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Survey on Blockchain Based Accounting and Finance Algorithms Using Bibliometric Approach

Sezer Bozkus Kahyaoglu and Tamer Aksoy

Abstract

The aim of this study is to evaluate the impact of blockchain especially on accounting and finance functions, the strategic role of CFOs, and to the restructuring process of accounting and finance functions in the future. In this respect, a business model is recommended that finance, accounting, and audit professionals can benefit from. It is aimed to contribute to the literature by providing blockchain adaptation and implementation strategy via providing information about accounting, finance, and auditing algorithm samples for revolutionizing these functions. To the best of our knowledge, this will be a pioneering work that makes a survey by examining blockchain algorithm samples in the field of accounting, auditing, and finance by using Bibliometric Network Analysis. In this analysis, six major clusters are estimated for defining the impacts of blockchain in the literature based on “Co-citation” aspects for the period 2005–2021 considering the SSCI indexed articles. In addition, the ranking of the top three contributing countries is found to be China, USA, and the UK respectively. This indicates the power of these countries to shape the future of accounting, finance, and auditing standards by means of producing blockchain algorithms and determining innovation policies of these professions in the future.

Keywords: blockchain, algorithms, accounting, finance, artificial intelligence, auditing, bibliometric network analysis

1. Introduction

One of the fast-paced innovations in accounting and finance is based on applications that have recently focused on blockchain. The major advantage of blockchain technology is that it offers a way to structure data without the need for any central authority [1–3]. In this context, the meaning of a blockchain in terms of accounting and finance function is to have a distributed ledger based on database structure that contains an ever-increasing number of accounting records [3–6]. In such a blockchain-based database, all records are in blocks, rather than being combined in a single file. Each block is chained to the next one in linear and chronological order using cryptographic infrastructure and signature [1, 2, 7]. Thus, if a change is attempted in the records, it can be seen by all participants within a predefined

verification in governance structure [8–10]. This approach refers to a situation where future businesses especially financial and accounting processes thereof are affected and forced to change [5, 11, 12]. In this context, future accounting and finance functions will be carried out based on algorithms [5, 11].

The organization of this chapter is as follows: Firstly, the impacts of blockchain on accounting and finance functions are explained. In this context, the effects of blockchain applications that change the “balance of power” between stakeholders are examined [9]. At the same time, areas of change regarding the future strategic position of CFOs and the restructuring process of accounting and finance functions come up for discussion. Secondly, blockchain algorithm samples in the field of accounting, finance, and auditing are presented by using bibliometric methods, i.e., “VOSviewer” [13] and “Bibliometrix” via R Program [14]. “VOSviewer” is a software tool based on web of science (WOS), and this tool is mainly used for constructing and visualizing bibliometric networks [13]. In conclusion, policy recommendations are made based on the survey results for the professionals and academics to contribute to the literature.

2. The impacts of blockchain on accounting and finance functions

Blockchain is a creative response to replace a trusted intermediary position in various fields and processes of accounting and finance functions [1, 2]. In the literature, Yermack [15] first demonstrated the advantages offered by the blockchain-based accounting system. Accordingly, Yermack states that a company that has an accounting and finance function based on blockchain algorithms, offers an infrastructure for both the internal and external stakeholders to access financial statements at any time [15]. Such an infrastructure eliminates the need to wait for the announcement of periodic financial reports. In this respect, the impact of blockchain on accounting and finance functions is directly related to the transformation in governance structure of organizations and hence, this important event is a cutting edge since the Securities Exchange Act in 1934 [16].

Whatever sector you take into consideration, the common feature of them all is that they have an accounting and finance function. Therefore, the effect of blockchain technology is observed in all sectors and economic units all around the world [8, 17]. When it comes to accounting and finance function, the first thing that comes to mind is the book recording system and the management of monetary movements. It is generally accepted that companies, that perform these two functions effectively, efficiently, and economically, will gain competitive advantage. Recently, blockchain-based algorithm has been defined as a new turning point for this competition. The main reason for this is that it reduces costs and improves the corporate functioning thanks to its distributed ledger structure that eliminates intermediaries and provides accuracy in transactions [3, 4, 6].

The benefits of blockchain technology go well beyond the cost advantage, transparency, and increased efficiency [8]. It transforms organizational culture as a fundamental tool of digital governance, especially with a perspective that forms the subject of this study. In this respect, the most important contribution of this transformation is that it changes the balance of power and promotes trust among stakeholders [9]. It is a fact that with the blockchain technology, the elements of double entry system such as debit and credit transactions, recording systems, and the balance sheet structure, which form the basis of accounting and auditing standards, become redundant [18, 19].

