Blockchain in Stock Market Transformation: A Systematic Literature Review

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Blockchain in Stock Market Transformation: A Systematic Literature Review

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Abstract
Blockchain, which is the core technology for Bit coin and other digital currencies, is a disruptive technology, especially in the Stock Exchange Market. Although blockchain has much potential in transforming the traditional stock exchange market, blockchain research in this field is still in its infancy. Business scholars began publishing studies related to blockchain in the Stock market transformation in 2015. In this research, we did a PRISMA guided systematic literature review of blockchain in the Stock market transformation from 2015 to 2019. The results show that even though there is an increase in studies, more empirical research is required to utilize the potential of blockchain technology fully. The findings also provide important insights into the current state of a blockchain scholarly study, including its top advantages and legal obstacles, the risk associated with implementing this technology, and the identification of various promising blockchain models currently being proposed in the stock market. We find that blockchain transforms the stock market remains in an early-stage research domain in terms of theoretical basis, methodological diversity, and empirically grounded work. Hence, this research identifies the research gaps and highlights areas where we need a further study that researchers can utilize.

1. Introduction

Blockchain is defined as an immutable public ledger or distributed record database of all digital events and transactions that have been executed and shared by all the participating entities. During the 2009 financial crisis, Satoshi Nakamoto introduced the Blockchain concept in his paper titled "Bit coin: A Peer-To-Peer Electronic Cash System" [1]. Through this, he describes an electronic

peer-to-peer version of money that can allow online transactions directly from one party to another and hence eliminates the role of any intermediaries. The initial realization of this technology was Bit coin. Nearly 700 other digital currencies have since emerged with varying degrees of success. Later, the core principle of Bit coin, blockchain technology, was used to build various other networks, such as the Ethereum and Hyper ledger, of public and private connectivity outside of traditional fiat currencies electronic voucher schemes. By combining properties such as distributed ledger, a decentralized mechanism, cryptographic security measures, and immutability allows blockchain-based economic networks to make radical changes in financial markets and challenge the role of traditional financial institutions such as banks or central securities depositories [2].

The blockchain's transparent and decentralized nature allows the development of an immutable data record, which is the basic characteristic of many applications such as insurance, fraud detection, finance, copyright protection, identity management, e-commerce, and healthcare. Blockchain Technology in Contract Management offers a solution for companies validating contract details that could greatly benefit organizations and companies of all kinds of businesses, for example, in the technological and construction industries [3]. Therefore, Blockchain Technology Contract Management will enable organizations to optimize the efficiency of their supply chains, analyze vendors and gain higher value. Blockchain provides a transparent transfer of royalties in real-time distributions in the entertainment sector within Smart Contract to everyone involved in both the music and film industries. The healthcare sector has already taken steps to use Blockchain Technology. In medical industries, smart contracts may hold the tabs between payers, vendors, and drug manufacturers [4]. Healthcare facilities can set up smart contracts with any payer or manufacturer to be stored on their Mettle digital records. Insurance is a new field for Blockchain Technology. The industry is expected to be spending more than $2 billion on fraud and enforcement per year. The use of Blockchain Technology has tremendous potential for the entire value chain of insurance. Smart Contracts will automate such insurance products. Blockchain has the power to remove error, failure, detect fraud and check customers' authenticity and their policies. In the financial sector, blockchain has brought in disruptive changes. Blockchain provides a simple and safe solution in payments, as it does not require authorization from third parties [5]. By cutting off many conventional intermediaries, the laborious and costly method of cross-border payments is streamlined, thus substantially speeding up the cross-border payment method and costing much less than conventional banking systems. Another major impact will be in the Securities Exchange Market, which is the background of this article [6]. The decentralized design of blockchain technology will replace all these intermediaries and allow trading to occur around the globe on computers.

Eliminating some of the intermediaries from the securities exchange process speeds up the settlement process and enables greater precision in trade. Trading transactions in blockchain thus decreases information redundancy and thus improves accuracy [7].

1.1. Securities Exchange Market: Current Scenario

A securities exchange or stock exchange market can be described as a marketplace where traders and stockbrokers can purchase and sell securities such as asset and bond shares and other financial tools. In a centralized program that governs all trading activities, the conventional financial markets are implemented [8]. An order is an instruction to buy or sell an asset at a given market price; and most of the times, the broker intermediates an order. In stock markets, it is possible to execute mainly three different types of orders, as shown in Figure 1.

Figure 1 - Traditional Stock Exchange Market
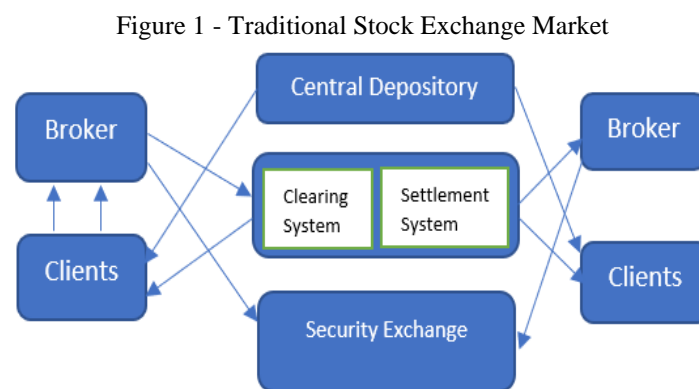
The traditional capital market system depends on centralized components. Stock Exchange, Settlement System, Clearing House, and Centralized Repository are various entities that make up the existing securities market. This system has many disadvantages. One of the key disadvantages of the traditional system is that a single third party control and governs the network, which makes the system more vulnerable to attacks and failures on a single level. Also, one central third party has handled every transaction in the system, which has created an oppressive structure. The owner controls the payments [9], which does not benefit from the low fees that a decentralized system can offer. Also, in the present scheme, the approval of new business activity only takes place through the intermediates, who are the brokers in the commercial market. Brokers are the trusted registered entities acting in exchange for a fee on behalf of the clients' trade market. Another big downside of managing each transaction is the high processing and settlement time. Depending on the form of exchange, a trade in the conventional system would take T+2 or T+3 days [10]. Only a fully

electronic system will be able to monitor all the settlements effectively in near real-time. Also, the central authority is responsible for implementing matching algorithms in the marketplace. To the exchange market, this very often lacks openness and transparency.

1.2. Prior Research

Ever since the introduction of blockchain in 2008, much research is being carried out in this area. Smart contracts and Ethereum concepts gave a new dimension to blockchain technology. They introduced the concept that blockchain can be extended to many different business areas. There are many research papers, which explain how decentralization can be achieved using the distributed Ledger Technology [11].

