Journal of Data Applications
Issue: 3, 2024
E-ISSN: 2980-3357

İSTANBUL UNIVERSITY PRESS

RESEARCH ARTICLE

Investigation of the Reasons for Failure in Blockchain Applications Using Bibliometric Analysis

Muzaffer ŞENLİK[1], Melih ENGİN[2]

DOI: 10.26650/JODA.1615884

ABSTRACT

The utilisation of blockchain technology has gained significant traction across multiple sectors, notably finance, healthcare, supply chain management and real estate, by offering decentralised, secure and transparent data management systems. Introduced in 2008 with Bitcoin, this technology has garnered attention for its smart contracts, various data tracking applications, and cryptocurrencies. The decentralised structure and high security features of the blockchain have led to its emergence as an alternative to traditional systems. The present study aims to examine the reasons for the failures encountered in blockchain applications through bibliometric analysis by reviewing and analysing the extant literature to reveal the conditions and reasons for blockchain technology's failure. The researchers obtained a dataset containing 2779 documents by searching the Scopus database using the keywords 'blockchain' and 'failure'. These data were analysed using Biblioshiny, a bibliometric analysis tool. The analysis provides a comprehensive statistical perspective by revealing quantitative data such as the number of publications on the research topic, the number of citations by years, the number of publications by countries, the most cited documents and their abstracts, the word cloud, the periodic distribution of the most used words, the thematic map of keywords and the association network. The bibliometrix library of the R programming language was utilised to analyse and visualise the data. The results indicate that factors such as scalability issues, cross-platform incompatibility, network security concerns, lack of user experience, inadequate real-world testing, and legal uncertainties complicate the implementation of blockchain technology. This analysis provides findings to guide future blockchain applications.

Keywords: Blockchain, Failure, Bibliometric Analysis

* This study was produced from the master's thesis prepared by Muzaffer ŞENLİK under the supervision of Dr. Melih ENGİN.

[1]Bursa Uludağ University, Management Information Systems Scientist, Bursa, Türkiye
[2]Bursa Uludağ University, İnegöl Business Faculty, Management Information Systems, Bursa, Türkiye

ORCID: M.Ş. 0009-0006-0341-4622;
M.E. 0000-0002-4953-6119

Corresponding author:
Muzaffer ŞENLİK,
Bursa Uludağ University, Management Information Systems Scientist, Bursa, Türkiye
E-mail: muzaffer.senlik96@gmail.com

Submitted: 08.01.2024
Accepted: 22.01.2024
Published Online: 30.01.2025

Citation: Şenlik, M., & Engin, M. (2024). Investigation of the Reasons for Failure in Blockchain Applications Using Bibliometric Analysis. *Journal of Data Applications, 3*, 85-105.
https://doi.org/10.26650/JODA.1615884

Introduction

The concept of blockchain technology was first introduced by Satoshi Nakamoto in 2008 with the publication of his article 'Bitcoin: Peer-to-Peer Electronic Cash Payment System' (Nakamoto, 2008). Researchers distinguish this technology by the encryption of records held by several network participants in a distributed database, as opposed to a centralised database. The records are individually labelled at the time of generation and cannot be modified retroactively. Each new transaction is verified by numerous participants and occurs autonomously, negating the necessity for intermediaries (Nakamoto, 2008). Consequently, blockchain technology can be used effectively across diverse sectors.

The growing interest in blockchain technology has also increased academic research examining the potential applications and consequences of this technology. A number of studies have been conducted in a variety of disciplines, including finance, information technology, law, healthcare and logistics, which examine the potential benefits of blockchain technology for different sectors. However, some academic studies make exaggerated claims about blockchain technology and offer untested solutions (Zile & Strazdina, 2018). This situation emphasises the necessity for future research on blockchain technology to be based on more concrete findings. In this context, the aim of this research is to examine the reasons for the failures in blockchain applications and to provide guidance for future applications.

Literature Review

Despite the fact that blockchain technology was introduced to the market as a cryptocurrency, with the rapid development of technology, it has become a technological development with applications in many different sectors, not only as a financial transaction. It offers revolutionary solutions in many areas, from health services to supply chain management, from public services to production (Ceylan & Işık, 2023).

Decentralised Finance (DeFi)

Decentralised finance (DeFi) is a structure developed with blockchain technology that offers a financial ecosystem accessible to all by eliminating intermediary institutions. The digitalisation of traditional financial services has enabled activities such as deposits, loans, insurance and stock exchange transactions to be conducted without the need for a central authority. Applications such as cryptocurrencies, non-fungible tokens (NFTs) and metaverses are platforms built on blockchain technology that meet the need for decentralisation. DeFi applications facilitate financial transactions in a secure and transparent manner through the utilisation of smart contracts and decentralised applications. This facilitates direct interaction

between users and the platforms, enabling them to engage in financial decision-making processes without the involvement of intermediaries (Parlar, 2022).