According to Yermack [10] and Byström [20], if a company performs all their transactions through the blockchain-based infrastructure, there will be a

permanent time stamp in every transaction. This means that the entire ledger of the company will be instantly accessible for the authorized stakeholders. Therefore, considering the accounting and finance function of such a company, the purpose, scope, and frequency of implementation of processes and transactions, and the controls and audits performed for them will need to be changed. Although digitalization and automation are being used in every field of business environment, there will always be a need for human in decision-making processes [21]. In this context, there is a similar situation for CFOs who are the top managers of the digitalized accounting and finance functions.

2.1 The strategic role of CFOs

One of the priorities of the CFO, which plays a strategic role in the corporate structure, is to create the fundamental building blocks of a strong, stable, and reliable financial functioning for a company [22]. In general, what is expected from a CFO is to perform an accurate and secure analysis of financial data by providing data reliability with an approach that adopts an advanced level of security.

It is important to have clean, reliable, and consistent data required for financial analysis and financial reporting, which are among the main responsibilities of accounting and finance functions. A great deal of effort is put to ensure that the data is accurate and reliable. This great effort put is considered a significant cost item for businesses as well as a risk factor that has the power to affect reputation [23].

Blockchain technologies for reliable financial analysis and reporting through effective and efficient, as well as transparent and consistent data are recognized as a revolutionary contribution to the accounting and finance functions [5, 11]. In this context, the use of smart contracts offered by the blockchain-based infrastructure, can be expressed as an example of how technology can provide more reliability, assurance, and efficiency for CFOs [22].

There are various examples of blockchain applications in finance field which are discussed in detail in the relevant literature. Each of these are practices that strengthen the strategic role of the CFO and shape its agenda [4, 8]. In the **Figure 1**, based on the main articles of this survey, the areas where the block chain is used for improving the strategic role of CFO and the accounting and finance function are summarized.

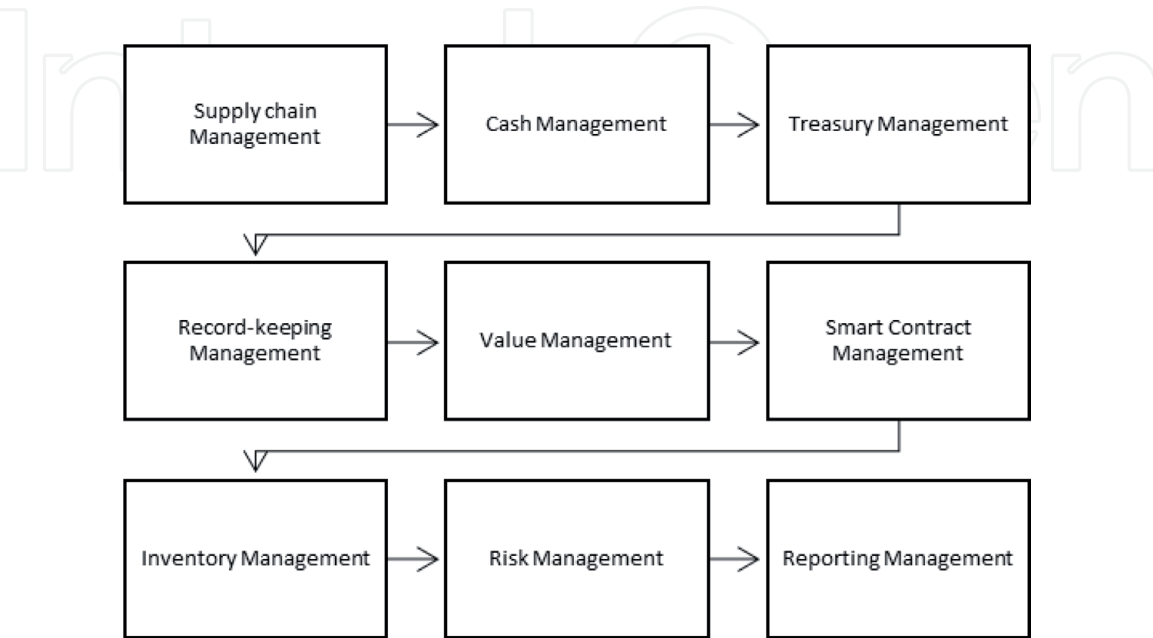


Figure 1.
Use-cases of blockchain in accounting and finance functions. Source: Compiled by the authors.

