank of America Corporation. (2020). *Annual Report (Form 10-K) for the fiscal year ended December 31, 2020*. Retrieved from https://investor.bankofamerica.com/regulatory-and-other-filings/annual-reports/content/0000070858-21-000023/0000070858-21-000023.pdf

Baum, A. (2021). TOKENISATION—The Future of Real Estate Investment? *Journal of Portfolio Management*, *47*(10), 41–61. https://doi.org/10.3905/jpm.2021.1.260

BBC News. (2017). *Australian stock exchange to move to blockchain.* https://www.bbc.com/news/business-42261456

Bech, M. & Garratt, R. (2017, Sept.). Central bank cryptocurrencies. *BIS Quarterly Review*.

Beck, R., Avital, M., Rossi, M., & Thatcher, J. B. (2017). *Blockchain technology in business and information systems research*. Academic Press.

Beck, R., & Müller-Bloch, C. (2017, January). Blockchain as radical innovation: a framework for engaging with distributed ledgers as incumbent organization. *Proceedings of the 50th Hawaii International Conference on System Sciences*. 10.24251/HICSS.2017.653

Beck, R., Müller-Bloch, C., & King, J. L. (2018). Governance in the blockchain economy: A framework and research agenda. *Journal of the Association for Information Systems*, *19*(10), 1. doi:10.17705/1jais.00518

Belousov, A. L., & Shustrov, A. A. (2019). Opportunities of using the blockchain technology in the insurance industry. *Finance and Credit*, *25*(1), 781. doi:10.24891/fc.25.1.196

Ben Fekih, R., & Lahami, M. (2020). Application of Blockchain Technology in Healthcare: A Comprehensive Study. In M. Jmaiel, M. Mokhtari, B. Abdulrazak, H. Aloulou, & S. Kallel (Eds.), Lecture Notes in Computer Science: Vol. 12157. *The Impact of Digital Technologies on Public Health in Developed and Developing Countries. ICOST 2020*. Springer. doi:10.1007/978-3-030-51517-1_23

Biais, B., Bisiere, C., Bouvard, M., & Casamatta, C. (2019). The Blockchain folk theorem. *Review of Financial Studies*, *32*(5), 1662–1715. doi:10.1093/rfs/hhy095

Blaney, B. (n.d.). What Are SWIFT Payments & How Does a SWIFT Payment Work? *Tipalti*. Retrieved from https://tipalti.com/swift-payments/

Blockchain: Practices and perspectives-Conference at UNESCO Headquarters. (2019). https://www.fmsh.fr/en/projects/blockchain-practices-and-perspectives

Bloomberg, J. (2018). *Don't let blockchain cost savings hype fool you*. Retrieved from https://www.forbes.com/sites/jasonbloomberg/2018/02/24/dont-let-blockchain-cost-savings-hype-fool-you/?sh=239723435811

Bloomberg. (2022). *Stablecoins Soar in Value as Everything Else in Crypto Shrinks*. https://www.bloomberg.com/news/articles/2022-02-24/stablecoins-soar-in-value-as-everything-else-in-crypto-shrinks#:~:text=The%20total%20market%20capitalization%20of,compiled%20by%20The%20Block%20show

Blumenthal, D. (2016). The biggest obstacle to the health-care revolution. *Wall Street Journal*.

Bogart, S., & Rice, K. (2015). *The Blockchain Report: Welcome to the Internet of Value*. https://www.the-blockchain.com/docs/The%20Blockchain%20Report%20

Bosisio, R., Burchardi, K., Calvert, T., & Hauser, M. (2018). *The first all-blockchain insurer.* Boston Consulting Group.

Bosisio, R., Burchardi, K., Calvert, T., & Hauser, M. (2018). *The first all-blockchain insurer*. Boston Consulting Group.

Brave New Coin. (n.d.). *LenderBot by Deloitte and Stratumn to bring insurance to the sharing economy using bitcoin's blockchain*. Retrieved January 2, 2022, from https://bravenewcoin.com/insights/lenderbot-by-deloitte-and-stratumn-to-bring-insurance-to-the-sharing-economy-using-bitcoins-blockchain

Broome, L. L. (2019). Banking on blockchain. *North Carolina Journal of Law & Technology*, *21*(1), 169–195.

Brophy, R. (2019). Blockchain and insurance: a review for operations and regulation. *Journal of Financial Regulation and Compliance*.

Bureau, B. (2022). India's Urban Housing Shortage Rises 54% To 29 Million In 2018: Report. *BW Businessworld*. Retrieved 10 March 2022, from https://www.businessworld.in/article/India-s-Urban-Housing-Shortage-Rises-54-To-29-Million-In-2018-Report/23-12-2020-357300/

Büyüközkan, G., Tüfekçi, G., & Uztürk, D. (2021). Evaluating Blockchain requirements for effective digital supply chain management. *International Journal of Production Economics*, *242*, 108309.

Caporale, G. M., Gil-Alana, L., & Plastun, A. (2018). Persistence in the cryptocurrency market. *Research in International Business and Finance*, *46*, 141–148. doi:10.1016/j.ribaf.2018.01.002

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*, *36*, 55–81. doi:10.1016/j.tele.2018.11.006

Castell, S. (2018). Blockchain: Beware of the crypto-hype. *ITNOW*, *60*(4), 22–23. doi:10.1093/itnow/bwy093

Catalini, C., & Gans, J. S. (2020). Some simple economics of the blockchain. *Communications of the ACM*, *63*(7), 80–90. doi:10.1145/3359552

CBInsights. (2021). *How Blockchain Is Disrupting Insurance*. Retrieved from https://www.cbinsights.com/research/blockchain-insurance-disruption/

Centobelli, P., Cerchione, R., Esposito, E., & Oropallo, E. (2021). Surfing blockchain wave, or drowning? Shaping the future of distributed ledgers and decentralized technologies. *Technological Forecasting and Social Change*, *165*, 120463. doi:10.1016/j.techfore.2020.120463

Cermeno, J. S. (2016). *Blockchain in financial services: Regulatory landscape and future challenges for its commercial application* (BBVA Research Working Paper No. 16/20).

Chainlink. (2021). *What Is a Blockchain Oracle?* Retrieved from https://chain.link/education/blockchain-oracles

Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How blockchain can impact financial services. The overview, challenges and recommendations from expert interviews. Elsevier Public Health Emergency Collection. 1011016/j.techfore.2020.120166.

Chang, Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How Blockchain can impact financial services – The overview, challenges and recommendations from expert interviewees. *Technological Forecasting and Social Change*, *158*, 120166. doi:10.1016/j.techfore.2020.120166 PMID:32834134

Chang, S. E., Chen, Y. C., & Lu, M. F. (2019). Supply chain re-engineering using blockchain technology: A case of smart contract based tracking process. *Technological Forecasting and Social Change*, *144*, 1–11. doi:10.1016/j.techfore.2019.03.015

Chen, G., Xu, B., Lu, M., & Chen, N.-S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1. Advance online publication. doi:10.118640561-017-0050-x

Chiu, J., & Koeppl, T. V. (2018, September). *The Economics of Cryptocurrencies - Bitcoin and Beyond.* Academic Press.

Chow, Y., & Tan, K. (2021). Is TOKENISATION of real estate ready for lift-off in APAC? *Journal Of Property Investment and Finance*. doi:10.1108/jpif-10-2021-0087

Chowdhury, M. U., Suchana, K., Alam, S. M. E., & Khan, M. M. (2021). Blockchain Application in Banking System. *Journal of Software Engineering and Applications*, *14*(07), 298–311. doi:10.4236/jsea.2021.147018

Chung, J., & Lee, C. (2020). Theoretical Approach to Blockchain-based Real Estate Transaction System. *Korea Real Estate Academy, 81*, 21-35. doi:10.31303/krear.2020.81.21

CNN Business Report. (2016). *ATM and overdraft fees top $6 billion at the big 3 banks*. Accessed from https://money.cnn.com/2016/01/14/investing/atm-overdraft-fees/index.html

Coalition Against Insurance Fraud. (2016). *By the numbers: Fraud statistics*. https://insurancefraud.org

Cocco, L., Pinna, A. & Marchesi, M. (2017). Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology. *Future Internet*, *9*(3), 25, 1-20. doi:10.3390/fi9030025

Cohen, R., Sehra, A., & Smith, P. (2018). Banking on the blockchain. *International Financial Law Review*, *37*(1), 42–46.

Cointelegraph. (n.d.). *A beginner's guide to understanding the layers of blockchain technology*. Retrieved from https://cointelegraph.com/blockchain-for-beginners/a-beginners-guide-to-understanding-the-layers-of-blockchain-technology

Colliers International, KPMG, Liquefy, & Sidley. (2020). *Real Estate TOKENISATION*. https://www.colliers.com/en-hk/research/real-estate-TOKENISATION

Cong, L. W., & He, Z. (2019). Blockchain disruption and smart contracts. *Review of Financial Studies*, *32*(5), 1754–1797. doi:10.1093/rfs/hhz007

Consensys. (n.d.). *Blockchain in Insurance*. Retrieved from https://consensys.net/blockchain-use-cases/finance/insurance/

Copigneaux, B., Vlasov, N., & Bani, E. (2020, May). *Blockchain for Supply Chains and International Trade.* Scientific Foresight Unit of European Parliamentary Research Service.

Crawford, S., Russignan, L., & Kumar, N. (2018). *Global insurance trends analysis 2018*. EY Report.

Crosby, M., Nachiappan, P., Verma, S., & Kalyanaraman, V. (2016). BlockChain Technology: Beyond Bitcoin. *Applied Innovation Review*, *2*, 6–19.

Cucari, N., Lagasio, V., Lia, G., & Torriero, C. (2021). The impact of blockchain in banking processes: The Interbank Spunta case study. *Technology Analysis and Strategic Management*, 1–13. doi:10.1080/09537325.2021.1891217

Cuccuru, P. (2017). Beyond bitcoin: An early overview on smart contracts. *International Journal of Law and Information Technology*, *25*(3), 179–195. doi:10.1093/ijlit/eax003

Cummings, M., Rawhouser, H., Vismara, S., & Hamilton, E. (2019). An equity crowdfunding research agenda: Evidence from stakeholder participation in the rulemaking process. *Small Business Economics*, *54*(4), 907–932. https://doi.org/10.1007/s11187-018-00134-5

Daley, S. (2019). 8 companies using blockchain to revolutionize insurance. *Builtin*. https://builtin.com/blockchain/blockchain-insurance-companies

Daley, S. (2019). *Nine companies using blockchain to revolutionize insurance*. Builtin. Accessed on January 2021. https://builtin.com/blockchain/blockchain-insurance-companies

Das, P., Sah, V., Sharma, D., Singh, V., & Galuppo, L. (2013). Real Estate Development Process in India. *Journal of Real Estate Literature*, *21*(2), 271–292. https://doi.org/10.1080/10835547.2013.12090362

Deloitte. (2016). *Blockchain in insurance: Turning a buzzword into a breakthrough for health and life insurers.* Retrieved and accessed on 21st February 2021. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/financial-services/us-fsi-blockchain-in-insurance-ebook.pdf

Deloitte. (2016). *Cross-Border Payments on Blockchain*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/global/Documents/grid/cross-border-payments.pdf

Delventhal, S. (2018). Santander Launches Blockchain Payments Service. *Investopedia*. Retrieved from https://www.investopedia.com/news/santander-launches-blockchain-payments-service/

Demarco, A. E. (2019). Analysing blockchain/distributed ledger technology in capital markets and know your customer process. *Journal of Securities Operations & Custody*, *12*(1), 58–71.