Systematic Literature Reviews concerning the development of the Stock Exchange Market using Blockchain technology appear to be very minimal to the best of our knowledge. The first paper regarding decentralization and Stock Market appeared in 2015. Later in 2016, Lee explained a blockchain model of the Stock Market, which can overcome the limitations of the traditional Structure of the Securities Exchange market [12]. Since then, many theoretical frameworks were suggested by researchers using blockchain. Only in 2018, we see empirical research providing statistical data regarding the efficiency of blockchain technology in the Stock Market. Here, the Stock Market was developed using Ethereum, and using statistical data proved that blockchain markets gave better results than the traditional markets by providing more transparency in trading, low transaction fees, etc. [13].

The previous studies describe different models implemented using blockchain technology and their advantage. However, they do not examine the feasibility of these models. The area of research related to blockchain has a fairly short history and is evolving rapidly. Therefore, to direct new research activities, a fresh overview of the more recent research work needs to be given, especially in the blockchain domain in the security exchange market [14].

2. Methodology

This study aims to review current studies and their results and summarize research efforts in stock market blockchain implementation and how it can be used to address the existing stock market structure limitation [15].We introduced the following four research questions to make the study more focused:

Q1: What are the benefits that Blockchain technology can offer in the Securities Exchange Market?

The traditional securities exchange market has several disadvantages. The unique characteristics of blockchain can tackle all the problems currently faced in the securities exchange market. Here, we discuss those unique properties and how they can be used to overcome the problems.

Q2: What are the latest blockchain developments in Stock Market?

Blockchain has diversified away from sole crypto currency. Many countries are currently researching how to use blockchain properties to overcome the limitations of the existing stock market structure [16]. An analysis of the recent developments happening in the stock market concerning blockchain, the countries currently focusing on blockchain developments, and have implemented some of the blockchain features in their existing structure will be discussed.

Q3: What are the different blockchain models proposed to overcome the existing limitations of the stock market?

Researchers have suggested different blockchain models, which can overcome the existing limitations of the stock market. A detailed review of the existing blockchain models proposed in the stock market and to analyze the feasibility of this model will be addressed [17].

Q4: What are the possible challenges and legal issues of implementing blockchain in the Securities Exchange Market?

Implementing blockchain in Securities involves many legal challenges. An analysis of the legal issues and laws required while implementing blockchain in the Securities Exchange Market.

2.1. Methods

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations have been adopted to standardize the characteristics of this systematic literature review [18].

2.2. Selection Criteria and Literature Search Strategy

The literature was searched through Scopus by Document search from 2015 to 2019 with the keywords of "Blockchain" AND "Stock Market," "Blockchain" AND "Securities Exchange,"

"Distributed Ledger" AND "Securities Exchange" and "Distributed Ledger" AND "Stock Market." Another database used is Google Scholar (GS), using the keywords "Blockchain, Stock Market, Securities Exchange Market, and Distributed Ledger" as search terms. Within Google Scholar, we screened the first 150 search records [19]. Furthermore, we checked all potentially applicable papers and book chapters on the reference lists. We chose Google scholar and Scopus because Google Scholar provided international and interdisciplinary research papers. At the same time, Scopus has more peer-reviewed papers. We took out redundant documents. Based on the following questions, the abstracts of the selected papers were scrutinized. We shortlisted those articles for further studies whose answers to all questions were yes [20].

- Is the article about Blockchain implementation in Stock Market?

- Is the focus of the paper on the Blockchain and Securities Exchange Market?

- Does this article address any of the problems in the existing Securities Exchange Market?

- Is it a conference article/journal/book chapter?

- Is the paper written in English?

After screening the abstract, the shortlisted papers were extensively read to ensure that earlier versions of the same article were excluded. The article's main emphasis was on the data-driven approach.

2.3. Study Selection

A simple Google Scholar article search yielded 16,300 references. 150 Google Scholar records were selected and evaluated. Scopus search yielded 80 papers. These 230 references were checked for duplicates [21]. From these papers, 27 papers were found relevant to the selected topic of research. Before 2015, we do not see any research papers on this topic. That is why we selected the timeline from 2015 to 2019. The flow chart of the study selection process is shown in Figure 2.

Figure 2 - Flowchart of Literature Synthesis
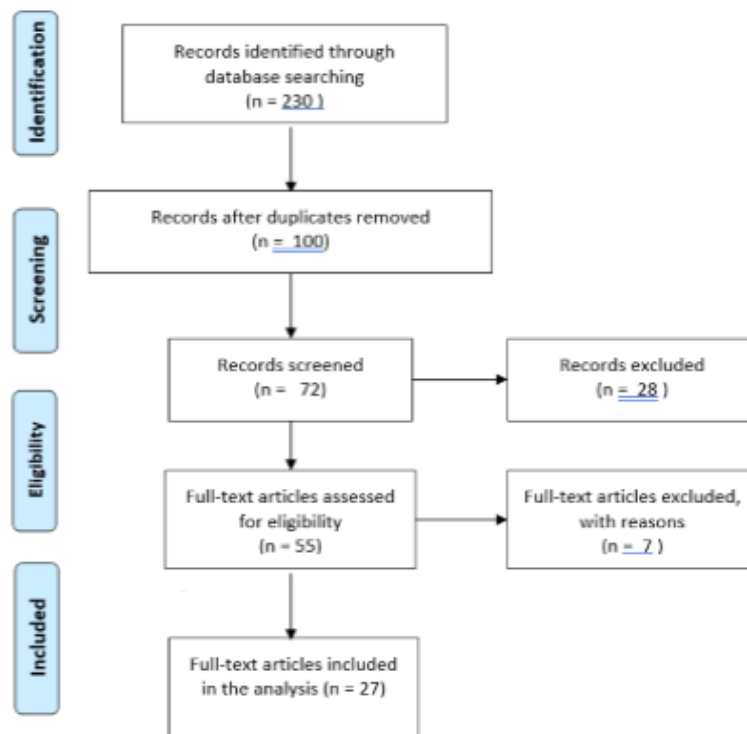
3. Results

This section highlights the initial analysis of our selected literature review population. The papers are grouped according to the geographic distribution, publication year, and type of papers, and research methods [22].