Firstly, blockchain ensures the end-to-end visibility in the supply chain management process [8, 21]. With the help of blockchain, it increases the quality of record keeping and reduces costs by ensuring the reliability and consistency of the data of all units that are related to finance. In this way, all business units are integrated via blockchain as considering “single source of true data” [24].

With untouched transactions and money transfers, the cash flow management of a company is realized with low cost and protected against misuse and fraud risks [5, 17, 24]. It should be noted that blockchain is the genesis of trust, which is not rely on any central party and distributed to the participants in a network. However, effective results are obtained when blockchain applications are supported by artificial intelligence in a wide variety of areas such as smart contract management, inventory management and treasury management [17, 25]. Thus, a solid reporting management supported by above mentioned process management and controls starting with reliable data entry based on the blockchain is achieved [24, 25]. This is the guide for the entire board of directors, and stakeholders of the company under the strategic leadership of the CFOs.

2.2 The restructuring process of accounting and finance functions

The most basic feature of a blockchain is that it simplifies the way people or businesses transact [2, 7, 11]. For this, there is an online general ledger that uses data in the blockchain infrastructure. It helps users to manage the trading book of all transactions made securely and without the contribution or intervention of a third party [1, 5]. The implementation of the innovative structure of the blockchain that simplifies the system, makes it transparent and reduces costs, means the restructuring of businesses using this type of infrastructure. In order for this restructuring to be effective and efficient i.e., “business process optimization (BPO)” [23], the business model [12] must be transformed, depending on blockchain technologies [7].

It is a fact that the blockchain-based algorithms contain a complete history of every transaction. Notwithstanding there are important advantages of blockchain technology, there are also issues that still await research [23, 26]. For example, although sensor data received in a blockchain application can be verified, it is not possible to identify data that has been manipulated in the “off-chain environment” [5, 7], that is, previously corrupted. Therefore, the way to reliably process blockchain algorithms is to determine the techniques to detect corrupted data incoming to the ledger before processing and posting [27].

3. Blockchain algorithm samples in the field of accounting, finance, and auditing

In this section, the data, methodology and the key findings are explained respectively as follows. Although the main subject of this study is to investigate the impact of blockchain on accounting and finance, an approach that includes the auditing of these areas, constitutes a more appropriate scope. In particular, the primary field of internal audit, internal control, and risk management in the literature is mostly based on analysis of the effectiveness of accounting and finance functions [9, 18, 28]. Therefore, digital transformation process necessitates the use of digital auditing and monitoring techniques in the governance of these functions. In this respect, expanding the scope by including auditing in the survey, becomes a common intersection point for our work to make more accurate policy recommendations.

3.1 Data and methodology

In this study, bibliometric method is used for executing the survey on blockchain algorithms in the field of accounting, finance, and auditing. In this respect, both VOSviewer [13] and R programs [14] are used, respectively. Bibliometric methods help to examine scientific studies from a diverse perspective by applying statistical analysis for books, articles, and other publications [29]. With this method, researchers are given the opportunity to move from “micro focus” to “macro focus” [30]. Thus, the researchers could examine and interpret the dynamics of the field they are studying with a broad perspective. As a result of the bibliometric network analysis made, inferences are obtained regarding various patterns of authors, documents, and countries [31]. The basic work steps of this analysis are shown in the **Figure 2** below:

The filtering words used to find relevant publications from the web of science (WOS) database are as follows: “Blockchain”, “Algorithms”, “Accounting”, “Finance”, “Digital Auditing”, “Auditing”, and “Artificial Intelligence”. There are (435) relevant articles obtained from the WOS. Since the discovery of blockchain has been a recent event, the survey period is intentionally chosen for the period 2005–2021. In this respect, after applying the basic steps in **Figure 2**, the mapping is formed by VOSviewer which is shown in **Figure 3**. The bibliometric network analysis findings are explained and discussed in the below section.

When the filtering area on the web of science is set as “blockchain” only, over a million articles are listed. However, when other keywords are added together with the blockchain by making the field specific and analyzed at the same time, the number decreases considerably as shown in **Figure 3**. Accordingly, the findings are obtained and discussed as follows.