Demir, M., Turetken, O., & Ferworn, A. (2019). A financial evaluation framework for blockchain implementations. *IEEE 10th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*, 715-722. 10.1109/IEMCON.2019.8936297

Demir, M., Turetken, O., & Ferworn, A. (2019, June). Blockchain based transparent vehicle insurance management. In *2019 Sixth International Conference on Software Defined Systems (SDS)* (pp. 213-220). IEEE. 10.1109/SDS.2019.8768669

Deshpande, A., Stewart, K., Lepetit, L., & Gunashekar, S. (2017). *Distributed ledger technologies / Blockchain: Challenges, opportunities and the prospects for standards.* The British Standards Institution (BSI) - Overview report. Retrieved from https://www.bsigroup.com/LocalFiles/zh-tw/InfoSec-newsletter/No201706/download/BSI_Blockchain_DLT_Web.pdf

Devlin, K. (2019). How double-entry bookkeeping changed the world. *Mathematical Association of America*. Retrieved from https://www.mathvalues.org/masterblog/2019/4/26/how-double-entry-bookkeeping-changed-the-world

Diemers, D., Lamaa, A., Salamat, J., & Steffens, T. (2015). *Developing a FinTech ecosystem in the GCC – Let's get ready for take off*. Retrieved from https://www.strategyand.pwc.com/m1/en/reports/developing-a-fintech-ecosystem-in-the-gcc.pdf

DiNizo Jr. (2018). *From Alice to Bob: The Patent Eligibility of Blockchain in a Post-CLS Bank World*. https://scholarlycommons.law.case.edu/jolti/vol9/iss1/29

Disruptor. (2018). *19 Startups Using Blockchain to Transform Insurance*. Retrieved from https://www.disruptordaily.com/blockchain-market-map-insurance/

Dubey, V. (2019). FinTech Innovations in Digital Banking. *International Journal of Engineering and Technical Research*, *8*(10), 597.

Eaton-Cardone, M. (2017). *How blockchain will affect financial services employment*. Retrieved from https://www.efinancialcareers.co.uk/news/2017/01/how-blockchain-will-affect-financial-services-employment

ElBahrawy, A., Alessandretti, L., Kandler, A., Pastor-Satorras, R., & Baronchelli, A. (2017). Evolutionary dynamics of the cryptocurrency market. *Royal Society Open Science*, *4*(11), 170623. doi:10.1098/rsos.170623 PMID:29291057

Ethereum Team. (n.d.). *Ethereum White Paper—A Next-Generation Smart Contract and Decentralized Application Platform*. https://github.com/ethereum/wiki/wiki/White-Paper

Excellarate. (2021). *Blockchain in Insurance: Use Cases and the Way Forward*. Retrieved from https://www.excellarate.com/blogs/blockchain-in-insurance-use-cases-and-the-way-forward/

Eyal, I. (2017). Blockchain Technology: Transforming Libertarian Cryptocurrency Dreams to Finance and Banking Realities. *Computer*, *50*(9), 38–49. doi:10.1109/MC.2017.3571042

Fabian Knirsch, A. U., & Engel, D. (2019, March). Implementing a Blockchain from Scratch: Why, How, and What We Learned. *Eurasip Journal on Information Security*.

Faisal, S. (2020, April). *Application and Impact of Crypto Economic Variable for Organizational Blockchain*. Academic Press.

Fanning, K., & Centers, D. P. (2016). Blockchain and its coming impact on financial services. *Journal of Corporate Accounting & Finance*, *27*(5), 53–57. doi:10.1002/jcaf.22179

Fenergo. (2021). *Global Financial Institution Fines for AML, Data Privacy and MiFID Rise 27% in 2020.* Retrieved from https://www.fenergo.com/press-releases/global-financial-institution-fines-for-aml-data-privacy-and-mifid-rise-26-in-2020/

Fernández-Caramés, T. M., & Fraga-Lamas, P. (2018). A Review on the Use of Blockchain for the Internet of Things. *IEEE Access: Practical Innovations, Open Solutions*, *6*, 32979–33001. doi:10.1109/ACCESS.2018.2842685

Findex, G. (2017). *2017 Findex Full Report Chapter 2*. Retrieved from https://globalfindex.worldbank.org/sites/globalfindex/files/chapters/2017%20Findex%20full%20report_chapter2.pdf

Firica, O. (2017). Blockchain technology: Promises and realities of the year 2017. *Quality - Access to Success*, *18*, 51–58.

Flovik, S., Moudnib, R., & Vassilakopoulou, P. (2021). Determinants of Blockchain Technology Introduction in Organizations: An Empirical Study among Experienced Practitioners. *Procedia Computer Science*, *181*, 664–670. doi:10.1016/j.procs.2021.01.216

Forum, I. (2022). *Real Estate TOKENISATION, The Next Big Thing In India*. Retrieved 10 March 2022, from https://www.openpr.com/news/2088565/real-estate-TOKENISATION-the-next-big-thing-in-india

Frankenfield, J. (2021). *51% Attack*. Accessed and retrieved on October 2021, https://www.investopedia.com/terms/1/51-attack.asp

Fyrigou-Koulouri. (2018). *Blockchain Technology: An Interconnected Legal Framework for an Interconnected System*. Available from: https://www.forbes.com/sites/bernardmarr/2018/02/19/the-5-big-problems-with-Blockchain-everyone-should-be-aware-of/#20420e951670

Gaikwad, D., Hambir, A., Chavan, H., Khedkar, G., & Athawale, D. (2022). Real Estate Land Transaction System Using Blockchain. *International Journal For Research In Applied Science And Engineering Technology, 10*(3), 307-311. doi:10.22214/ijraset.2022.40633

Gan, Q., Lau, R. Y. K., & Hong, J. (2021). A critical review of blockchain applications to banking and finance: A qualitative thematic analysis approach. *Technology Analysis and Strategic Management*, 1–17. doi:10.1080/09537325.2021.1979509

Garcia, A. (2018). *IBM's blockchain app store wants to help banks cut costs*. Retrieved from https://money.cnn.com/2018/07/30/technology/ibm-blockchain-app-store/index.html

Garcia, V. (2018). *4 key ways blockchain can facilitate people with no formal identify to access banking*. Retrieved from https://irishtechnews.ie/4-key-ways-blockchain-can-facilitate-people-with-no-formal-identify-to-access-banking/

Garcia-Teruel, R. (2020). Legal challenges and opportunities of Blockchain technology in the real estate sector. Journal Of Property, Planning And. *Environmental Law (Northwestern School of Law)*, *12*(2), 129–145. https://doi.org/10.1108/jppel-07-2019-0039

Garg, P., Gupta, B., Chauhan, A. K., Sivarajah, U., Gupta, S., & Modgil, S. (2021). Measuring the perceived benefits of implementing blockchain technology in the banking sector. *Technological Forecasting and Social Change*, *163*, 1–18. doi:10.1016/j.techfore.2020.120407

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaría, V. (2018). Blockchain and smart contracts for insurance: Is the technology mature enough? *Future Internet*, *10*(2), 20. doi:10.3390/fi10020020

Gaur, N. (2020). Blockchain challenges in adoption. *Managerial Finance*, *46*(6), 849–858. doi:10.1108/MF-07-2019-0328

Geiregat, S. (2018). Cryptocurrencies are (smart) contracts. *Computer Law & Security Review*, *34*(5), 1144–1149.

George, R. P., Peterson, B. L., Yaros, O., Beam, D. L., Dibbell, J. M., & Moore, R. C. (2019). Blockchain for business. *Journal of Investment Compliance*, *20*(1), 17–21. doi:10.1108/JOIC-01-2019-0001

Ghaemi Asl, M., Rashidi, M. M., & Hosseini Ebrahim Abad, S. A. (2021). Emerging digital economy companies and leading cryptocurrencies: Insights from blockchain-based technology companies. *Journal of Enterprise Information Management*, *34*(5), 1506–1550. Advance online publication. doi:10.1108/JEIM-08-2020-0348

Gibilaro, L., & Mattarocci, G. (2020). Crowdfunding REITs: A new asset class for the real estate industry? *Journal of Property Investment & Finance*, *39*(2), 84–96. https://doi.org/10.1108/jpif-08-2019-0112

Glaser, F. (2017, January). Pervasive decentralisation of digital infrastructures: a framework for blockchain enabled system and use case analysis. *Proceedings of the 50th Hawaii international conference on system sciences*. 10.24251/HICSS.2017.186

Global, T. F. (2020). *Trade finance explained an SME guide for importers and exporters*. Retrieved from https://www.tradefinanceglobal.com/wp-content/uploads/2020/10/SME-Trade-Finance-Guide-for-Importers-and-Exporters_TFG.pdf

Golosova, J., & Romanovs, A. (2018, November). The advantages and disadvantages of the blockchain technology. In *2018 IEEE 6th workshop on advances in information, electronic and electrical engineering (AIEEE)* (pp. 1-6). IEEE. 10.1109/AIEEE.2018.8592253

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems*, *35*(1), 220–265. doi:10.1080/07421222.2018.1440766

Graglia, J., & Mellon, C. (2018). Blockchain and Property in 2018: At the End of the Beginning. *Innovations: Technology, Governance, Globalization*, *12*(1-2), 90–116. https://doi.org/10.1162/inov_a_00270

Grima, S., Spiteri, J., & Romānova, I. (2020). A STEEP framework analysis of the key factors impacting the use of blockchain technology in the insurance industry. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *45*(3), 1–28. doi:10.105741288-020-00162-x

Guo and Liang. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation, 2*(24). Retrieved from https://link.springer.com/content/pdf/10.1186%2Fs40854-016-0034-9.pdf

Guo, Y., Qi, Z., Xian, X., Wu, H., Yang, Z., Zhang, J., & Wenyin, L. (2019). WISChain: An Online Insurance System based on Blockchain and DengLu1 for Web Identity Security. *Proc. 2018 1st IEEE Int. Conf. Hot Information-Centric Networking, HotICN 2018*. https://101blockchains.com/blockchain-for-insurance/Alhamra

Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation*, *2*(1), 24. Advance online publication. doi:10.118640854-016-0034-9

Haber, S., & Stornetta, W. S. (1990). How to time-stamp a digital document. *Conference on the Theory and Application of Cryptography*, 437–455.

Hackett, R. (2016). *Wait, what is Blockchain?* Accessed on February 2021, http://fortune.com/2016/05/23/block chain-definition/

Hameed, Z., Shafi, K., & Nawab, S. (2021). Long Term Memory Effect in Selected Cryptocurrencies. *Research Journal of Social Sciences and Economics Review*, *2*(2), 255–263.

Hans, R., Zuber, H., Rizk, A., & Steinmetz, R. (2017). *Blockchain and smart contracts: Disruptive technologies for the insurance market*. Academic Press.

Harris, W. L., & Wonglimpiyarat, J. (2019). Blockchain platform and future bank competition. *Foresight*, *21*(6), 625–639. doi:10.1108/FS-12-2018-0113

Harsono, H. (2018). *Bank-based blockchain projects are going to transform the financial services industry.* Retrieved from https://techcrunch.com/2018/01/28/bank-based-blockchain-projects-are-going-to-transform-the-financial-services-industry/

Hassani, H., Huang, X., & Silva, E. (2018). Banking with blockchain-ed big data. *Journal of Management Analytics*, *5*(4), 256–275. doi:10.1080/23270012.2018.1528900

He, D., Habermeier, K., Leckow, R., Haksar, V., Almeida, Y., Kashima, M., Kyriakos-Saad, N., Oura, H., Sedik, T. S., Stetsenko, N., & Verdugo-Yepes, C. (2016). *Virtual Currencies and Beyond: Initial Considerations (No. 16/3)*. International Monetary Fund.