3.1. Geographic Distribution and Publication Year

The first analysis is based on the year in which the selected research population is published. Figure 3 shows the distribution of several research papers published per year across the timeline for the selected literature population [23]. The distribution is as follows: 1 paper (4%) was published in 2015, 7 papers (26%) in 2016, 6 papers (22%) in 2017, 6 (22%) in 2018, and 7 papers (26%) in 2019. We also identified that before 2015 we do not see any papers published for blockchain in the Stock market. After 2015 we see an increase. Hence, the graph indicates the newness of the topic. The researchers have started to focus on how blockchain can be used to implement the securities exchange market. Even though we see an increase in the number of papers, there is not much significant research being carried out in this area [24], which points out the research gaps and the new areas, which can be explored by the researchers in the Securities Exchange Market. The related publications

selected belong to a variety of journals. The majority of the papers in our selected population belong to IEEE [25].

Global interest in blockchain technology can be observed for selected literature populations based on 14 countries. (See Figure 5) The majority of papers selected were written by authors located in the US and India (14.8%), which mainly proposes the different blockchain models, followed by the UK and China (11.11%), which discusses equity crowd funding and the capital markets and Australia, Hong Kong and Sweden (7.4%). The rest of the countries have published just one paper each. (See Figure5).

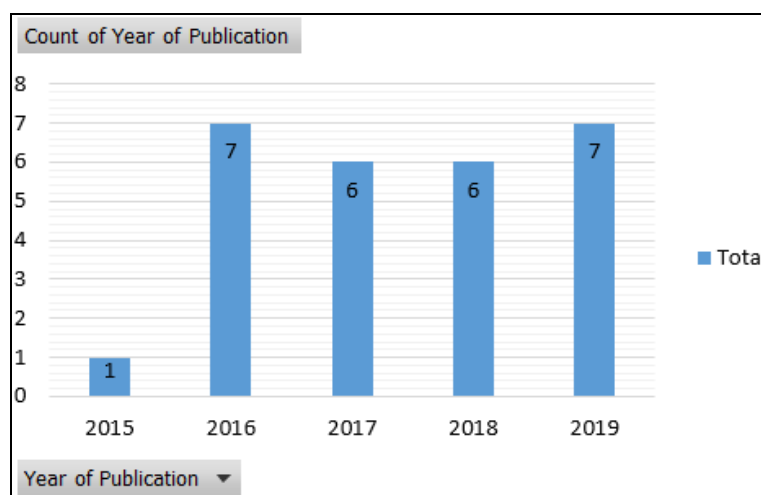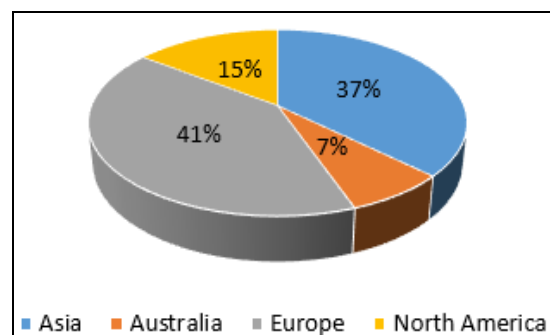Figure 3 - Classification based on Publication Year

Figure 4 - Classification based on the continent


The geographic distribution by continents is also analyzed (See Figure 4). The regions where the selected literature belongs are Europe (41%), Asia (37%), followed by North America (15%), and Australia (7%). One of the main reasons for the increase of blockchain research in Europe is the research done by many start-up companies and how blockchain helps address data security problems

[26]. Even though we see much research in blockchain, there are still areas, especially in the Stock Exchange, where we can utilize the advantages of Distributed Ledger Technology.

Figure 5 - Classification based on Country
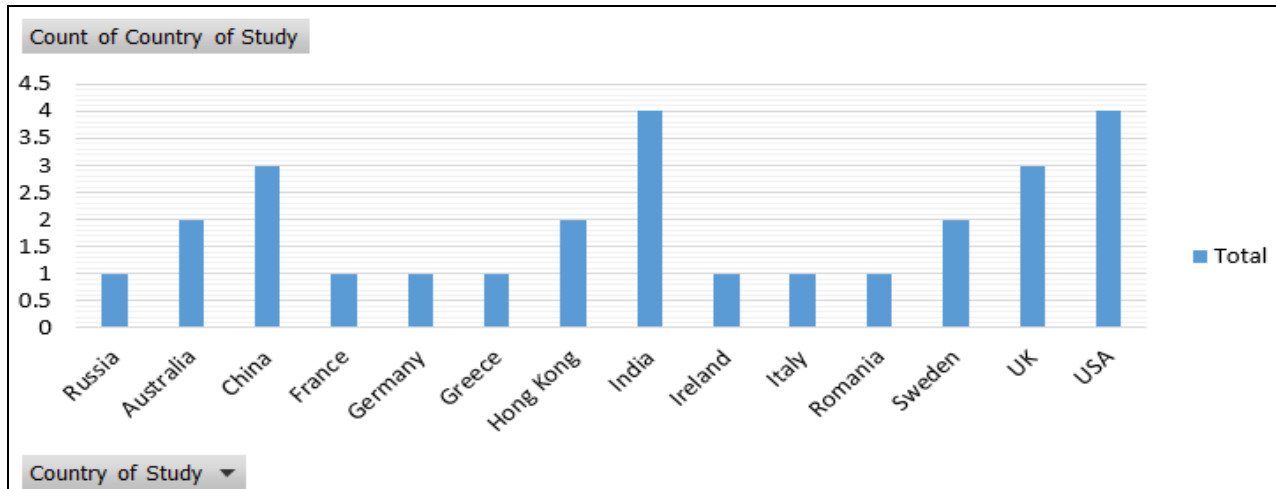
3.2. Classification of the Selected Literature

The first classification of the selected literature population is based on the research methods adopted, which helps define the current state of research on the subject and what research is needed to go further in this field. In our literature population, the research methods identified are exploratory studies (63%), followed by theoretical frameworks (33%), systematic reviews (11%), statistics (7%), case studies, and comparative studies (both 4%). The above figures indicate that blockchain implementation in the Securities Exchange market needs further scientific analysis, case studies, and comparative studies.