3.2 Discussion on the bibliometric findings

The findings of the bibliometric network analysis are summarized based on “Co-citation” aspects for the period 2005–2021 considering the SSCI indexed articles. In bibliometric network analysis, a total of (6) basic clustering structures have emerged. Hence, there are basically (39) items, (6) clusters, (200) links and (469) strength of the “Co-citation” mapping. The keywords that make up these clusters are presented in Appendix A and findings are discussed as follows:

3.2.1 Cluster 1: finance

The first set of bibliometric network analysis reveals a strong interaction between blockchain and finance. In the literature, it has been determined that the

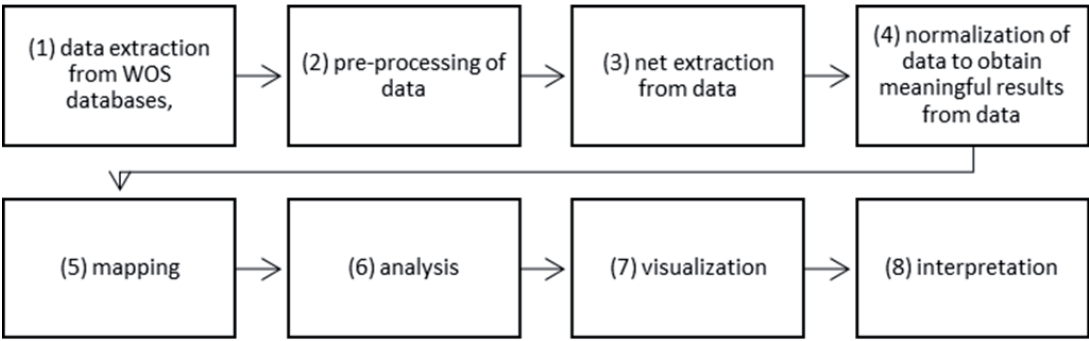


Figure 2.
The basic steps of bibliometric network analysis. Source: [31, 32].

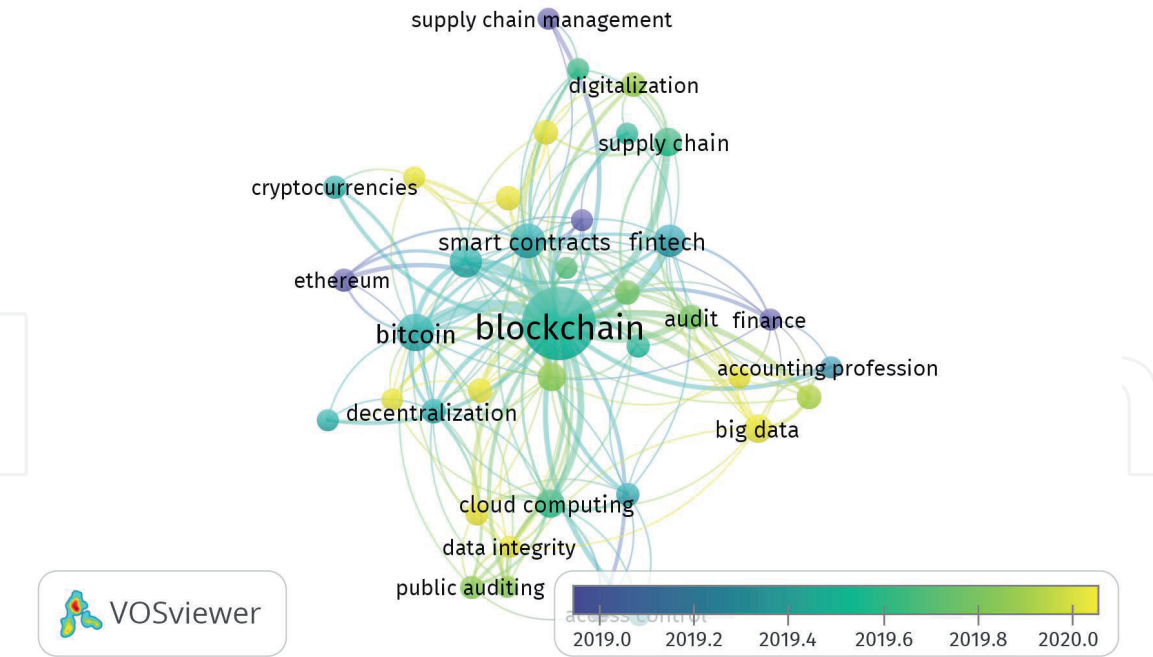


Figure 3.
Bibliometric network of Blockchain, accounting, auditing and finance. Source: [13].