Health sector

It is evident that certain domains within the healthcare sector hold considerable potential for technological transformation facilitated b78y blockchain protocols. This section discusses the current and potential uses of blockchain protocols in healthcare. The sub-use scenarios encompass health information transfer, health research integrity, personal health records, health data storage, billing, damage records, drug supply chain, and pandemic situations (Aydar & Çetin, 2020).

Public/Government Services

A plethora of states, international organisations and the private sector are closely monitoring blockchain technology, conducting research activities and developing various projects. A diversity of countries and organisations are employing a combination of a competitive and collaborative approach to the utilisation of blockchain in domains other than cryptocurrencies. For instance, the US state of Delaware has adopted blockchain technology for the purpose of company incorporations, while Sweden, in collaboration with banking institutions and land registry authorities, is undertaking the testing of a blockchain-based land registry application that enables buyers and sellers to view and approve transactions in real time (Tüfekçi & Karahan, 2019).

Property Sector

Blockchain technology is a decentralised system that records transactions in a secure and unalterable way thanks to its distributed structure. This technology can create a paradigm shift within the domain of land and real estate records. The integration of blockchain technology into land registry records has the potential to enhance transparency and reliability in the tracking of property rights. Furthermore, it has the capacity to expedite transfer processes and reduce intermediary costs. The transparency characteristic of blockchain technology ensures that all records are accessible to the public, thereby equalising access to information and enhancing transparency within the property market. Consequently, this will contribute to the creation of a fairer and more competitive market (Atzori, 2018).

Supply Chain Sector

The blockchain technology utilised ensures the immutability of records, thereby guaranteeing complete transparency concerning the provenance, quality and reliability of the products. The use of smart contracts enables the automation of supply chain processes,

facilitating more expeditious and dependable payments and product deliveries. Furthermore, the use of blockchain-based platform fosters enhanced data sharing among supply chain partners, thereby optimising operational efficiency and reducing costs (Treiblmaier, 2018).

Production

The supply chain, from the procurement of raw materials to the delivery of the final product to the end user, is meticulously recorded on the blockchain in a secure and unalterable manner. This provides a comprehensive and transparent account of the origin of the products, the materials utilised and the manufacturing conditions. Consequently, the prevalence of counterfeit and substandard products can be mitigated, thereby empowering consumers to make informed decisions. The utilisation of smart contracts facilitates the automation of production processes and expedites transactions between suppliers, manufacturers and distributors, ensuring reliability (Güven, 2023).

Education

The potential of blockchain technology in the context of educational applications is significant, particularly in domains that require a reliable information infrastructure. This includes the recognition of learning histories, the management of open and distance education courses, the processing of on-campus applications, and the implementation of learning management systems. In all these contexts, the primary requirement is the creation of secure systems that individuals can use in the future. In particular, learning management systems and trust-based systems are potential application areas of blockchain technology in education. Furthermore, the integration of blockchain technology with other technologies, such as the Internet of Things, augmented reality, and artificial intelligence, can enhance open and distance learning environments. This integration can enhance the learning experience by making it more engaging, personalised and effective (Yıldırım, 2018).

Method

In this study, the data obtained from the Scopus database were subjected to a rigorous filtering process in accordance with the criteria delineated in Table 1, ensuring their suitability for the research objectives. Subsequently, the data underwent a comprehensive analysis through the lens of bibliometrics. A bibliometric analysis provides a comprehensive statistical perspective, revealing data such as the number of publications, frequency of citations, and authors' countries (Donthu et al., 2021). This qualitative research method is interpreted and provides meaningful results. The bibliometrix library of the R programming language was used for the analysis and visualisation of the data obtained (Aria & Cuccurullo, 2017).

Table 1. *Flowchart for the determination of data.*

The following search was conducted on the Scopus database:	(TITLE-ABS-KEY (blockchain OR block-chain) AND TITLE-ABS-KEY (fail OR failure))
	The aforementioned query was employed in the search of all relevant publications.
	Results: 3089 documents.
Language Selection	Documents written in languages other than English were not included in this study. The following languages are excluded: Chinese (77), Russian (3), Portuguese (2), Korean (2), Spanish (1), and Japanese (1). This equates to 86.
	The results yielded a total of 3,003 documents.
2011-2023 Elections	The research conducted in all years revealed that the initial period started in 2011.
	The current year was constrained to 2023 by subtracting 2024.
	The results yielded 2,779 documents.

Method

The study was conducted using the Scopus database, which includes a range of terms related to blockchain and failure. These terms were used in conjunction with one another to identify relevant research. The data extracted from the Scopus database was obtained through text mining using the Biblioshiny library of the RStudio program.