He, Q. (2021). Application of Blockchain Technology in Commercial Banks. *2020 International Conference on New Energy Technology and Industrial Development (NETID 2020)*. 10.1051/e3sconf/202123503070

Hetavkar, N. (2019). *Bank digitisation creates new jobs: Robot programmer to blockchain expert*. Retrieved from https://www.business-standard.com/article/finance/bank-digitisation-creates-new-jobs-robot-programmer-to-blockchain-expert-119062900851_1.html

Hileman, G., & Rauchs, M. (2017). *Global cryptocurrency benchmarking study*.

Hillsberg, A. (2018). *Can Blockchain Technology Impact Banking? We Analyse this Important Trend*. https://www.comparethecloud.net/articles/can-blockchain-technology-impact-banking-we-analyse-this-important-trend/

Hillsberg, A. (2018). *Can blockchain technology impact banking? We analyse this important trend*. Retrieved from https://www.comparethecloud.net/articles/can-blockchain-technology-impact-banking-we-analyse-this-important-trend/

Ho, F. (2016). *What blockchain actually means for the future of banking*. Retrieved from https://medium.com/decentralize-today/what-blockchain-actually-means-for-the-future-of-banking-4dd868d020cf

Hota, J. (2021). *Framework of Challenges Affecting Adoption of People Analytics in India Using ISM and MICMAC Analysis. Vision-The Journal of Business Perspective*. doi:10.1177/09722629211029007

HSBC. (2018). *HSBC and ING execute groundbreaking live trade finance transaction on R3's Corda Blockchain platform*. Retrieved from https://www.hsbc.com/news-and-media/media-releases/2018/hsbc-trade-blockchain-transaction-press-release

Huang, Z., Chiu, C., Mo, S., & Marjerison, R. (2018). The nature of crowdfunding in China: initial evidence. *Asia Pacific Journal Of Innovation And Entrepreneurship, 12*(3), 300-322. doi:10.1108/apjie-08-2018-0046

Huang, L., Zhen, L., Wang, J., & Zhang, X. (2022). Blockchain implementation for circular supply chain management: Evaluating critical success factors. *Industrial Marketing Management*, *102*, 451–464. doi:10.1016/j.indmarman.2022.02.009

Huckstep, R. (2016). *What does the future hold for blockchain and insurance?* Available online at https://dailyfintech.com/2016/01/14/what-does-the-future-hold-for-blockchain-and insurance/ unpublished

Hughes, A., Park, A., Kietzman, J., & Brown, C. (2019). Beyond Bitcoin: What blockchain and distributed ledger technologies mean for firms. *Business Horizons*, *62*(3), 273–281. doi:10.1016/j.bushor.2019.01.002

Huh, J., & Kim, S. (2020). Verification Plan Using Neural Algorithm Blockchain Smart Contract for Secure P2P RealEstate Transactions. *Electronics (Basel)*, *9*(6), 1052. https://doi.org/10.3390/electronics9061052

Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*, *95*(1), 118–127.

IFC. (2017). *Blockchain in Financial Services in Emerging Markets*. Retrieved from https://www.ifc.org/wps/wcm/connect/f12930a4-a78b-43c0-9fe1-35018cdd9fb5/EMCompass+Note+44.pdf?MOD=AJPERES&CVID=m4Qcm5N

Inform, I. T. (2003). *Asymmetric Cryptography*. Retrieved from https://www.informit.com/articles/article.aspx?p=102212

Insights, C. (2019). *Blockchain and Insurance: New Technology*. New Opportunities.

International Chamber of Commerce (ICC). (2017b). *ICC hails entry into force of WTO Trade Facilitation Agreement.* ICC News. Retrieved from https://iccwbo.org/mediawall/news-speeches/icc-hails-entry-force-wto-trade-facilitation-agreement-watershed-momentworld-trade/

Iredale, G. (2020, December). *List Of Top 50 Companies Using Blockchain Technology*. Academic Press.

Iskandar, K. (2017). *What Blockchain Will Mean for Banks?* Retrieved from https://www.linkedin.com/pulse/what-blockchain-mean-banks-karim-iskandar/

James, P. B., & Parashar, P. M. (2018, April 2). Cryptocurrency: An Overview on its Impact on Indian Economy. *International Journal of Creative Research Thoughts*, *6*(2), 695–698.

Jani, S. (2019). *The Emergence of Blockchain Technology & its Adoption in India*. Academic Press.

Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analysing blockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, *50*, 302–309. doi:10.1016/j.ijinfomgt.2019.08.012

Jayasuriya Daluwathumullagamage, D., & Sims, A. (2021). Fantastic Beasts: Blockchain Based Banking. *Journal of Risk and Financial Management*, *14*(4), 170. doi:10.3390/jrfm14040170

Ji, F., & Tia, A. (2021). The effect of blockchain on business intelligence efficiency of banks. *Kybernetes*. Advance online publication. doi:10.1108/K-10-2020-0668

Ji, G., Zhou, S., Lai, K. H., Tan, K. H., & Kumar, A. (2022). Timing of blockchain adoption in a supply chain with competing manufacturers. *International Journal of Production Economics*, *247*, 108430. doi:10.1016/j.ijpe.2022.108430

Johnson, G.L. (2017). Planning the future. Blockchain technology and the insurance industry. Insurance law. *In-House Defense Quarterly*, 73–78.

Joo, M. H., Nishikawa, Y., & Dandapani, K. (2020). Cryptocurrency, a successful application of blockchain technology. *Managerial Finance*, *46*(6), 715–733. Advance online publication. doi:10.1108/MF-09-2018-0451

Judmayer, A., Stifter, N., Krombholz, K., & Weippl, E. (2017). Blocks and chains: Introduction to bitcoin, cryptocurrencies, and their consensus mechanisms. Synthesis Lectures on Information Security, Privacy, &. *Trust*, *9*(1), 1–123.

Kalsgonda, V., & Kulkarni, R. (2020). Application of Blockchain in Insurance Industry: A Review. *PIMT Journal of Research*, *12*(4), 1–3.

Kamin, D. (2021). Investors Snap Up Metaverse Real Estate in a Virtual Land Boom. *New York Times*. Retrieved from https://www.nytimes.com/2021/11/30/business/metaverse-real-estate.html

Kandil, T. T., Nassar, S., & Taysir, M. (2019). Blockchain technology: A review of the contemporary disruptive business applications. In N. Shi (Ed.), *Architectures and Frameworks for Developing and Applying Blockchain Technology* (pp. 86–109). IGI Global. doi:10.4018/978-1-5225-9257-0.ch005

Kant, N. (2021). Blockchain: A strategic resource to attain and sustain competitive advantage. *International Journal of Innovation Science*.

Kar, A. K., & Navin, L. (2021). Diffusion of blockchain in insurance industry: An analysis through the review of academic and trade literature. *Telematics and Informatics*, *58*, 101532. doi:10.1016/j.tele.2020.101532

Karamitsos, I., Papadaki, M., & Barghuthi, N. (2018). Design of the Blockchain Smart Contract: A Use Case for Real Estate. *Journal Of Information Security*, *09*(03), 177–190. https://doi.org/10.4236/jis.2018.93013

Karanam, M., Ramani, S. E., & Srinivasan, R. (2020). Leveraging the New Business Model: The Blockchain World of Banking. *Test Engineering and Management*, *82*, 11525–11531.

Kashyap, R., & Saurav, V. (2021). (in press). Blockchain technology: Road to transform the Indian banking sector. *Materials Today: Proceedings*, *1-4*. Advance online publication. doi:10.1016/j.matpr.2021.02.774

Kashyap, S., & Chand, D. K. (2018, December). Impact of Cryptocurrency in India. *International Journal of Law Management & Humanities*, *2*(1), 1–10.

Kawasmi, Z., Gyasi, E. A., & Dadd, D. (2020). Blockchain Adoption Model for the Global Banking Industry. *Journal of International Technology and Information Management*, *28*(4), 5.

Kelly, J. (2016). Barclays says conducts first blockchain-based trade-finance deal. *Reuters*. Retrieved from https://www.reuters.com/article/us-banks-barclays-blockchain-idUSKCN11D23B

Kersten, W. (2017). *Blockchain in logistics and supply chain: Trick or treat?* Academic Press.

Khan, S. N., Loukil, F., Ghedira-Guegan, C., Benkhelifa, E., & Bani-Hani, A. (2021). Blockchain smart contracts: Applications, challenges, and future trends. *Peer-to-Peer Networking and Applications*, *14*(5), 2901–2925. doi:10.100712083-021-01127-0 PMID:33897937

Kibet, A. M., Bayyou, D. G., & Esquivel, R. A. (n.d.). Blockchain: Its Structure, Principles, Applications and Foreseen Issues. *Journal of Emerging Technologies and Innovative Research*, *6*(4), 515–526.

Kimani, D., Adams, K., Attah-Boakye, R., Ullah, S., Frecknall-Hughes, J., & Kim, J. (2020). Blockchain, business and the fourth industrial revolution: Whence, whither, wherefore and how? *Technological Forecasting and Social Change*, *161*, 1–16. doi:10.1016/j.techfore.2020.120254

Kim, H. M., & Laskowski, M. (2018). Toward an ontology-driven blockchain design for supply-chain provenance. *Intelligent Systems in Accounting, Finance & Management*, *25*(1), 18–27. doi:10.1002/isaf.1424

KimH.MeharM. (2019) Blockchain in Commercial Insurance: Achieving and Learning Towards Insurance That Keeps Pace in a Digitally Transformed Business Landscape. SSRN Electron J. doi:10.2139/ssrn.3423382

Kim, K., Lee, S. Y. T., & Assar, S. (2021). The dynamics of cryptocurrency market behavior: Sentiment analysis using Markov chains. *Industrial Management & Data Systems*.

King, S. (2013). Primecoin: Cryptocurrency with prime number proof-of-work. *July 7th, 1*(6).

Kitsantas, H., Vazakidis, A., & Chytis, E. (n.d.). *A Review of Blockchain Technology and Its Applications in the Business Environment.* Academic Press.

Kitsantas, T., Vazakidis, A., & Chytis, E. (2019). A Review of Blockchain Technology and Its Applications in the Business Environment. *International Conference on Enterprise, Systems, Accounting, Logistics & Management.*

Kittu, V. M., & Aruna, P. (2018). Status Check on Blockchain Implementations in India. *International Conference on Technological Innovations in Management Ecosystem*.

Knewtson, H. S., & Rosenbaum, Z. A. (2020). Toward understanding FinTech and its industry. *Managerial Finance*, *46*(8), 1043–1060. doi:10.1108/MF-01-2020-0024

Konashevych, O. (2020). Constraints and benefits of the Blockchain use for real estate and property rights. Journal Of Property, Planning And. *Environmental Law (Northwestern School of Law)*, *12*(2), 109–127. https://doi.org/10.1108/jppel-12-2019-0061

Kosba, A., Miller, A., Shi, E., Wen, Z., & Papamanthou, C. (2016). Hawk: The Blockchain model of cryptography and privacy-preserving smart contracts. *Proceedings of the IEEE Symposium on Security and Privacy (SP)*, 839–858.