other keywords, that are mainly considered together with finance and blockchain, are “accounting profession”, “artificial intelligence”, “audit”, “big data”, “internet of things” and “machine learning”. This means, it can be stated that the perspective of the “accounting profession” has changed with “fintech” in the financial sector. In addition, “machine learning”, “big data”, “internet of things”, and “artificial intelligence” are shown as the main source of this change. The point to note here is that the keyword “audit” has been processed in terms of the private sector within this cluster. However, the scope of “public auditing” in Cluster 2 within the context of auditing, mainly deals with compliance auditing and tax regulations relevant for public sector.

3.2.2 Cluster 2: public auditing

In bibliometric network analysis of the Cluster 2, the keywords are presented as “access control”, “cloud computing”, “cloud storage”, “data integrity”, “data privacy”, and “privacy” respectively. Hence, it is understood that the scope and purpose of blockchain applications in the public sector differ from those of the private sector. Here, it can be stated that especially prominent keywords give priority to the purpose of making the legislative harmonization process in public business processes safe and confidential. At the same time, it is observed that data security and data storage conditions are the main areas of discussion to reveal the social benefit in the digitalization process.

3.2.3 Cluster 3: blockchain

In Cluster 3, there are keywords such as “digitalization”, “distributed ledger technology” and “traceability”, which are directly related to the blockchain implementation process and can be considered an integral part of the technical characteristics of blockchain. On the other hand, the key words defining the “supply chain management”, “supply chain finance”, and “smart contracts” applications that stand out among the sectoral best practices, are also included in the list.

3.2.4 Cluster 4: accounting

Keywords in this cluster, which are closely related to accounting, can be expressed as “auditing”, “blockchain technology”, “permissioned blockchain” and “security” respectively. Accounting and “auditing” are generally regarded as intertwined practices. One of the primary audit areas in auditing in the literature is financial statements and financial management processes. Therefore, the keywords given in this cluster as “blockchain technology”, “permissioned blockchain” and “security” are also supportive of the current situation of accounting profession and related findings in the literature.

3.2.5 Cluster 5: bitcoin

When it comes to blockchain, “bitcoin” comes to mind first. The keywords associated with bitcoin such as “crowd funding”, “cryptocurrency” and “Ethereum” are clearly monitored in this cluster. In the literature, developments that are closely related to accounting and finance, especially covering these keywords, are discussed. “Crowd funding”, which has the potential to change the corporate functioning of accounting and finance, can be given as an important example among these clusters.

3.2.6 Cluster 6: consensus algorithm

The consensus algorithm is a concept that is closely related to the blockchain. This concept is considered widespread as to be mapped under a separate cluster within this bibliometric network analysis. In addition, there are other important and related keywords which are as follows: “decentralization”, “distributed ledger”, “peer to peer computing”, and “smart contract”.

The “Conceptual Structure Map” based on the correspondence analysis method is performed by using R program and the findings are presented in **Figure 4**. This analysis is performed by using R code, namely “bibliometrix” package with BiblioShiny App which is used for “performing bibliometric analysis and building