Figure 6 - Conceptual Papers vs. Empirical Papers
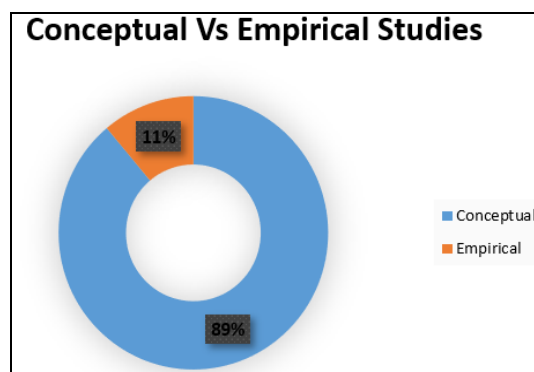
To identify the current state of research of blockchain in the Stock exchange market, we did a high-level analysis of the selected literature population based on the relative proportion of empirical and conceptual papers (Figure 6). Empirical papers focus on measurable and observable methods to explain our classification method, using various quantitative and qualitative activities. In contrast, conceptual papers address blockchain concepts, hypotheses, benefits, implementations, and challenges without gathering primary data or analyzing secondary data. 89% (n=24) of our total selected literature population of 27 papers were conceptual, and 15% (n=3) were empirical. The first empirical study was published in 2018. It received statistical data, providing promising results for the stock exchange market from implementing the Ethereum blockchain. Figure 7 presents a conceptual vs. empirical paper ratio over a chosen period (2015 to 2019). The figure indicates very little improvement in the ratio of conceptual papers and empirical papers published each year, which shows that blockchain is a new concept in the securities market, and the work in this area is also growing. Figure 8, however, indicates that the rate of academic transformation from the conceptual study to empirical research remains in the initial stages of a new topic.

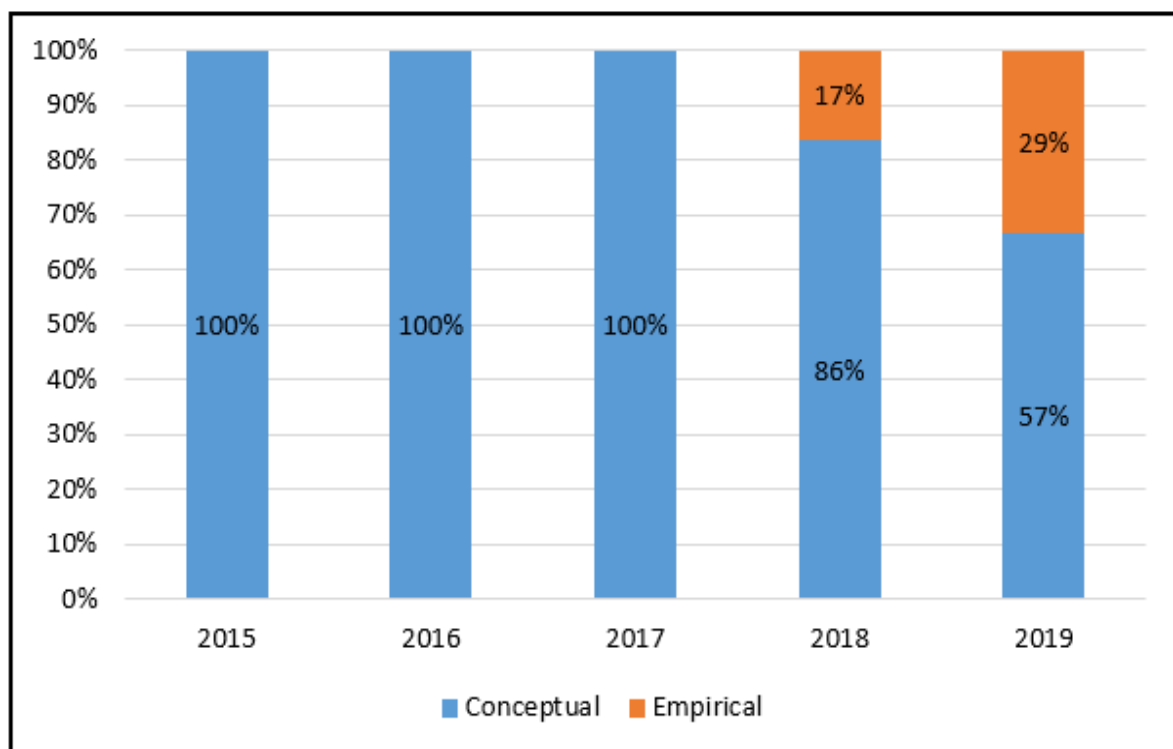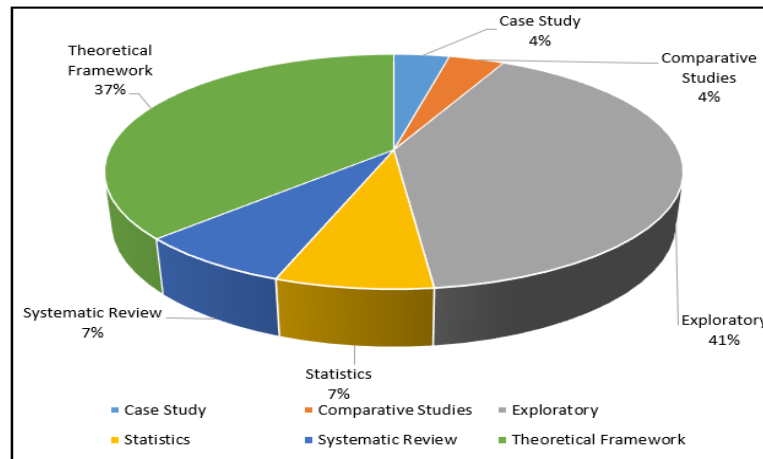Figure 7 - Conceptual Papers vs. Empirical Studies Year Wise

Figure 8 - Research Methods Adopted in the Selected Literature Population

In this case, new concepts, such as blockchain on the Securities market, typically spread throughout the literature, starting with an exploratory discussion of predictions, definitions, opportunities, excitement, disadvantages, and skepticism that are later observed, tested, and empirically measured in practice. Conceptual studies provide blockchain insights, structures, commentaries, and criticism from a range of perspectives. A rise in this type of study indicates the topic's newness [27]. Overall, our findings demonstrate that the Securities Exchange market research into blockchain implementation remains in the early research stage, both conceptually and, particularly, empirically, in the industry. The third classification is based on the number of citations. Table 1 shows the top five cited papers and their authors and the journals they published. A review of selected 27 papers on Blockchain Technology in the Stock Market is explained in Table 2.