Kothari, P., Bharambe, A., Motwani, R., & Rathi, A. (2020). Smart Contract for Real Estate Using Blockchain. *SSRN Electronic Journal*. doi:10.2139/ssrn.3565497

Krishnan, K. (2021). Dispelling Challenges and Applications of Blockchain Technology. Academic Press.

Kristoufek, L., & Vosvrda, M. (2019). Cryptocurrencies market efficiency ranking: Not so straightforward. *Physica A*, *531*, 120853. doi:10.1016/j.physa.2019.04.089

Kshetri, N. (2017). Blockchain's roles in strengthening cybersecurity and protecting privacy. *Telecommunications Policy*, *41*(10), 1027–1038. doi:10.1016/j.telpol.2017.09.003

Kshetri, N. (2020). Blockchain-based financial technologies and cryptocurrencies for low-income people: Technical potential versus practical reality. *Computer*, *53*(1), 18–29. doi:10.1109/MC.2019.2951977

Kumar, D., & Kumar, D. (2015). Modeling Hospital Inventory Management using Interpretive Structural Modeling (ISM) approach. *International Journal of Logistics Systems and Management*, *21*(3), 319–334. doi:10.1504/IJLSM.2015.069730

Kuo, T. T., & Ohno-Machado, L. (2018). *Modelchain: Decentralized privacy-preserving healthcare predictive modeling framework on private blockchain networks.* arXiv preprint arXiv:1802.01746.

Lacity, M. C. (2018). Addressing key challenges to making enterprise blockchain applications a reality. *MIS Quarterly Executive*, *17*(3), 201–222.

Lamberti, F., Gatteschi, V., Demartini, C., Pranteda, C., & Santamaria, V. (2017). Blockchain or not blockchain, that is the question of the insurance and other sectors. *IT Professional*. Advance online publication. doi:10.1109/MITP.2018.021921652

Lamport, L. (1978). Time, Clocks, and the Ordering of Events in a Distributed System. *Communications of the ACM*, *21*(7), 558–565. doi:10.1145/359545.359563

Lamport, L. (1998). The Part-Time Parliament. *ACM Transactions on Computer Systems*, *16*(2), 133–169. doi:10.1145/279227.279229

LangJ. (2017). *Three uses for blockchain in banking*. Retrieved from https://www.ibm.com/blogs/blockchain/2017/10/three-uses-for-blockchain-in-banking/

Law, I. (2022). *Crowdfunding, Tokenisation And Reits - Technology - India*. Retrieved 10 March 2022, from https://www.mondaq.com/india/fin-tech/1025628/crowdfunding-Tokenisation-and-reits

Lee, D. (2016). *Arachneum: Blockchain meets Distributed Web*. arXiv.

Lee, I., & Shin, Y. J. (2018). Fintech: Ecosystem, business models, investment decisions, and challenges. *Business Horizons*, *61*(1), 35–46. doi:10.1016/j.bushor.2017.09.003

Lee, P. (2017). Banking jumps to post blockchain. *Euromoney*, *48*(584), 82–84.

LeMahieu, C. (2018). *Nano: A feeless distributed cryptocurrency network*. Nano. https://nano.Org/en/whitepaper

Lemieux, V. L. (2016). Trusting records: Is Blockchain technology the answer? *Records Management Journal*, *26*(2), 110–139. doi:10.1108/RMJ-12-2015-0042

Lepoint, T., Ciocarlie, G., & Eldefrawy, K. (2018). BlockCIS - A blockchain based cyber insurance system. *Proc. 2018 IEEE Int. Conf. Cloud Eng. IC2E.*

Lewis, R., McPartland, J. & Ranjan, R. (2017). Blockchain and Financial Market Innovation. *Economic Perspective.*

Li, R., & Wan, Y. (2021). Analysis of the Negative Relationship between Blockchain Application and Corporate Performance. Mobile Information Systems. doi:10.1155/2021/9912241

Li, Z., Xiao, Z., Xu, Q., Sotthiwat, E., Mong Goh, R. S., & Liang, X. (2018). Blockchain and IoT Data Analytics for Fine-Grained Transportation Insurance. *IEEE 24th International Conference on Parallel and Distributed Systems (ICPADS),* 1022-1027. 10.1109/PADSW.2018.8644599

Liang, Y.-C. (2019). Blockchain for Dynamic Spectrum Management. *Signals and Communication Technology*, 121–146. . doi:10.1007/978-981-15-0776-2_5

Liedtke, P. M. (2007). What's insurance to a modern economy? *The Geneva Papers on Risk and Insurance. Issues and Practice*, *32*(2), 211–221. doi:10.1057/palgrave.gpp.2510128

Li, L., Sy, M., & McMurray, A. (2018). Blockchain innovation and its impact on business banking operations. In M. Mittal, V. E. Balas, J. Hemanth, & R. Kumar (Eds.), *Data Intensive Computing Applications for Big Data* (pp. 583–598). IOS Press Ebooks. doi:10.3233/978-1-61499-814-3-583

Lim, M. (2021, September). *81 of top 100 companies use Blockchain technology, Blockdata research shows*. Academic Press.

Lim, M. K., Li, Y., Wang, C., & Tseng, M.-L. (2021). A literature review of blockchain technology applications in supply chains: A comprehensive analysis of themes, methodologies and industries. *Computers & Industrial Engineering*, *154*, 107133. doi:10.1016/j.cie.2021.107133

Lindman, J., Tuunainen, V., & Rossi, M. (2017). Opportunities and Risks of Blockchain Technologies: A Research Agenda. *Proceedings Of The 50Th Hawaii International Conference On System Sciences*. doi:10.24251/hicss.2017.185

LiT.ShinD.WangB. (2021). Cryptocurrency pump-and-dump schemes. SSRN, 1-58.

Liu, Y., Tsyvinski, A., & Wu, X. (2019). Common risk factors in cryptocurrency (No. w25882). National Bureau of Economic Research.

Liu, J. L., Wu, X. Y., Yu, W. J., Wang, Z. C., Zhao, H. L., & Cang, N. M. (2019). Research and design of travel insurance system based on blockchain. *4th Int. Conf. Intell. Informatics Biomed. Sci.*

Liu, L., Zhang, J. Z., He, W., & Li, W. (2021). Mitigating information asymmetry in inventory pledge financing through the Internet of things and blockchain. *Journal of Enterprise Information Management*, *2013*(5), 1429–1451. Advance online publication. doi:10.1108/JEIM-12-2020-0510

Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. *Review of Financial Studies*, *34*(6), 2689–2727. doi:10.1093/rfs/hhaa113

Lizcano, D., Lara, J. A., White, B., & Aljawarneh, S. (2019). Blockchain-based approach to create a model of trust in open and ubiquitous higher education. *Journal of Computing in Higher Education*, *32*(1), 109–134. doi:10.100712528-019-09209-y

Lohana, Y. (2021). ISM and MICMAC Model for Construction Delay. *International Research Journal of Engineering and Technology.*, *8*, 1382–1391.

Lord, S. (2016). Bankchain&itBit: Settling on the blockchain. *Modern Trader, 16*.

Lorenz, N., Münstermann, J. T., Higginson, B., Olesen, M., & Bohlken, P. B. (2016). *Blockchain in Insurance-Opportunity or Threat? McKinsey & Company*.

Lounds, M. (2020). *Blockchain and its Implications for the Insurance Industry*. Unpublished.

Low, R., & Marsh, T. (2019). Cryptocurrency and blockchains: Retail to institutional. *Journal of Investing*, *29*(1), 18–30.

Ludlow, A. (2018). *Blockchain in capital markets: benefits and challenges.* https://www.bobsguide.com/articles/blockchain-in-capital-markets-benefits-and-challenges/

Luo, H. R. & Yan, D. (2021). Blockchain architecture and its applications in a bank risk mitigation framework. *Economic Research-Ekonomska Istraživanja*, 1-19. doi:10.1080/1331677X.2021.1986672

Macrinici, D., Cartofeanu, C., & Gao, S. (2018). Smart contract applications within blockchain technology: A systematic mapping study. *Telematics and Informatics*, *35*(8), 2337–2354. doi:10.1016/j.tele.2018.10.004

MainelliM.MansonB. (2016). *Chain reaction: How blockchain technology might transform wholesale insurance*. https://ssrn.com/abstract=3676290

Maiti, M., Vukovic, D., Mukherjee, A., Paikarao, P. D., & Yadav, J. K. (2021). Advanced data integration in banking, financial, and insurance software in the age of COVID-19. *Journal of Software: Practice and Experience*, 1-17. doi:10.1002/spe.3018

Makridakis, S., & Christodoulou, K. (2019, December). Blockchain: Current Challenges and Future Prospects/Applications. *Future Internet, 11*(12).

Malhotra, D., Saini, P., & Singh, A. K. (2021). How Blockchain Can Automate KYC: Systematic Review. *Wireless Personal Communications*, *122*(2), 1987–2021. doi:10.100711277-021-08977-0

Marr, B. (2017). Practical Examples Of How Blockchains Are Used In Banking And The Financial Services Sector. *Forbes*. https://www.forbes.com/sites/bernardmarr/2017/08/10/practical-examples-of-how-blockchains-are-used-in-banking-and-the-financial-services-sector/?sh=4c3b945b1a11

Marr, B. (2017). *Practical Examples Of How Blockchains Are Used In Banking And The Financial Services Sector.* Retrieved from https://www.forbes.com/sites/bernardmarr/2017/08/10/practical-examples-of-how-blockchains-are-used-in-banking-and-the-financial-services-sector/?sh=1c7c83a61a11

Marr, B. (2018). *The 5 big problems with blockchain everyone should be aware of*. Retrieved from https://www.forbes.com/sites/bernardmarr/2018/02/19/the-5-big-problems-with-blockchain-everyone-should-be-aware-of/?sh=2a18d4c21670

Martino, P. (2021). *Blockchain and banking: How technological innovations are shaping the banking industry*. Springer Nature Switzerland. doi:10.1007/978-3-030-70970-9

Maslova, N. (2018). Blockchain: Disruption and opportunity. *Strategic Finance*, *7*, 24–29.

Mason, J. (2017). *Why Blockchain will revolutionize the banking industry*. Retrieved from https://bravenewcoin.com/insights/why-blockchain-will-revolutionize-the-banking-industry

Mazer, J. (n.d.). *Demystifying Cryptocurrencies, Blockchain, and ICOs.* Retrieved April 26, 2022, from https://www.toptal.com/finance/market-research-analysts/cryptocurrency-market

McKinlay, J., Pithouse, D., McGonagle, J., & Sanders, J. (2018). *Blockchain: background, challenges and legal issues*. DLA Piper Publications.

McKinsey & Company. (2018). *Blockchain explained: What it is and isn't, and why it matters.* Retrieved from https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-explained-what-it-is-and-isnt-and-why-it-matters

McKinsey & Company. (2021). *Reconceiving the global trade finance ecosystem*. Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/reconceiving%20the%20global%20trade%20finance%20ecosystem/reconceiving-the-global-trade-finance-ecosystem-final.pdf#:~:text=Reconceiving%20the%20global%20trade%20finance%20ecosystem%201%20Analysis,and%20to%20position%20the%20sector%20for%20the%20future

Mclean, S., & Deane-Johns, S. (2016). Demystifying blockchain and distributed ledger technology – Hype or hero? *Computer Law Review International*, *17*(4), 97–102. doi:10.9785/cri-2016-0402

Meiklejohn, S., Pomarole, M., Jordan, G., Levchenko, K., McCoy, D., Voelker, G. M., & Savage, S. (2013). A fistful of bitcoins: characterizing payments among men with no names. *Proceedings of the ACM IMC 2013*, 127–140. 10.1145/2504730.2504747

Mell, P., Kelsey, J., & Shook, J. (2017). Cryptocurrency Smart Contracts for Distributed Consensus of Public Randomness. In P. Spirakis & P. Tsigas (Eds.), Lecture Notes in Computer Science: Vol. 10616. *Stabilization, Safety, and Security of Distributed Systems. SSS 2017*. Springer.