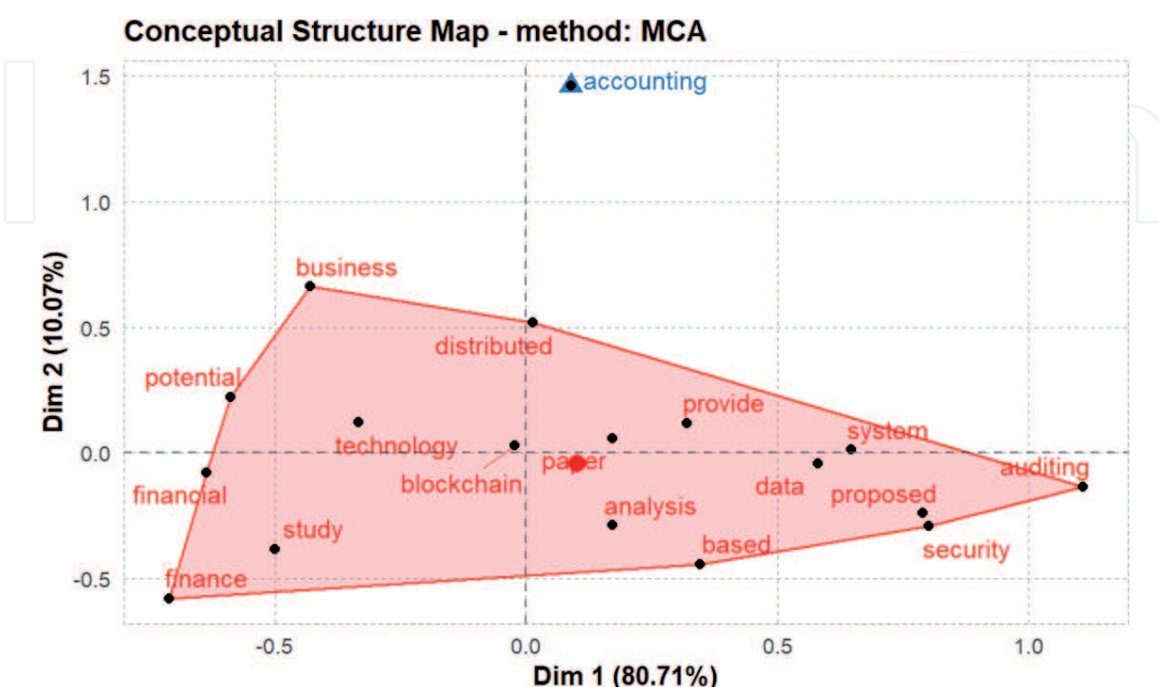


Figure 4.
Conceptual structure map of Blockchain, accounting, auditing and finance. Source: [14].

data matrices for co-citation, coupling, scientific collaboration analysis and co-word analysis” [14]. In this respect, **Figure 4** can be seen as the big picture concerning the blockchain in the literature and hence, based on the block chain and related concepts that are the subject of bibliometric network analysis, it is stated in the literature that there will be considerable technological developments that deeply affect accounting, finance, and audit processes.

The prominent and top (10) journals, in which these studies were conducted, are given below in **Figure 5**. For instance, the first journal in the list is “COMPUTER SCIENCE INFORMATION SYSTEMS” and the second is “BUSINESS FINANCE”. Accordingly, it is seen that journal structures are interdisciplinary and the whole list is presented in Appendix B.

Looking at the development of the literature on blockchain over the years, it is predicted that a significant acceleration has been observed in 2020 and this will increase further in the coming years. This situation is clearly monitored in the **Figure 6**.

In addition, it has been determined that China is by far the first among the contributing countries among the top (20) countries. This is true for China in the case of both single and multiple country publications. This is presented in **Figure 7**. The countries included here are generally similar to the G20 countries. However, it

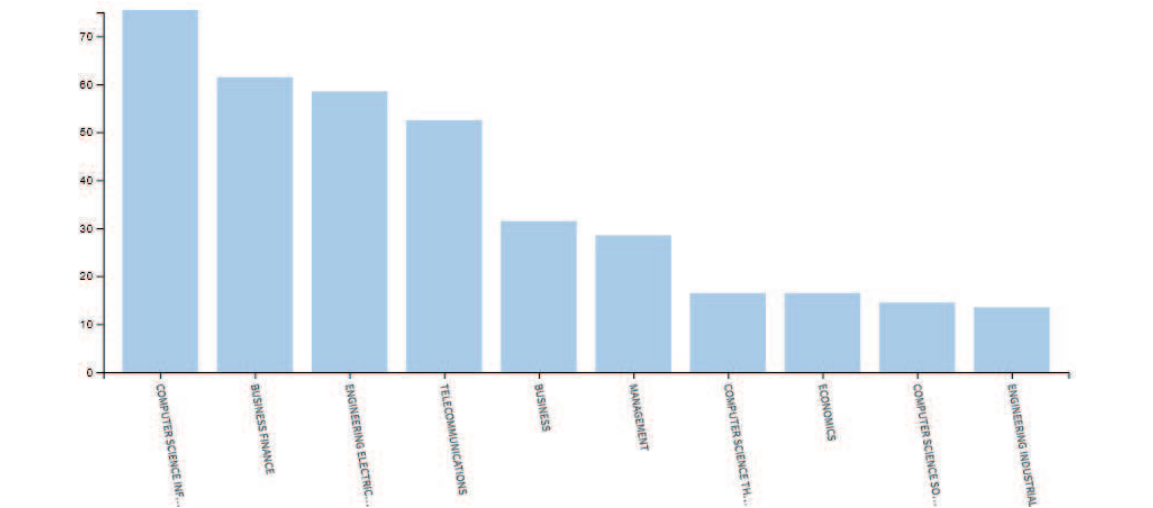


Figure 5.
Top 10 journals related to the bibliometric network survey. Source: [13].