Table 1 - Top 5 Cited Papers from the Selected Literature Population

Rank	Title	Journal	Cited By
1	*Blockchain Technology: Beyond Bit coin*	*Applied Innovation Review*	916
2	*New Kids on the Blockchain- How Bit coin's Technology Could Reinvent the Stock Market*	*Hastings Business Law Journal*	92
3	*Applications of Blockchain Technology beyond Crypto currency*	*Annals of Emerging Technologies in Computing*	80
4	*Evaluating Suitability of Applying Blockchain*	*2017 International Conference on Engineering of Complex Computer Systems*	56
5	*Blockchain /Distributed Ledger Technology (DLT): What Impact on the Financial Sector*	*Digi World Economic Journal*	54

Table 2 - Review of Selected 27 Papers on Blockchain Technology in Stock Market

Authors	Objective of Study	Findings
Mahdi H. Miraz, *David C. Donald* (Miraz and Donald 2018)	*The study proposes a Blockchain hybrid model customized to the needs of the respective stock exchange.*	*The research is conducted in-depth on various types of Blockchain technology to determine how blockchain can help promote a stock exchange's transactions. Based on the results on BC innovations and considering the stock exchange operating framework, this paper puts forward a BC hybrid solution that can overcome the drawbacks of a conventional system.*
Usman W. Chohan (Discussion and Discussion 2017)	*Development of the Australian Securities Exchange (ASX) using blockchain technologies.*	*The blockchain-based Australian Securities exchange offers several advantages over the traditional system (CHESS) like efficiency, delivery, privacy, interoperability, accessibility, and reliability.*
Akshay A Bhandarkar, Vinith V Bhandarkar, Aditya Shiva (Bhandarkar, Bhandarkar, and Shiva 2019)	*This study describes digital stocks that essentially tokenize real-world stocks on equity tokens that can easily be transferred from one peer to another via a blockchain.*	*Using Blockchain technology, sellers can build digital stocks that allow everyone in public to buy and sell and see each other's transaction as it happens and increase the transparency of the trading.*
Vijaya Kittu Manda, Dr. S.S. Prasada Rao (Manda 2019)	*To study the implementation of blockchain in the Mutual Fund Industry.*	*Blockchain technology will help all stakeholders in the mutual fund industry with its transparency, decentralization, tamper-resistance, accountability and privacy, and immense saving of time and cost with all stakeholders.*
Jonas Hedin (Jonas Hedin, Oskar Janson, and Moström Examiner Henrik Björklund 2017)	*This study identifies blockchain technology and its applications in the finance industry, especially on how it can reduce the responsibility of the central securities depository*	*Using blockchain the securities depository could be decentralized to reduce the industry's costs while also reaching near-instant settlement times. All of this is done without the need for a trusted intermediary.*
Alexandros Seretakis (Seretakis 2017)	*To study how the legal regime can act both as an impediment and a catalyst to the widespread adoption of the distributed ledger technology in the Securities Market and Central banking.*	*The study shows that the hype surrounding distributed ledger technology and regulatory obstacles can hinder the widespread adoption of the blockchain in the financial markets.*
Andreea Vesa, Antal Marcel, Cristian Pop, Tudor Cioara, Teodor Petrican, Claudia Pop, Ionut Anghel (Pop et al. 2018)	*The study proposes a blockchain architecture model of a decentralized securities exchange market in Ethereum using a smart contract.*	*The studies showed that the blockchain model provides less transaction cost for a partially filled order book and a filled order book. The decentralized system gave better results than the traditional system.*
Qinghua Lu, Yin Kia Chiam, Sin Kuang Lo, Xiwei Xu (Lo and Chiam 2017)	*The study analyses the suitability of applying blockchain in different fields. The suitability is analyzed using an evaluation framework that contains a list of criteria along with a process.*	*The study shows that identity management and supply chain will benefit from using blockchain. In contrast, the design and weakness of blockchain render the stock market and Electronic Health Records unsuitable yet.*
Larissa Lee (Business et al. 2016)	*The study discusses a peer-to-peer security exchange scheme, the legal implications, and how such a system would suit existing legislation and regulation.*	*The stock exchange system will allow sellers to trade directly through blockchain, removing different layers of intermediaries like the transfer agents and brokers, which will also offer greater transparency.*
Jiaqi Liang, Linjing Li, Weiyun Chen, Daniel Zeng (Liang et al. 2019)	*This study compares crypto currency and its dynamic characteristics with Foreign exchange and Stock.*	*The study shows that in terms of the diversity of the central nodes and the correlation between the minimum risk and the mean correlation coefficient or the normalized tree length in the portfolio risk, the crypto-currency market is more similar to the stock market.*

Eric Wall, Gustaf Malm (Wall and Malm 2016)	*This study examines the potential of using distributed ledger technology in the creation of a distributed securities depository.*	*Decentralization of the securities network depository layer is a massive undertaking that needs wide-ranging industry cooperation. It should be slowly introduced, and this could theoretically open up opportunities to plumb the financial system.*
Philipp Paech (Paech 2016)	*This study examines the new international legal framework and how it could be built for the securities exchange market.*	*Early development of a legal framework is important for developing the Securities exchange market using blockchain technology. The legal framework should also data protection laws in addition to the regular laws.*
Emilios Avgouleas, Aggelos Kiayias (Avgouleas and Kiayias 2019a)	*The study proposes a robust blockchain-based architecture to develop permission-based derivative clearing and settlement platforms and address liquidity shortages within DLT systems.*	*DLT structures can improve awareness of both risk and position and build a more diverse and therefore more capable of managing risk, environment, and greater investor control over their assets. Enhanced post-trade transparency will curb excessive leverage-fuelled speculation.*
Katya Malinova, Andreas Park (Malinova and Park 2016)	*This study proposes a theoretical model of an intermediated and peer-to-peer trading using blockchain technology.*	*The electronic nature of blockchain securities, peer-to-peer interactions, and the possibility of linking ownership to a public key makes market trading possible with blockchain technology.*
Alexis COLLOMB, Klara SOK (Collomb and Sok n.d.)	*This study examines the impact of DLT on the financial market with a particular analysis of the post-trade infrastructure.*	*The new decentralized transactional model made possible by DLT will impact the securities market to a great extent with an added advantage for the low-frequency private securities market.*
Mahdi H. Miraz1, Maaruf Ali (Miraz and Ali 2018)	*This study identifies applications of blockchain technology beyond Bitcoin.*	*The characteristics of blockchain like security, privacy, immutability, transparency, and time stamping resulted in its adoption beyond its initial application into areas like payments, securities trade, and IoT.*
Reade Ryan, Mayme Donohue (Ryan and Donohue n.d.)	*This article offers advice on the issuance and selling of shares on a blockchain for corporate lawyers faced with providing a legal opinion.*	*The article identifies the legal regulations needed for trading securities using blockchain.*
Michael Crosby, Nachiappan, Pradan Pattanayak, Sanjeev Verma, Vignesh Kalyanaraman (Miraz and Ali 2018)	*This study examines blockchain technology and its unique applications in both the financial and non-financial sectors.*	*This paper points out the latest developments of blockchain in the private securities market like NASDAQ, Medici.*
Julie Frizzo-Barker, Peter A. Chow-White, Philippa R. Adams, Jennifer Mentankoa, Dung Hab, Sandy Greenc (Frizzo-Barker et al. 2020)	*This study provides a systematic literature review of blockchain technology, showing how it can be disruptive in business literature.*	*Identifies the work going on in the financial industry and how blockchain removes the need for intermediaries to check ownership or validity of funds and maintain a master copy for clearing transactions.*
Gaurang Bansal, Mohsen Guizani, Neeraj Kumar, Vikas Hassija, Vinay Chamola (Bansal et al. 2019)	*The study proposes a Stock exchange model using a Blockchain solution that uses smart contracts that can be accessed using machine learning.*	*Blockchain helps solve many problems of the traditional securities exchange market based on a traditional system. Machine learning combined with it can make it more intelligent and provide a future proof model for the securities exchange market.*
Huasheng Zhu and Zach Zhizhong Zhou. (Zhu and Zhou 2016)	*This study identifies the current problems in equity crowdfunding in China and how blockchain technology can act as a better solution.*	*Blockchain technology is a solution that enables secure and low-cost identification of shares, shares settlement and transfer, and shareholder voting in the crowdfunding sector, removing the legal risks associated with fund management.*
Benedikt Notheisen, Magnus G¨odde, and Christof Weinhardt (Maedche et al.	*The study proposes a software structure of the market framework that illustrates the feasibility of*	*A blockchain-based Stock market mechanism provides low-cost and intermediary-free stock transactions in an algorithmically governed*