Merriam-Webster. (n.d.). *Cryptography*. Retrieved from https://www.merriam-webster.com/dictionary/cryptography

Min, H. (2019). Blockchain technology for enhancing supply chain resilience. *Business Horizons*, *62*(1), 35–45. doi:10.1016/j.bushor.2018.08.012

Miraz, M. H., & Ali, M. (2018). *Applications of blockchain technology beyond cryptocurrency*. arXiv preprint arXiv:1801.03528.

Mishra, L. & Kaushik, V. (2021). Application of blockchain in dealing with sustainability issues and challenges of financial sector. *Journal of Sustainable Finance & Investment*, 1-16. doi:10.1080/20430795.2021.1940805

Mitra, M. (2018). *5 Real-world Blockchain Use-cases in Insurance Industry*. Retrieved from https://www.mantralabsglobal.com/blog/blockchain-use-cases-in-insurance-industry/

Momoh, M. O., Chinedu, P. U., Nwankwo, W., Aliu, D., & Shaba, M. S. (2021). Blockchain adoption: Applications and challenges. *International Journal of Software Engineering & Computer Systems*, *7*(2), 19–25. doi:10.15282/ijsecs.7.2.2021.3.0086

Moore, J. (2020). *11 Industries Blockchain Will Change Forever*. Retrieved from https://www.bairesdev.com/blog/industries-blockchain-will-change-forever/

Mukhopadhyay, U., Skjellum, A., Hambolu, O., Oakley, J., Yu, L., & Brooks, R. (2016, December). A brief survey of cryptocurrency systems. In *2016 14th annual conference on privacy, security and trust (PST)* (pp. 745-752). IEEE.

Murray, S. (2016). *Blockchain can create financial sector jobs as well as kill them*. Retrieved from https://www.ft.com/content/3a9ef8d8-33d5-11e6-bda0-04585c31b153

Nakamoto, N. (2017). Centralized Bitcoin: A Secure and High-Performance Electronic Cash System. *SSRN Electronic Journal*. doi:10.2139/ssrn.3065723

Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. Disponibile all'indirizzo https://bitcoin.org/bitcoin.pdf

Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*. Retrieved from https://bitcoin.org/bitcoin.pdf

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. *Decentralized Business Review*, *21260*. Advance online publication. doi:10.1108/TG-06-2020-0114

Nam, K., Dutt, C. S., Chathoth, P., Khan, M. S., & Dutt, C. S. (2021). *Blockchain technology for smart city and smart tourism : Latest trends and challenges*. doi:10.1080/10941665.2019.1585376

Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). *Bitcoin and cryptocurrency technologies: A comprehensive introduction*. Princeton University Press. Retrieved from https://lccn.loc.gov/2016014802

Narayanan, A., & Clark, J. (2017). Bitcoin's academic pedigree. *Communications of the ACM*, *60*(12), 36–45. doi:10.1145/3132259

Nath, I. (2016). Data Exchange Platform to Fight Insurance Fraud on Blockchain. *IEEE Int. Conf. Data Min. Work. ICDMW*.

National Institute of Standards and Technology, *Secure Hash Standard (SHS).* (2015). Federal Information Processing Standards (FIPS) Publication.

News 18. (2021). Metaverse Hype Boosts High Investment in Digital Real Estate. *Cable News Network*. Retrieved from https://www.news18.com/news/buzz/metaverse-hype-boosts-high-investment-in-digital-real-estate-4521755.html

Nguyen, Q. K. (2016). Blockchain – A financial technology for future sustainable development. *3rd International Conference on Green Technology and Sustainable Development (GTSD)*, 51-54. 10.1109/GTSD.2016.22

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering*, *59*(3), 183–187. doi:10.100712599-017-0467-3

Nowinski, W., & Kozma, M. (2017). How can blockchain technology disrupt the existing business models? *Entrepreneurial Business and Economics Review*, *5*(3), 173–188. doi:10.15678/EBER.2017.050309

Oberoi, S., & Kansra, P. (2019). Factors Influencing Medical Tourism in India: A Critical Review. *SAMVAD*, *17*, 9-16.

Oberoi, S., & Kansra, P. (2020). Economic menace of diabetes in India: A systematic review. *International Journal of Diabetes in Developing Countries*, *40*(4), 1–12. doi:10.100713410-020-00838-z PMID:32837090

Oberoi, S., & Kansra, P. (2021). *Motivating Antecedents and Consequences of Blockchain Technology in the Insurance Industry*. IGI Global. doi:10.4018/978-1-7998-8081-3.ch017

Oh, J., & Shong, I. (2017). A case study on business model innovations using Blockchain: Focusing on financial institutions. *Asia Pacific Journal of Innovation and Entrepreneurship*, *11*(3), 335–344. doi:10.1108/APJIE-12-2017-038

Okere, A. (2020). *Blockchain, Fintech and the Future of Banking*. Retrieved from https://www.afsic.net/wp-content/uploads/sites/78/2020/10/Fintechs-and-the-Future-of-Banking-28.09.2020-002.pdf

Olaf, A., Hagen, H., & Hajj, J. (2017). *2017 Technology trends.* PwC. Accessed on February 2021. https://www.strategyand.pwc.com/ trend/2017-technology-trends

Olaf, A., Hagen, H., & Hajj, J. (2017). *2017 Technology trends*. PwC. Accessed on February 2021. https://www.strategyand.pwc.com/trend/2017-technology-trends

Open Access Government. (2019). *Crypto Valley: Why Switzerland is a world-leading location for blockchain companies.* https://www.openaccessgovernment.org/crypto-valley-switzerland-blockchain-companies/58442/

Osmani, M., El-Haddadeh, R., Hindi, N., Janssen, M., & Weerakkody, V. (2021). Blockchain for next generation services in banking and finance: Cost, benefit, risk and opportunity analysis. *Journal of Enterprise Information Management*, *34*(3), 884–899. doi:10.1108/JEIM-02-2020-0044

Padda, A. (n.d.). *How Will Blockchain Revolutionize the Global Financial System?* https://www.wns.com/insights/articles/articledetail/534/how-will-blockchain-revolutionize-the-global-financial-system

Pal, A., Tiwari, C. K., & Behl, A. (2021). Blockchain technology in financial services: A comprehensive review of the literature. *Journal of Global Operations and Strategic Sourcing*, *14*(1), 61–80. doi:10.1108/JGOSS-07-2020-0039

Palihapitiya, T. (2020). *Blockchain in Banking Industry*. Academic Press.

Pancetta, K. (2016). *Gartner's top 10 strategic technology trends for 2017.* Gartner. Accessed on June 2021, https://www.gartner.com/smarterwithgartner/gartners-top-10-technology-trends-2017

Panetta, K. (2017). *Gartner Top 10 strategic technology trends for 2018*. Retrieved from Gartner: https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2018/

Park, J. H., & Park, J. H. (2017). Blockchain security in cloud computing: Use cases, challenges, and solutions. *Symmetry*, *9*(8), 164. doi:10.3390ym9080164

Patel, B. (2018). *How can blockchain help with AML KYC*. Retrieved from https://www.finextra.com/blogposting/15022/how-can-blockchain-help-with-aml-kyc

Patidar, L., Soni, V. K., & Soni, P. K. (2017). Manufacturing wastes analysis in lean environment: An integrated ISM-fuzzy MICMAC approach. *Int J Syst Assur Eng Manag*, *8*(S2), 1783–1809. doi:10.100713198-017-0669-6

Patki, A., & Sople, V. (2020). Indian banking sector: Blockchain implementation, challenges, and way forward. *Journal of Banking and Financial Technology*, *2020*(4), 65–73. doi:10.100742786-020-00019-w

Patrickson, B. (2021). What do blockchain technologies imply for digital creative industries? *Creativity and Innovation Management*, *30*(3), 585–595. doi:10.1111/caim.12456

Patwardhan, A. (2014). *Blockchain – A disruptive force for good?* Available at: https://www.linkedin. com/pulse/blockchain-disruptive-force-good-anju-patwardhan?trk=mp-reader-card

Pawczuk, L., Holdowsky, J., Massey, R., & Hansen, B. (2020). *Deloitte insights – Deloitte's 2020 global blockchain survey – From promise to reality*. Retrieved from https://www2.deloitte.com/mt/en/pages/technology/articles/2020-global-blockchain-survey.html

Pawczuk, L., Massey, R., & Holdowsky, J. (2019). *Deloitte insights – Deloitte's 2019 global blockchain survey – Blockchain gets down to business*. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/se/Documents/risk/DI_2019-global-blockchain-survey.pdf

Peck, M. E. (2017). Blockchains: How they work and why they'll change the world. *IEEE Spectrum*, *54*(10), 26–35. doi:10.1109/MSPEC.2017.8048836

Perkins, D. W. (2020). *Cryptocurrency: The Economics of Money and Selected Policy Issues*. Congressional Research Service.

Peters, G., & Panayi, E. (2016). Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money. *Banking Beyond Banks and Money,* 239-278.

Peters, G. W., & Panayi, E. (2016). Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money. In P. Tasca, T. Aste, L. Pelizzon, & N. Perony (Eds.), *Banking beyond banks and money* (pp. 239–278). Springer International Publishing. doi:10.1007/978-3-319-42448-4_13

Petrov, D. (2020). A new digital age in finance: Blockchain and smart contracts. *Horizons Series A*, *26*, 7–20. doi:10.20544/HORIZONS.A.25.2.20.P01

Pichl, L., Nan, Z., & Kaizoji, T. (2020). Time series analysis of ether cryptocurrency prices: Efficiency, predictability, and arbitrage on exchange rates. In *Advanced studies of financial technologies and cryptocurrency markets* (pp. 183–196). Springer.

Pilkington, M. (n.d.). Blockchain Technology: Principles and Applications. *Journal of International Technology and Information Management*.

Pilkington, M. (2016). *Blockchain technology: principles and applications*. *Research Handbook on Digital Transformations*. doi:10.4337/9781784717766

Pimentel, E., & Boulianne, E. (2020). Blockchain in Accounting Research and Practice: Current Trends and Future Opportunities*. *Accounting Perspectives*, *19*(4), 325–361. doi:10.1111/1911-3838.12239

Pinzón, C., & Rocha, C. (2016). Double-spend Attack Models with Time Advantange for Bitcoin. *Electronic Notes in Theoretical Computer Science*, *329*, 79–103. doi:10.1016/j.entcs.2016.12.006

Polyviou. (2019). Blockchain Technology: Financial Sector Applications Beyond Cryptocurrencies. *Proceedings of e 3rd annual Decentralized Conference.* 10.3390/proceedings2019028007

Popova, N. A., & Butakova, N. G. (2019). Research of a Possibility of Using Blockchain Technology without Tokens to Protect Banking Transactions. *2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus),* 1764-1768.