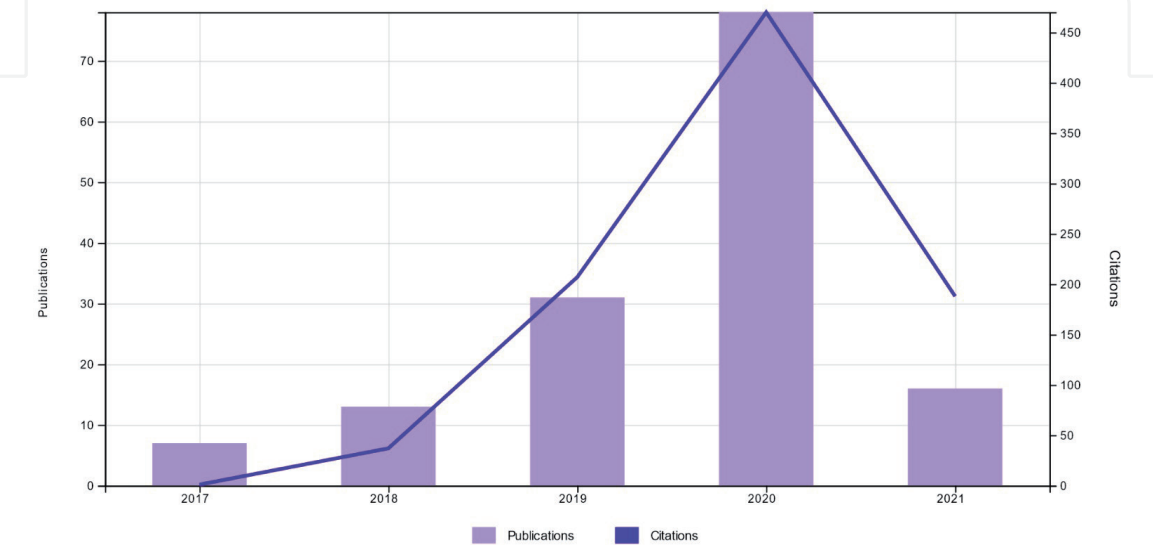


Figure 6.
Publications and citations related to Blockchain (2005–2021). Source: [13].