2017)	decentralized market mechanisms. It highlights potential use cases as well as limitations.	way. It provides a trust-free, decentralized and immutable system.
K. R. Adamova*and I. E. Pokamestov (Adamova and Pokamestov 2018)	*This paper studies the technology of the distributed ledger by institutions of custodian infrastructure.*	*Blockchain technology has significant advantages that allow solving many problems, especially in the securities market. It can increase calculation speed, Cryptographic protection in the transactions, etc., are some of the advantages.*
Geranio, M. (Geranio 2017)	*The study identifies how blockchain technology affects the financial sector.*	*Blockchain is expected to transform the financial market. Key impacts on the post-trading sector are expected. Settlement and custody will be the areas most affected, as the distributed ledger streamlines and shortens the storage and exchange process.*
Xu, M., Chen, X., Kou, G. (Xu, Chen, and Kou 2019)	*Systematic literature review of blockchain identifying the major Fintech revelation.*	*Ethereum and its ERC20 standard can be used in the securities market to act as a form of validation of any right, including personal identity for stocks.*
Ishant Choudary (Implementing Blockchain in Stockmarket.pdf n.d.)	*This study examines the effect of transparency of holdings on investor welfare in a theoretical model of peer-to-peer trading.*	*From the study, it is identified that the highest investor welfare is provided with full transparency. Hence, transparency and the possibility of linking ownership with the public key make the blockchain technology an attractive solution for the Stock market.*
Eupraxia D. Zamani, Kypriotaki and George M. Giaglis (Kypriotaki, Zamani, and Giaglis 2015)	*This study describes blockchain technology and how this technology can be used to enable decentralized business structures to emerge fully;*	*The study identifies how decentralization can be achieved using the underlying technology of Bit coin, blockchain technology.*

4. Discussion

The second stage of our research is outlined in this section. The main aim is to discuss the answers to each research question that we have found. Following this, we discuss this research limitation, its relevance, and the implications for future studies [28].

Q1: What are the benefits that Blockchain technology can offer in the Securities Exchange Market?

Blockchain provides a decentralized solution that tackles all the problems of the traditional Securities Exchange market. The unique properties of the blockchain like self-enforced validation, transparency, low transaction fees, global agreement of all the transactions that take place help to create a Securities exchange market that can overcome all the limitations of the traditional system. Self-enforced validation is accomplished using a smart contract, which is a piece of code reflecting various business laws. Like the transactions, the blockchain also records the smart contracts and gets activated during the transaction calls [29]. Smart contracts decide which node will change its status according to the results obtained after its execution. They also represent agents with functionality and

state that could be activated even after the successful execution at any time [30]. Consequently, the main objective of smart contracts is to remove any third-party agents and operate in compliance with the pre-established rules that offer a fair-trade climate. Smart contracts also depend on the blockchain framework implementing them. Even though Ethereum is the most developed platform for smart contracts, many other platforms like Side chains, NXT, and Hyper ledger implement smart contracts [31]. In addition to this, Blockchain technology will offer lower costs than existing legacy systems. It will require less maintenance while eventually reducing transaction costs in the long run. Blockchain would incorporate automation into the necessary post-trade activities. Instead of days, securities can be solved in minutes, i.e., real-time settlement with a greater degree of transparency and accountability along with supply chain management and liquidity [32].

Q2: What are the latest blockchain developments in Stock Market?

Blockchain is a promising breakthrough technology, but it is still in the early stage of development in the Securities Exchange Market. Once it is implemented, the present-day intermediaries in the market (e.g., brokers) will have a major role in change and responsibilities. Here, we summarize some of the recent blockchain developments in the Securities Exchange Market:

i. National Association of Securities Dealers Automated Quotations Exchange (NASDAQ), which is the second-largest Stock Exchange in the world, launched the Private Equity Exchange on top of blockchain in 2014 called 'Linq' in collaboration with chain.com, the leading provider of blockchain infrastructure to financial institutions and businesses, which helped to promote safe issuance and transfer of private-held companies' shares in the study of the blockchain platform [33]. It was also intended to provide key functionalities, such as the Cap table and investor relationships for pre-IPO or private companies. Due to the involvement of multiple third parties, the current stock trading process in this exchange is slow and inefficient. Compared to the conventional method, this product is incredibly simple, traceable, and effective.

ii. Overstock, an e-commerce corporation, launched the 'tZERO Crypto.' This blockchain platform issues its corporate bonds, which helped eliminate naked short selling and reduce the settlement time to almost zero. Overstock earned regulatory approval to issue equities through its blockchain, six months after the bond's issue. The company also announced in September 2016 about working with regulators on more improvements for its network is collaborating with Keystone Capital.

iii. Medici is the blockchain subsidiary of Overstock.com, which offers shares that use Bit coin 2.0 counterparty implementations. The goal behind Medici was to establish a stock exchange.