Popovic, D., Avis, C., Byrne, M., Cheung, C., Donovan, M., Flynn, Y., Fothergill, C., Hosseinzadeh, Z., Lim, Z., & Shah, J. (2020). Understanding blockchain for insurance use cases. *British Actuarial Journal*, *25*(13), 1–23. Retrieved from https://www.cambridge.org/core/journals/british-actuarial-journal/article/understanding-blockchain-for-insurance-use-cases/3F0FBE7A633CE3EAC2CEA0DD98A63286

Price, D. (2018). *5 Big Blockchain Issues: Security, Privacy, Legal, Regulatory, and Ethical*. Available from: https://blocksdecoded.com/Blockchain-issues-security-privacy-legal-regulatory-ethical/

PricewaterhouseCoopers. (2016). *Blockchain in the insurance sector*. Accessed on January 2021, https://www.pwc.co.uk/financial-services/fintech/assets/blockchain-in-insurance.pdf

PricewaterhouseCoopers. (2016). *Blockchain in the insurance sector.* Accessed on May 2021, https://www.pwc.co.uk/financial-services/fintech/assets/blockchain-in-insurance.pdf

Pritzker, S. (2020). *Everything You Need To Know About Peer-To-Peer (P2P) Insurance*. Unpublished.

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2020). Blockchain and supply chain management integration: A systematic review of the literature. *Supply Chain Management*, *25*(2), 241–254. doi:10.1108/SCM-03-2018-0143

Rabbani, M. R., Khan, S., & Thalassinos, E. I. (2020). FinTech, blockchain and Islamic finance: An extensive literature review. *International Journal of Economics and Business Administration*, *8*(2), 65–86.

Rahman, A., Nazri, M., Alias, N., Siraj, S., & DeWitt, D. (2013). Textbook Content Transformation: Interpretive Structural Modelling (ISM) Approach. *Life Science Journal*, *10*, 1736–1745.

Raikwar, M., Mazumdar, S., Ruj, S., Gupta, S. S., Chattopadhyay, A., & Lam, K. Y. (2018, February). A blockchain framework for insurance processes. In *2018 9th IFIP International Conference on New Technologies, Mobility and Security (NTMS)* (pp. 1-4). IEEE. 10.1109/NTMS.2018.8328731

Rajnak, V., & Puschmann, T. (2021). The impact of blockchain on business models in banking. *Information Systems and e-Business Management*, *19*(3), 809–861. doi:10.100710257-020-00468-2

Ramana, C., Rajesh, M. V., & Devi, B. (2018). A Future Perspective of Blockchain Technology, It's Design and Implementations. *International Journal of Scientific Research and Review*, *7*(5), 357–364.

Ramchandra, M. V., Kumar, K., Sarkar, A., Mukherjee, S. K., & Agarwal, K. (2021). Assessment of the impact of blockchain technology in the banking industry. *Materials Today: Proceedings*, 1–6. doi:10.1016/j.matpr.2021.11.554

Rane, S. B., & Narvel, Y. A. M. (2019). Re-designing the business organization using disruptive innovations based on blockchain-IoT integrated architecture for improving agility in future Industry 4.0. *Benchmarking*, *28*(5), 1883–1908. doi:10.1108/BIJ-12-2018-0445

Raut, R., Priyadarshinee, P., Jha, M., Gardas, B. B., & Kamble, S. (2018). Modeling the implementation barriers of cloud computing adoption: An interpretive structural modeling. *Benchmarking*, *25*(8), 2760–2782. doi:10.1108/BIJ-12-2016-0189

Rawat, D. B., Chaudhary, V., & Doku, R. (2020). Blockchain Technology: Emerging Applications and Use Cases for Secure and Trustworthy Smart Systems. Journal of Cyber Security and Privacy, 1-15.

Re, M. (n.d.). *Blockchain and its Implications for the Insurance Industry*. Retrieved from https://www.munichre.com/us-life/en/perspectives/underwriting/blockchain-implications-insurance-industry.html

Real Estate TOKENISATION: Pros, Cons, and Challenges. (2022). Retrieved 10 March 2022, from https://www.commercialcafe.com/blog/real-estate-TOKENISATION/

Relan, M. (2020). Digitalization in the Bancassurance Model of Distribution - Opportunities and Challenges. *Bimaquest, 20*(3). Accessed on December, 2021. http://www.bimaquest.niapune.org.in/index.php/bimaquest/article/view/79

Report on National Strategy on Blockchain. (2021). Ministry of Electronics and Information Technology, GOI.

ReportLinker. (2022). *Blockchain In Banking And Financial Services Global Market Report 2022*. https://finance.yahoo.com/news/blockchain-banking-financial-services-global-114700539.html

Reyna, A., Martín, C., Chen, J., Soler, E., & Díaz, M. (2018). On blockchain and its integration with IoT. Challenges and opportunities. *Future Generation Computer Systems*, *88*, 173–190. doi:10.1016/j.future.2018.05.046

Rijanto, A. (2021). Blockchain Technology Adoption in Supply Chain Finance. *Journal of Theoretical and Applied Electronic Commerce Research*, *16*(7), 3078–3098. doi:10.3390/jtaer16070168

Ripple. (2014). *The Ripple protocol: A deep dive for finance professionals*. Available at: https://ripple.com/ files/ripple_deep_dive_for_financial_professionals.pdf

Risius, M., & Spohrer, K. (2017). A Blockchain Research Framework: What We (don't) Know, Where We Go from Here, and How We Will Get There. *Business & Information Systems Engineering*, *59*(6), 385–409. doi:10.100712599-017-0506-0

Routledge, B., & Zetlin-Jones, A. (2021). Currency stability using blockchain technology. *Journal of Economic Dynamics & Control*, *104155*. Advance online publication. doi:10.1016/j.jedc.2021.104155

Rupareliya, K. (2021). How smart contracts are transforming banks and financial institutions, *BusinessofApps*. https://www.businessofapps.com/insights/how-smart-contracts-are-transforming-banks-and-financial-institutions/

Rust, R. (2019). Banking on Blockchains: A Transformative Technology Reshaping Latin American and Caribbean Economies. *The University of Miami Inter-American Law Review*, *50*(2), 184–211.

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. doi:10.1080/00207543.2018.1533261

Saha, S., & Finiloza, C. (2021). *How blockchain and smart contracts will disrupt insurance claims.* Retrieved from https://www.youtube.com/watch?v=oxpCf6KeC5Q

Saheb, T., & Mamaghani, F. H. (2021). Exploring the barriers and organizational values of blockchain adoption in the banking industry. *The Journal of High Technology Management Research*, *32*(2), 1–18. doi:10.1016/j.hitech.2021.100417

Sahu, M. (2020, March). Why is Blockchain the Future? *Future Prospects, Expectations & Current Scenario*.

Sangani, P. (n.d.). *India's insurance industry is improving efficiency through the use of new-age technology*. https://economictimes.indiatimes.com/industry/banking/finance/insure/indias insurance-industry-is-improving-efficiency-through-the use-of-new-age technology/articleshow/70902516.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Sanka, A. I., Irfan, M., Huang, I., & Cheung, R. C. C. (2021). A survey of breakthrough in blockchain technology: Adoptions, applications, challenges and future research. *Computer Communications*, *169*, 179–201. doi:10.1016/j.comcom.2020.12.028

Sarkar, A., Qian, L., Peau, A. K., & Shahriar, S. (2021). Modeling drivers for successful adoption of green business: An interpretive structural modeling approach. *Environmental Science and Pollution Research International*, *28*(1), 1077–1096. doi:10.100711356-020-10490-z PMID:32829426

Sarmah, S. S. (2018). Understanding blockchain technology. *Computing in Science & Engineering*, *8*(2), 23–29.

Saxena, J. P., Sushil, & Vrat, P. (1990). The impact of indirect relationships in classification of variables e a MICMAC analysis for energy conservation. *Systems Research*, *7*(4), 245–253. doi:10.1002res.3850070404

Schweizer, A., Schlatt, V., Urbach, N., & Fridgen, G. (2017, December). Unchaining Social Businesses-Blockchain as the Basic Technology of a Crowdlending Platform. ICIS.

Setyowati, W., Rahardja, U., Aini, Q., Santoso, N., & Prihastiwi, W. (2021). Design financial accounting using blockchain approach in education. *Media Riset Akuntansi. Auditing & Informasi*, *21*, 161. doi:10.25105/mraai.v21i2.9448

Shah, T., & Jani, S. (2018). *Applications of Blockchain Technology in Banking & Finance*. Academic Press.

Sharifinejad, M., Dorri, A., & Rezazadeh, J. (2020). *BIS-A Blockchain-based Solution for the Insurance Industry in Smart Cities*. arXiv.

Sharma, M., & Joshi, S. (2021). Barriers to blockchain adoption in health-care industry: An Indian perspective. *Journal of Global Operations and Strategic Sourcing*, *14*(1), 134–169. doi:10.1108/JGOSS-06-2020-0026

Shetty. (2022, January-March). Block Chain Application in Insurance Services: A Systematic Review of the Evidence. *Artificial Intelligence for Smart Society - Literature Review*, 1–15. https://journals.sagepub.com/doi/pdf/10.1177/21582440221079877

Shin, G., Kim, J., & Kim, G. (2021). Real Estate Transactions in the Post-Corona Era: Introduction of Smart Contracts and Legal Issues. *Korea Association Of Real Estate Law, 25*(2), 1-28. doi:10.32989/rel.2021.25.2.1

Shrimali, B., & Patel, H. B. (2021). Blockchain state-of-the-art: architecture, use cases, consensus, challenges and opportunities. *Journal of King Saud University - Computer and Information Sciences*. . doi:10.1016/j.jksuci.2021.08.005

Sindhu, S., Nehra, V., & Luthra, S. (2016). Identification and analysis of barriers in implementation of solar energy in Indian rural sector using integrated ISM and fuzzy MICMAC approach. *Renewable and Sustainable Energy Reviews, 62*, 70–88. doi:10.1016/j.rser.2016.04.033

Singer, A. W. (2019). *Can Blockchain Improve Insurance? Risk Management Studies in Indian Place Names*. archives.tpnsindia.org

Singh, S. S. (2018). *How blockchain will change the way you trade in stock markets.* https://economictimes.indiatimes.com/markets/stocks/news/how-blockchain-will-change-the-way-you-trade-in-stock-markets/articleshow/62161610.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Siyal, A. A., Junejo, A. Z., Zawish, M., Ahmed, K., Khalil, A., & Soursou, G. (2019). Applications of blockchain technology in medicine and healthcare: Challenges and future perspectives. *Cryptography*, *3*(1), 3. doi:10.3390/cryptography3010003

Stulz, R. M. (2019). FinTech, BigTech, and the future of banks. *Journal of Applied Corporate Finance*, *31*(4), 86–97. doi:10.1111/jacf.12378

Suichies, B. (2016). *Why blockchain must die*. https://www.linkedin.com/pulse/whyblockchain-must-die-2016-bart-suichies?trk=prof-post

Swan, M. (2015). *Blockchain: Blueprint for a new economy*. O'Reilly Media, Inc.

Swan, M. (2017). Anticipating the Economic Benefits of Blockchain. *Technology Innovation Management Review*, *7*(10), 6–13. doi:10.22215/timreview/1109

Swanson, T. (2015). *Consensus-as-a-service: a brief report on the emergence of permissioned, distributed ledger systems.* Report.