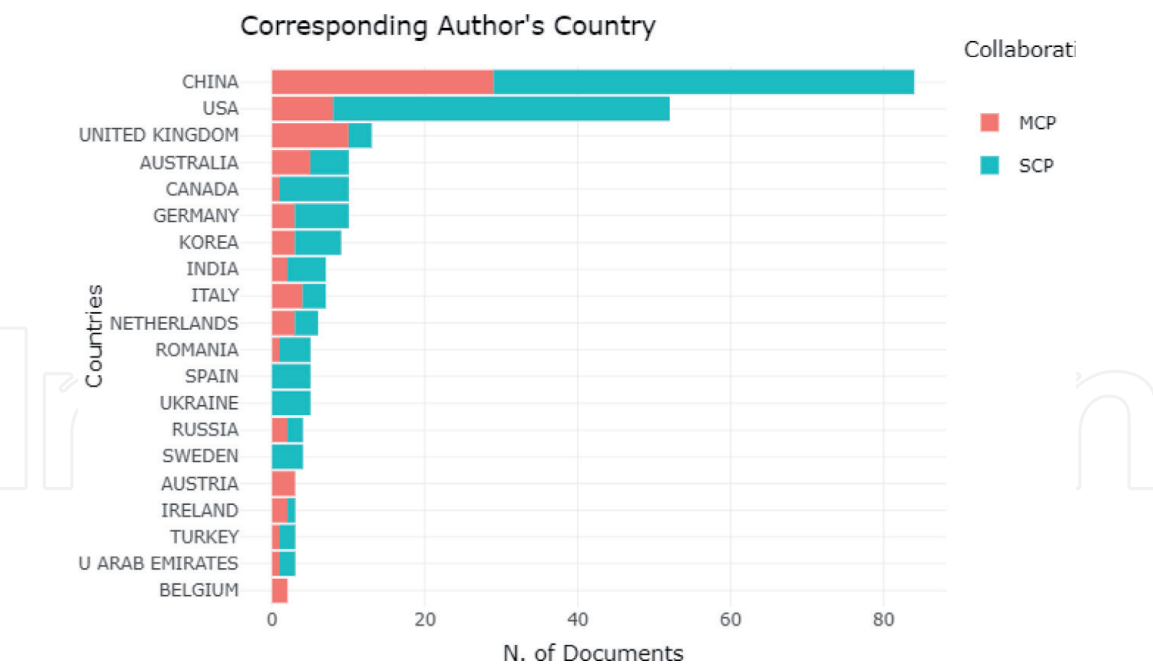


Figure 7.
The list of top 20 corresponding Author's country. SCP: Single country publications (intra country collaboration); MCP: Multiple country publications (inter country collaboration). Source: [14].

can be stated that there is no ranking proportional to their economic size. China is by far the top three, followed by the USA and the UK. This situation indicates that China, the USA and the UK will be the countries producing technology and determining innovation policies in the future.

4. Concluding remarks

In this study, the developments in the literature in the field of accounting, finance and auditing with block chain algorithms were investigated through bibliometric network analysis. According to the findings obtained by using VOSviewer and R program for this analysis, the development areas seen in the literature are collected under six basic clusters. When the interaction areas within these clusters are examined, the first is; It can be stated that private sector and public sector distinction has emerged. Latter, it is concluded that finance, blockchain and auditing are intertwined. Third, it has been revealed that the interaction of public auditing with the blockchain differs and the data security perspective comes to the fore. Fourth, it has been determined that there is an important literature dealing with accounting, finance, auditing, and blockchain interaction. Fifth, it is revealed that a separate literature on the blockchain and bitcoin and cryptocurrencies in general has developed. This cluster gives a significant clue for the emergence of new financial instruments in the near future. Sixth, since the blockchain is based on algorithms, it has been demonstrated that algorithmic applications have evolved significantly to the extent of being located in a separate cluster.

In this context, it is concluded that the three countries, that contribute the most to the literature, have the power to determine the areas of change in the fields of accounting, finance, and audit in the future. These countries are China, USA, and the UK respectively, and the ranking is evaluated in accordance with the expectations within the framework of general economic standards and approaches.

While this survey is a pioneering work, the limitations arising from the current state of the blockchain are also worth mentioning. There is a need for standardization of the blockchain. When this structure is standardized, it may be possible for it to become widespread and to be more accepted in the field of finance. Since the

blockchain is not yet subject to generally accepted legal regulations, it may cause difficulties in registration and valuation processes in the financial field. Difficulties may also arise if the consensus lead time on the blockchain is prolonged. Therefore, it would be appropriate to cooperate at international level on blockchain-related issues in order to use resources effectively.

Conflict of interest

“The authors declare that there is no conflict of interest.”

Appendix A. Bibliometric Network Analysis-Mapping of Co-citations Clusters (2005–2021)

Cluster 1 (8 items)	Cluster 2 (8 items)	Cluster 3 (8 items)	Cluster 4 (5 items)	Cluster 5 (4 items)	Cluster 6 (5 items)
Finance	Public auditing	Blockchain	Accounting	Bitcoin	Consensus algorithm
Accounting profession	Access control	Digitalization	Auditing	Crowd funding	Decentralization
Artificial intelligence	Cloud computing	Distributed ledger technology	Block chain technology	Cryptocurrency	Distributed ledger
Audit	Cloud storage	Smart contracts	Permissioned blockchain	Ethereum	Peer to peer computing
Big data	Data integrity	Supply chain finance	Security		Smart contract
Fintech	Data privacy	Supply chain management			
Internet of things	Data sharing	Traceability			
Machine learning	Privacy				

B. List of Top 10 Journals

1. Computer Science Information System
2. Business Finance
3. Engineering Electrical Election
4. Telecommunications
5. Business
6. Management
7. Computer Science Theory Methods

8. Economics

9. Computer Science Software Engineering

10. Engineering Industrial

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Author details

Sezer Bozkus Kahyaoglu^{1*} and Tamer Aksoy²

1 Izmir Bakircay University, Izmir, Turkey

2 Ibn Haldun University, Istanbul, Turkey

*Address all correspondence to: sezer.bozkus@bakircay.edu.tr

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