Counterparty is a protocol applying conventional financial instruments as smart contracts executing themselves. These smart contracts enable, validate and execute contract negotiation and remove the need to provide a physical document. It also removes the need for a broker or a bank.

iv. Another landmark in the Securities Exchange Market will be the Australian Stock Exchange (ASX) launch, using Blockchain technology. In January 2016, ASX purchased a 10-million stake in New York-based Digital Asset Holding to fund R&D in blockchain applications. ASX revealed after a few months that it was completing the first iteration of a new distributed ledger to replace its current settlement system, known as CHESS. The procedure included collaborating during the implementation period with regulatory bodies in Australia and related stakeholders in the trade. ASX completed the development and is currently in the testing phase. This product is considered to be a breakthrough for the distributed ledger technology in Stock Market.

v. Block stream is a blockchain development company. Its open-source project called 'Elements' focuses mainly on side chains to prevent fragmentation, security, and other crypto currencies-related problems. Elements allow you to issue multiple different asset types on a single blockchain, opening up several new usage instances for implementation. The application can include securities registration, bonds, stocks, and derivatives to bank balances and mortgages. [34]

vi. Coin Setter is a Bit coin trading site based in New York with tools for traders in forestry. It works on a Highline Project, which uses a blockchain-based solution for the settlement and clearing of financial transactions in T+10 minutes instead of the T+3 or T+2 days required in the traditional system.

vii. In 2016, Switzerland's Securities Services post-trade market infrastructure (SIX) established a blockchain-based framework that covers the entire bond of a trading life cycle from issuance to securities settlement. This prototype enabled issuing bonds as smart contracts, which had the dates on which coupon payments were made, the amounts, and the repayment dates. The smart contract was also linked to the chain. Buyers paying in digitalized currency can allocate money to the bond. The advantages of the newly developed SIX Securities Services are the sole source of data stored on the ledger and significant cost savings due to the removal of reconciliation processes and operations.

viii. Augur is a decentralized prediction platform based on the Ethereum blockchain that enables users to buy and sell shares in anticipation of an occurrence with the probability of a

specific outcome. These can also be used to render economic and financial predictions dependent on the "wisdom of crowds."

Q3: What are the different blockchain models proposed to overcome the existing limitations of the stock market?

This section outlines the best-identified blockchain models proposed for the Security Exchange market from our systematic review population. Table 3 shows the 6 best blockchain models in the Stock market. The majority of the blockchain models are proposed with the Ethereum platform. The blockchain model using machine learning can be viewed as the best identified one. It gives a new perspective of combining two technologies and the added advantage of prediction using Machine learning.

Table 3 - Review of best identified blockchain models in stock market

Author	Description
Larissa Lee (Business et al. 2016)	*The blockchain model is proposed using Ripple and Ethereum platforms. This model utilizes the underlying blockchain principles with the SHA-256 algorithm and smart contracts. Ethereum has increased transaction speed, and confirmations from Ripple take only a few seconds to complete. As a public ledger, a copy of all transactions will be available in each node, eliminating some of the shrouds of confidentiality covering most of today's dark pool trading and high-frequency, and enabling traders to trade directly through an exchange that eliminates many layers of intermediaries like brokers.*
Mahdi H. Miraz and David C. Donald (Miraz and Ali 2018)	*This model uses Proof of Stack (PoS) for matching and randomizing round-robin clearing and settlement approaches. A central mechanism of trade will carry out the matching of any purchase and sale order of transaction. It will be performed jointly by brokers and dealers. However, the central counterparty clearing house (CCP) will also have power over clearance and settlement. This system provides advantages such as a better trustworthy and stable market, lower transaction costs, and openness than the traditional approach used in the stock exchange market. It can also replace the exchange operators with the BC system building engineers as intermediaries.*
Vijaya Kittu Manda, Dr. S.S. Prasada Rao (Manda 2019)	*A hybrid blockchain model is proposed for the mutual fund system. The permission private segment provides information (such as investor transaction information) only to and by authorized parties. In contrast, the public segment provides information (such as day-end NAV data, factsheets, etc.) to all users without any restrictions. Smart contracts are used for the information (and fund) flow between the stakeholders as and when necessary. The user interface and interaction with the blockchain network will be through a DAPP (Decentralized Application).*
Andreea Vesa, Antal Marcel, Claudia Pop, Cristian Pop, Teodor Petrican, Tudor Cioara, Ionut Anghel, Ioan Salomie .(Pop et al. 2018)	*A decentralized Exchange Platform was developed using the smart contract, which served as an improved ledger for orders. Various Smart Contract states were specified with the required details. The smart contract also defined the order action as a structure that contains details about the address of the person, the timestamp of the action when it was registered in the network, the number of assets transacted, and the price for the sale or purchase. The mapping between the owner's address and the sum of securities held was done by the decentralized depository that kept track of all the assets and replicated the data in the network. The model implemented in Ethereum showed positive results offering lower prices for partially filled order books and full order books.*
Katya Malinova, Andreas Park (Malinova and Park 2016)	*This model highlights the three critical features of the distributed ledger, allowing for new market designs relative to the current security trading environment. The first is the electronic design of blockchain securities. Investors can explicitly program trading rules into the so-called smart contracts. Secondly, peer-to-peer interactions are possible and simple. The third is the option of linking ownership to a public key. This feature allows market participants to contact each other directly and therefore do not have to go through a third party or a separate system.*
Gaurang Bansal, Mohsen Guizani , Neeraj Kumar, Vikas Hassija, Vinay Chamola (Zhu and Zhou 2016)	*A quantitative model for stock market analysis is developed using the New York Stock Exchange test dataset to achieve 99.71% accuracy. The model uses a smart contract, and once the agreement's rules are met, the transaction is further processed. The smart contract conducts the verification and execution of the transaction negotiation. Whether an issuer or acquirer wants to sell his stocks or purchase a stock, calling the smart contract triggers a transaction. The name of the company and the number of stocks to be transferred should be mentioned in the transaction. The smart contract then accesses the smart agent, a different entity accessible only via the smart contract, which trains the predictive model using the distributed ledger and forecasts the future. The future forecast is offered to the agent who wants to continue or choose to alter the transactions. When the transaction is completed, it is authenticated as well as logged with the distributed consensus mechanism.*

Q4: What are the possible challenges and legal issues of implementing blockchain in the Securities Exchange Market?

The adoption of Blockchain Technology in the Securities Exchange market will bring about a radical change in the industry. Despite the promise that blockchain technology can bring, major legal impediments create uncertainty about its wider adoption in the financial market. The wider adoption of blockchain also depends on its ability to conform to the existing regulatory framework, including many new regulations imposed on financial markets and market participants since the financial crisis. This section highlights the challenges and significant risks in the adoption of this technology are. First, we will discuss the major changes that blockchain will bring to the industry and then how to tackle these changes [35].