Swathi, P., & Venkatesan, M. (2021). Scalability improvement and analysis of permissioned-blockchain. *ICT Express*, *7*(3), 283–289. doi:10.1016/j.icte.2021.08.015

Szabo, N. (1994). *Smart Contracts*. http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/ LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html

Taniyama, T. (2019). Real Estate Crowdfunding: The Fusion of Real Estate, Finance, and Technology. *The Japanese Journal Of Real Estate Sciences, 32*(4), 54-59. doi:10.5736/jares.32.4_54

Tapscott, A., & Tapscott, D. (2017). How blockchain is changing finance. *Harvard Business Review*, *1*, 2–5.

Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution*. Penguin Random House.

Tarr, J.A. (2018). Distributed ledger technology, blockchain and insurance: Opportunities, risks and challenges. *Insur. Law J*.

Tarr, J. A. (2018). Distributed ledger technology, blockchain and insurance: Opportunities, risks and challenges. *Insurance Law Journal (Chicago, Ill.)*, *29*(3), 254–268.

Tasca, P. (2019). Insurance under the blockchain paradigm. In *Business Transformation through Blockchain* (pp. 273–285). Palgrave Macmillan. doi:10.1007/978-3-319-98911-2_9

Taskinsoy, J. (2018). *Bitcoin Mania: An End to the US Dollar's Hegemony or another Cryptocurrency Experiment Destined to Fail?* Available at SSRN 3311989.

Thake, M. (2018). *What's the difference between blockchain and DLT?* Nakamo. To.

The 2021 McKinsey Global Payments Report. (2021). Retrieved from https://www.knowledgeinnovations.com/2021/10/14/a-report-entitled-the-2021-mckinsey-global-payments-reports-by-alessio-botta-philip-bruno-jeff-galvin/#:~:text=The%202021%20McKinsey%20Global%20Payments%20Report%20is%20based,payments%20leaders%E2%80%99%20actions%20will%20help%20determine%20market%20trajectory

Tian, X., He, J. S., & Han, M. (2021). Data-driven approaches in FinTech: A survey. *Information Discovery and Delivery*, *49*(2), 123–135. doi:10.1108/IDD-06-2020-0062

Tiwari, K. R. (2013). Identification of factors affecting reverse chain performance in relation to customer satisfaction using ISM Modelling & MICMAC Analysis. *Uncertain Supply Chain Management*, *1*, 237–252. doi:10.5267/j.uscm.2013.08.005

Treiblmaier, H. (2018). The impact of the blockchain on the supply chain: A theory-based research framework and a call for action. *Supply Chain Management*, *23*(6), 545–559. doi:10.1108/SCM-01-2018-0029

Ullah, F., & Al-Turjman, F. (2021). A conceptual framework for Blockchain smart contract adoption to manage real estate deals in smart cities. *Neural Computing And Applications*. doi:10.1007/s00521-021-05800-6

UN Women. (2021). *UN women-WFP blockchain pilot project for cash transfers in refugee camps Jordan case study.* UN Women. Retrieved from https://jordan.unwomen.org/en/digital-library/publications/2021/un-women-wfp-blockchain-pilot-project-for-cash-transfers-in-refugee-camps-jordan-case-study

Uzair, M., Karim, E., Sultan, S., & Ahmad, S. (2022). *The Impact of Blockchain Technology on the Real Estate Sector Using Smart Contracts*. Greenwich University, Karachi.

Vakilinia, I., Badsha, S., & Sengupta, S. (2018). Crowdfunding the Insurance of a Cyber-Product Using Blockchain. *9th IEEE Annu. Ubiquitous Comput. Electron. Mob. Commun. Conf. (UEMCON)*. 10.1109/UEMCON.2018.8796515

Varma, J. R. (2019). Blockchain in Finance. *Vikalpa*, *44*(1), 1–11. doi:10.1177/0256090919839897

von Solms, J. (2021). Integrating Regulatory Technology (RegTech) into the digital transformation of a bank Treasury. *J Bank Regul*, *22*, 152–168. https://doi.org/10.1057/s41261-020-00134-0

Vysya, V. N., & Kumar, A. (2019). *Blockchain adoption in financial services. In Perspective*. Infosys Limited.

Walker, G. (2018). *Is KYC using blockchain the answer for banks?* Retrieved from https://www.refinitiv.com/perspectives/regulation-risk-compliance/kyc-using-blockchain-answer-banks/

Wang, H., Ma, S., Dai, H., Imran, M., & Wang, T. (2020). Blockchain-based data privacy management with Nudge theory in open banking. *Future Generation Computer Systems*, *110*, 812–823. doi:10.1016/j.future.2019.09.010

Wang, R., Lin, Z., & Luo, H. (2019). Blockchain, bank credit and SME financing. *Quality & Quantity*, *53*(3), 1127–1140. doi:10.100711135-018-0806-6

Wang, S., & Vergne, J. P. (2017). Buzz factor or innovation potential: What explains cryptocurrencies' returns? *PLoS One*, *12*(1), e0169556.

Wang, Y., Hugh Han, F., & Beynon-Davies, P. (2019). Understanding blockchain technology for future supply chains: A systematic literature review and research agenda. *Supply Chain Management*, *24*(1), 62–84. doi:10.1108/SCM-03-2018-0148

Wan, N., Liu, Y., & Xiao, W. (2020). A Financial Transaction Methods Based on MapReduce Technology and Blockchain. *3rd International Conference on Smart BlockChain (SmartBlock)*, 109-113. 10.1109/SmartBlock52591.2020.00027

Wan, Y., Gao, Y., & Hu, Y. (2022). Blockchain application and collaborative innovation in the manufacturing industry: Based on the perspective of social trust. *Technological Forecasting and Social Change*, *177*, 121540. doi:10.1016/j.techfore.2022.121540

Waynman, O. (2016). *Blockchain in Capital Markets The Prize and the Journey.* https://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/feb/BlockChain-In-Capital-Markets.pdf

Werbach, K. (2018). Trust, but verify: Why the blockchain needs the law. *Berkeley Technology Law Journal*, *33*, 487–550. doi:10.15779/Z38H41JM9N

Wikipedia. (2021). *Medici Bank*. Retrieved from https://en.wikipedia.org/wiki/Medici_Bank

Wikipedia. (2022). *Cryptography*. Retrieved from https://en.wikipedia.org/wiki/Cryptography

Wipro. (n.d.). *Adopting a New Approach to Demystify the Future of Insurance with Blockchain*. Retrieved from https://www.wipro.com/insurance/adopting-a-new-approach-to-demystify-the-future-of-insurance-wit/

Wipro. (n.d.). *Adopting a new approach to demystify the future of insurance.* https://www.wipro.com/insurance/adopting-a-new-approach-to-demystify-the-future-of-insurance-wit/

Woodside, J. M., Augustine, F. K. Jr, & Giberson, W. (2017). Blockchain technology adoption status and strategies. *Journal of International Technology and Information Management*, *26*(2), 65–93.

Wouda, H., & Opdenakker, R. (2019). Blockchain technology in commercial real estate transactions. *Journal of Property Investment & Finance*, *37*(6), 570–579. https://doi.org/10.1108/jpif-06-2019-0085

WrightA.De FilippiP. (2015). Decentralized blockchain technology and the rise of lex cryptographia. Available at SSRN 2580664. doi:10.2139/ssrn.2580664

X, C. (2020). *Upgrading Real Estate TOKENISATION to the Next Level*. Finextra Research. Retrieved 10 March 2022, from https://www.finextra.com/blogposting/21252/upgrading-real-estate-TOKENISATION-to-the-next-level

Xie, J. (2017). Who Is "Misleading" Whom in Real Estate Transactions? *Real Estate Economics*, *46*(3), 527–558. https://doi.org/10.1111/1540-6229.12196

Xu, M., Chen, X., & Kou, G. (2019, July). A systematic review of Blockchain. *Financial Innovation, 27*(5).

Xu, J., Wu, Y., Luo, X., & Yang, D. (2020). Improving the Efficiency of Blockchain Applications with Smart Contract based Cyber-insurance. *IEEE Int. Conf. Communication*. 10.1109/ICC40277.2020.9149301

Yapicioglu, B., & Leshinsky, R. (2020). Blockchain as a tool for land rights: Ownership of land in Cyprus. Journal Of Property, Planning And. *Environmental Law (Northwestern School of Law)*, *12*(2), 171–182. https://doi.org/10.1108/jppel-02-2020-0010

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where Is Current Research on Blockchain Technology? A Systematic Review. *PLoS One*, *11*(10), e0163477. doi:10.1371/journal.pone.0163477 PMID:27695049

Yoo, S. (2017). Blockchain based financial case analysis and its implications. *Asia Pacific Journal of Innovation and Entrepreneurship*, *11*(3), 312–321. doi:10.1108/APJIE-12-2017-036

Zetzsche, D. A., Buckley, R. P., Arner, D. W., & Barberis, J. N. (2017). From FinTech to TechFin: the regulatory challenges of data-driven finance. SSRN *Electron. J.*, (6), 1–36. doi:10.2139/ssrn.2959925

Zhao, J. L., Fan, S., & Yan, J. (2016, December). Overview of Business Innovations and Research Opportunities in Blockchain and Introduction to the Special Issue. *Financial Innovation, 28*(2).

Zhao, J., Fan, S., & Yan, J. (2016). Overview of business innovations and research opportunities in Blockchain and introduction to the special issue. *Financial Innovation, 2*(1). doi:10.1186/s40854-016-0049-2

Zheng, Xie, Dai, Chen, & Wang. (2017). An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. *International Congress on Big Data (BigData Congress)*, 557-564. 10.1109/BigDataCongress.2017.85

Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, *14*(4), 352. doi:10.1504/IJWGS.2018.095647

Zhong, L., Wu, Q., Xie, J., Li, J., & Qin, B. (2019). A secure versatile light payment system based on blockchain. *Future Generation Computer Systems*, *93*, 327–337. doi:10.1016/j.future.2018.10.012

Zhou, L., Wang, L., & Sun, Y. (2018). MIStore: A blockchain-based medical insurance storage system. *Journal of Medical Systems*, *42*(8), 1–17. doi:10.100710916-018-0996-4 PMID:29968202

Zhu, H., & Zhou, Z. (2016). Analysis and outlook of applications of Blockchain technology to equity crowdfunding in China. *Financial Innovation, 2*(1). doi:10.1186/s40854-016-0044-7

Zuberi, M. M. (2017). A Silver ('Chain') Lining: Can Blockchain Technology Succeed in Disrupting the Banking Industry? *Banking & Financial Services Policy Report*, *36*(3), 1–4.

About the Contributors

S. L. Gupta, working as the Director, BIT, Noida, India, is an Educationist and Professor of Marketing Management. He has an excellent record to his credit right from the very beginning. His experience into academics has been very long. He has been teaching Marketing Management, Marketing Research, Sales and Distribution Management and Service Marketing since 1992. He believes in upliftment of deserving through micro finance.

* * *

Sugandh Arora is a Research Scholar at Mittal School of Business, ACBSP USA, Accredited, Lovely Professional University, Punjab (India). Her work mainly focuses on the effectiveness of household food security in Punjab and on the various PDS reforms. Her recent publications are under Int. J. Economic Policy in Emerging Economies (Inderscience); Emerging Trends in Business Economic, Vol 1. (2020); International Journal of Research and Analytical Reviews (IJRAR) Vol 6. (2019) and Management in Practice. Challenges and Strategies (2019). Her research interest areas are Agriculture economics, International Trade, and global food security.