Blockchain is making many improvements to the trading of securities. The first big improvement in the crypto-securities industry is that it would no longer allow brokers to participate in trades, which gives the traders an advantage indirectly trading through the exchanges or peer-to-peer, thus increasing income. Another big shifts in the position of the transfer agents the market for crypto-securities could overlook the need for transfer agents. For the proof of ownership, paper certificates will no longer be needed. The blockchain can keep a clear and accurate record of who owns what. With the use of technology such as colored coins, however, issuers will be able to apply code to the underlying shares that will automatically contain the required restrictions. Unregistered securities can be coded as unregistered, and shares with reselling restrictions can be coded with appropriate reselling restrictions. Hence, there is no confusion about when the owner will sell the shares.

Distributed Ledger technology is built on a highly failure-proof, complicated technological system. The function of a legal framework is not yet completely established, which is one of the major challenges when implementing this technology. Because of the extremely fail-proof blockchain technology, we could be convinced by the scheme of leaving dispute resolution between various users or the engineers of the software platform or by the rules set up already in the platform, since the interference of a state-made legal system might make the platform less practical and efficient. However, investment companies, regulated banks, etc., cannot afford to transfer large securities portfolios into a platform, which is technically good but is not safe from the regulatory and another legal perspective, which is where the importance of a system of economic control comes in.

As users of the network, the value of acquisitions and securities transactions using the distributed ledger technology goes beyond the sole interests of the seller and buyer. If either - buyer or seller is insolvent, the issue of 'who owns what' would be of vital concern to unsecured creditors. Commercial and insolvency laws ought to respond. Acquisitions and transactions made on securities

networks using blockchain technology required to be subjected to state laws. This technology cannot replace the whole industry with a single step. It should go step-by-step and replace the entire industry, just like the e-mail, which brought a major change in the postal sector. Similarly, the existing system should also be maintained just like how we retain the postal methods even though we have an e-mail facility [36].

Even though it is an early stage, legislators should take more interest in the regulation and law framework for this new blockchain securities market. The present global securities trading system shows how disintegrated business practice and law can develop. Therefore, national policymakers and foreign organizations should take a constructive approach and develop an effective and legally safe environment for securities instead of being reactive. Early identification of regulatory and legislative participation is also critical, as a legally protected environment would attract only the mainstream sections of the financial sector, which would be the joint work of policymakers, regulators, and the financial sector to achieve the highest potential productivity and liquidity benefits in securities settlement from blockchain technology.

5. Limitations

There are some limitations to a systematic literature review. Firstly, a systematic review's output is dependent on the accuracy of the included studies. If there are fundamental flaws in the original study's methodology, that flaw will continue in the pooled analysis. Secondly, there is a greater chance that significant and positive research will be published. That means negative or insignificant findings are less likely to be available to the public for inclusion in the systematic review. We checked for peer-reviewed articles on the most important sources and scoured a large pool of information to fix this. Another drawback is the bias in choosing samples, which refers to possible biases due to the parameters used to pick studies and identify the sample population, which may be the product of a badly crafted search protocol. To resolve this, we identified the papers based on a defined set of questions.

6. Future Research Directions of Blockchain in Securities Exchange Market

Blockchain implementation of Securities Exchange is still in the initial stage of development. However, in the context of the current studies that we have, we have identified a range of expertise

gaps that point to potential study directions. For further inquiry, we are discussing some of the most pressing areas below:

After the concept of decentralization using blockchain, we see much conceptual research in blockchain implementation in the stock market. However, the empirical studies are still in the emerging phase. We need more empirical studies about blockchain implementation in the Securities Exchange market to understand the feasibility and understand how much more efficient it can provide than the traditional system.

Since Satoshi Nakamoto publicized the white paper, he proposed Bit coin as a viable peer-to-peer digital currency. Research work has increased, and other applications utilizing blockchain technology have emerged. Also, several blockchain platforms have been developed since then. Ethereum is the most popular one, and others include IBM Blockchain, Eric, and Ripple. However, our analysis indicates that most of the studies in our selected population are focused only on Ethereum. There are many more platforms available, and more empirical studies are required to understand the efficiency of each of these platforms. In addition to this, we need more studies focused on a particular stock market. For example, the Australian current securities exchange, known as CHESS, is replaced by blockchain technology known as ASX private permission ledger designed with high levels of privacy and security. So, depending on the nature of each Stock market, we need to select blockchain platforms. Hence, studies focused on different Stock exchanges, and blockchain platforms suitable for them are required.

Financial markets and the market participants are subjected to strict regulation. These regulations are focused on investor protection, financial stability, and establishing fair and open capital markets. Besides this regulatory structure, blockchain systems, data security frameworks, and regulations also become important. The potential of blockchain technology lies in generating a record of information that participants update and share. Therefore, the legal basis for such documents is vitally important for the widespread adoption of distributed ledger technology. Therefore, we need more legal frameworks-related studies to accommodate record-keeping on a distributed ledger and the current legislation [37]. Table 4 shows summary of future research directions.

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Table 4 - Summary of Future Research Directions

Potential research agenda	Description
1	*More empirical studies are required for blockchain in the Securities Exchange market since most of the studies are conceptual.*
2	*Several blockchain platforms are available, but most of the current studies are focused on the Ethereum platform. Since many new platforms are coming up and studies on these platforms and applying that to the securities exchange market are required.*
3	*Studies focused on a specific Stock market by identifying the limitations of the existing structure, suitable blockchain platforms, and advantages of applying blockchain technology.*
4	*Potential research agenda 4: By applying blockchain technology, there is an added concern of data privacy and protection that must be added to the existing legal framework. Hence more studies related to legal frameworks that can help blockchain implementation in the securities exchange market are required.*

7. Conclusion

The main objective of this analysis is to map the early stages of blockchain implementation in the Stock Exchange market, how it can resolve the limitation of the existing framework, the current state of the various studies, the different models proposed, and the legal criteria for their implementation. We analyze that the research is still in the early stage, demonstrated by the ratio of conceptual (89%) to empirical articles (11%), which we would presume would be the case for a new theory for scholarships. The studies clearly illustrate that blockchain is a ground breaking technology that can bring a revolutionary shift to securities trading. However, scholars balanced the positive tones by addressing threats and challenges, including technological and organizational obstacles, to a more comprehensive technology application. Altogether, there is a lack of empirical studies and more data-driven studies. While blockchain technology is a very innovative field, the pace of research happening is low. This (Ølnes 2017) article, summing up the latest studies and highlighting the study gaps in those studies, contributes to the early stage of research in the stock exchange market. In this, we help researchers understand the current state of science, recognize gaps in research and serve as a starting point for further study.

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