Nitin Balwani is a versatile, effective leader with more than two and a half decades of progressive experience in managing business schools and financial outsourcing services. Dr Balwani has published extensively and presented at national and international conferences in areas covering behavioural finance, strategic analysis, FinTech applications, equity research, and advances in management education. His articles have been published in top-ranked journals including the Indian Management, International Journal of Applied Business and Economic Research, International Journal of Economic Research, Focus: International Journal of Management, Human Capital, Huffington Post, Business World, The Economic Times, etc. Dr Balwani also has two books and several cases to his credit

Meena Bhatia has over 24 years of experience which includes both corporate and academic experience. Her teaching interests range from financial accounting, management accounting, corporate finance, Management control system, and Securities Analysis and portfolio management. She has taught at postgraduate management programmes of BIMTECH, IIFT, IMT, Bombay Stock Exchange Institute and many other B Schools in NCR. Besides this, she has also taught at the University of Bradford, UK. She was also the Dean for the University of Bradford, UK programme in India. Was responsible for giving students' at two campuses the same learning experience and quality assurance as was given by the University of Bradford. Successfully led Quality Assurance Agency (QAA) visit and validation process of Business programmes to award UK degrees. As Director with IILM Graduate School of Management was responsible for developing academic policies and frameworks, curriculum and programmes development, people development and accreditation for the PGDM programmes. The role also included establishing and implementing efficiency improvement measures in different verticals of programmes, building synergetic relationships, networking and establishing linkages with corporate, ranking agencies and international accreditation bodies like the AACSB and the EFMD. Her research interest and contribution include topics covering financial markets, disclosures and financial reporting. She has presented her research work at internationally acclaimed institutions such as Harvard University (Boston USA), University of London, IIM (Ahmadabad), IIT (Delhi), IIT (Kharagpur), IIM (Lucknow), IMI (Delhi), etc. Dr Bhatia has publications in national and international journals of repute. She also provides research guidance to PhD scholars. She is on the Editorial Board and reviewers' panel of South Asian Journal of Business and Management Cases published by Sage Publications and on the reviewers' panel of many Emerald and Inderscience Journals. Dr Bhatia is passionately involved in Management development and training programs. She routinely conducts training & development programmes in costing, finance, accounting, analysis and investments for managers of Private and Public sector enterprises in India. She has provided consultancy to small and medium scale enterprises. She has a PhD in Finance, besides FCMA, CFA, MBA and B.Com (Hons) from Delhi University. She is a merit holder of the Institute of Cost Accountants of India and a scholarship holder of the Institute of Chartered Financial Analyst of India.

Ritesh Chandra is a Banking professional with 14yrs experience in credit risk management. He is currently working as President, Credit Risk Management, YES Bank. Ritesh is a PGDM from IIM-Calcutta, B. Tech from IIT-Kanpur, and CFA(USA) charter holder. He is a member of the Board of Studies (BOS) in the area of Finance at IMT-Center of Distance Learning (CDL), Ghaziabad. Ritesh is also a guest faculty at the Indian Institute of Banking & Finance (IIBF) - IIBF is a national apex body under the ownership of the Ministry of Finance, that imparts professional education in banking and finance. His areas of interest include Credit Risk, Machine Learning, and Blockchain technology.

Lorenzo Gai is a Full Professor of Economics of Financial Intermediation, University of Florence, Department of Economics and Management, from 2005 to date. Awarded by the Italian Republic President of the honorary distinction of Cavaliere dell'Ordine "Al Merito della Repubblica Italiana", by decree dated 27 December 2020. Main research interests: Central banking; Banking management; Fintech; Banking regulation; Mutual guarantee institutions. Scientific coordinator of several research projects and authors of national and international papers.

Gulnawaz Gani is currently pursuing the Ph.D. degree in Computer Science from the University of Kashmir, India. He completed his post-graduate degree from the same university in 2014. His research interests are in the area of image and video forensics, machine learning, deep learning.

Zubair Jeelani was awarded Ph.D. in Computer Science from University of Kashmir, India in the year 2020. He is an active researcher and his current research interests are cellular automata, image processing, computer vision and Blockchain Technology.

Pitresh Kaushik is currently working as an Assistant Professor at Doon Business School, Dehradun. He is having a distinguished history of working with both industry as well as academia where he has dealt with the matters related to Finance, Taxation, Corporate Laws, Auditing, and Accounting. He is a consultant to various CA and CS Firms for the matters related to corporate laws and taxation. He is an Associate Member of The Institute of Company Secretaries of India (ICSI) and a member of American Finance Association (AFA) as well. His articles are published by reputed Institutes like The Institute of Chartered Accountants of India (ICAI), The Institute of Company Secretaries of India (ICSI) and other International Journals listed by Australian Business Dean Council. He not only possess silver certificates in various subjects from the likes of IIT-Bombay and IIT-Roorkee but also possess certificates from International Universities like IESE Business School, Spain and University of California, Irvine.

Neha Kukrety is currently working as an Assistant Professor at Doon Business School, Dehradun. She had worked as a banker for 9 years with the banks likes ICICI Bank, HDFC Bank, Kotak Mahindra Bank, IndusInd Bank, and Edelweiss Capital Finance. She had bagged multiple awards and accolades for her work as CRM and

BAM with ICICI Bank, HDFC Bank Etc. She has also contributed as visiting faculty -Finance Domain since 2015 with prestigious institutes in Uttarakhand. She holds various certificates of Merchant Banking Services. She has actively taken part in training and development programs for Assets Training.

Hesham Magd has more than twenty-five years of combined experience in traditional and nontraditional higher education teaching, training, consultancy, community development, academic administration, curricula design, organizational change and development, distinguished research and scholarly writing, resulting in Honors, awards and recognition for academic excellence and outstanding achievement. Hesham is currently heavily involved in International accreditation and reshaping the aviation education in Oman and offer strategic direction on the direction of the sector In his previous appointments throughout the world in British, European, and American oriented Curriculum (Middle East, USA, and UK), he has been the driving force behind strategic institutional development during the time of profound change in the Higher Education in the Middle East. Hesham has broad knowledge of the UK, USA, Middle East University Systems, and Quality and accreditation systems (AACSB, AABI, OAAA, NCAAA…).

Vandana Mehrotra has 27 years of corporate and teaching experience. For the past 14 years, Vandana has delivered accounting and finance courses to management students at postgraduate and undergraduate levels. In addition to her teaching responsibilities, Vandana has handled administrative responsibilities as well. She is presently the program leader for the PhD program in the School of Management, GD Goenka University. Prior to joining G D Goenka University Vandana worked as an Associate Professor at G D Goenka World Institute | Lancaster University and IILM Institute for Higher Education, which offered the Bradford University courses in India. Vandana has conducted several management development programs for corporate executives and has taken training sessions on finance for civil servants. Her area of research is corporate disclosure and intellectual capital. Before joining academics, she worked for 13 years in the corporate which included working as Manager with National Housing Bank, an erstwhile subsidiary of Reserve Bank of India. Vandana holds a PhD from Ansal University; is an Associate member of Institute of Cost Accountants of India; M.Com (Finance) from Delhi School of Economics, University of Delhi and B.Com (Hons.) from Shri Ram College of Commerce, University of Delhi.

Tawheed Nabi is currently working as an Assistant Professor at Mittal School of Business ACBSP USA, Accredited, Lovely Professional University, Punjab. He has received his Ph.D. degree from DOS in Economics, Karnataka University, Dharwad, and has been a UGC-UPE research fellow. His expertise entails areas like International Trade, Agriculture Economics, and Business Models. He has published his research ideas in journals, edited volumes, conference proceedings in the areas of International Economics, Agricultural Economics, and Business Models. He has presented several papers in International and National level seminars. Dr. Nabi has guided many Ph.D. Scholars. He has sixteen publications in peer-reviewed journals. He has also presented his work at numerous international conferences held at some of the top-notch institutes of the country. Additionally, he is also an Editorial Board member of KJEMS.

Sumit Oberoi is working at Symbiosis School of Economics (SSE), Pune. His areas of interest embrace health economics, international trade, research methodology and micro-economics. He has published paper in high indexed journals such as Economic & Political Weekly, Int. J. of Diabetes in Developing Countries, Springer, Int. J. of Commerce, Economics and Policy (IJCEP) and Anvesha etc. Sumit is also reviewer for various journals viz. International Journal of Emerging Markets (Emerald), Int. J. of Diabetes in Developing Countries, ClinicoEconomics and Outcomes Research, etc.

Sahil Raj is a faculty at the School of Management Studies, Punjabi University, Patiala. His main area of interest is the application of information systems in business organizations. He has done Engineering, MBA, and Ph.D. Dr. Sahil Raj is regularly contributing research papers in national, international journals and presenting research papers at national and international conferences. He has authored five books. Presently, he is guiding research projects in the area of Artificial Neural Networks, Decision Trees, Fuzzy Logic, Business Analytics, and Strategic Information Systems. He teaches in the field of Information Technology and Data Analytics.

Vishal Sarin obtained PhD degree in International Trade from Punjabi University, Patiala, Punjab, India. Currently working as Professor in the Department of Economics at Mittal School of Business (ACBSP accreditation by the USA, and the 2nd ranked in the Management field in India) with Lovely Professional University (LPU) since September 2007. Author of the book 'India ASEAN Trade and Economic Relations' and research papers published under SCOPUS- Indexed, Econ Lit, and Refereed journals on Optimum Currency Area, Financial and Monetary Integration. Primary area of research includes Regional Trade Agreements, Trade Competitiveness and Blockchain Technology. Over 15 years of teaching and research experiences.

Anup Sharma is a research scholar and an MBA faculty. He is a graduate from IIM-Ahmedabad and served in Industry as well as in Education. His research area is Finance and most of the work is around retirement planning, insurance, and wealth management.

Priti Sharma is an Academician with 25 years of experience including 3 years of corporate experience. She is associated with IMT CDL, Ghaziabad as Associate Professor (Finance). Priti completed her Ph.D. from Aligarh Muslim University (AMU), and her master's in finance from Pondicherry University. She is the author of the Palgrave Publication Book, "An Insight into Mergers & Acquisitions - A Growth Perspective". Priti has also authored e-content for EPGPathshala; an MHRD Project and several research papers in the area of finance. Her interest areas include Mergers & Acquisitions, Mutual Funds, Business Valuation, Fintech, etc.

Gargi Shukla, a prolific trainer and researcher, has presented and published over 25 research papers in places of International repute including IIM Lucknow, IIT Delhi and IIT Roorkee. She is an expert in conducting experiential learning based training & development programs in the area of Financial Inclusion & Planning She is a SEBI certified trainer for imparting Financial Education in different sections of society. She has published her various research papers in ABDC "C" Category, Scopus and UGC Care list.

Fasel Shusha received Bachelor's Degree from the University of Kashmir in 2005. He completed his Master's Degree in Computer Applications from Rajiv Gandhi Technical University and Master's Degree in Mathematics from Barkatullah University. He received his PhD Degree in Computer Science from the University of Kashmir. Currently, he is working as Assistant Professor in the Department of Computer science, University of Kashmir.

Derya Ucoglu received her MSc in Financial Economics (Accounting and Finance Path) from İstanbul Bilgi University and her Ph.D. in Accounting and Finance from Marmara University in 2012. After working in different financial institutions, she has been an Assistant Professor of Accounting at Istanbul Bilgi University since 2014. She has published articles mainly on financial reporting. She currently focuses on the changes in the recognition and presentation of financial statement items due to the pandemic and disclosures regarding COVID-19 and the impact of technological innovations on finance, accounting, and auditing.

Index

S

T

U

V