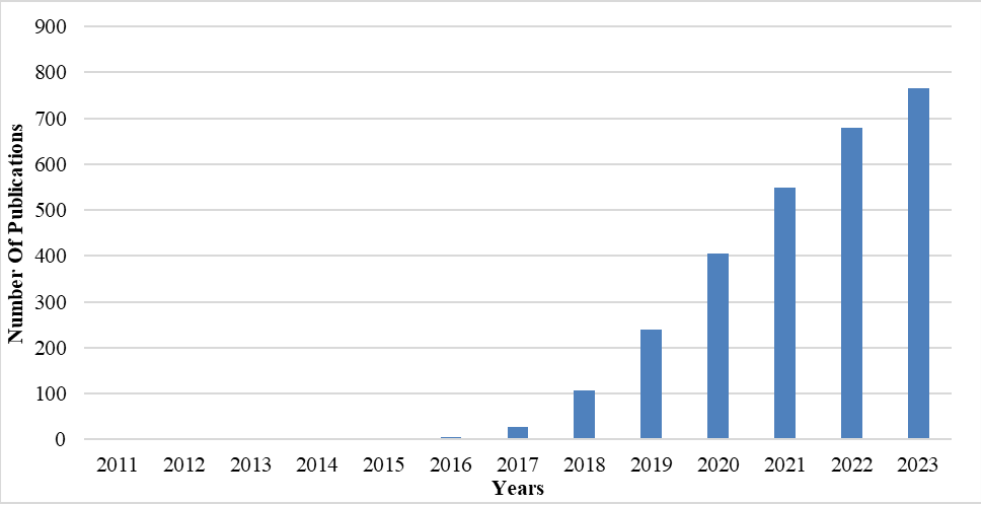

Figure 1. *Number of publications by years.*

Figure 1 illustrates the number of publications by years. Accordingly, the initial notable increase occurred in 2017. In 2018, there were more than 100 publications. There has been a notable surge in activity, particularly over the past five years. This upward trajectory has

continued unabated annually. In 2023, the highest number of publications was recorded. The upward trajectory started with 27 publications in 2017 and culminated in 765 annual publications by 2023. Figure 1 illustrates that the number of errors or failure examples of blockchain applications has increased. The growth in research activity in this area is of significant value to both developers of blockchain applications and businesses seeking to use this technology. By analysing the areas of weakness identified in the aforementioned examples of failed blockchain applications, it is possible to gain insight into the key challenges and potential pitfalls that must be addressed to ensure the successful deployment of blockchain technology in practice.

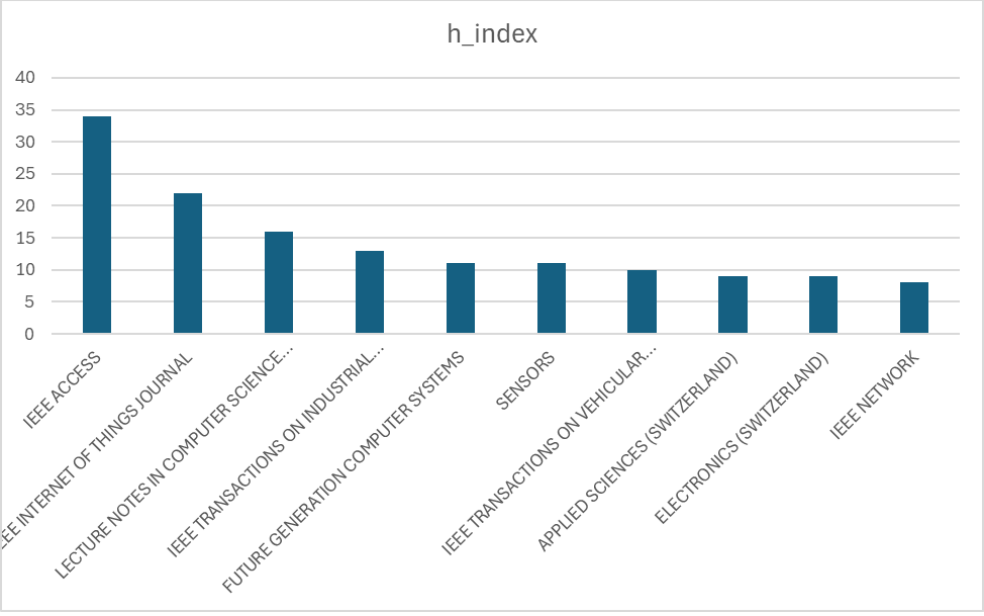

Figure 2. *H-indexes of journals.*

Figure 2 presents a comparative analysis of the average number of citations received by the publications under examination. This comparison allows for evaluating the academic impact of different publications. It can be stated that the publications of IEEE Access receive a significantly higher number of citations than other sources, indicating a greater level of influence. However, it should be noted that some publications, such as Lecture Notes in Computer Science, may have a lower number of citations due to the inclusion of more lecture notes and conference proceedings. While such publications are not direct research outputs, they play a crucial role in supporting the accumulation of knowledge and academic discourse.

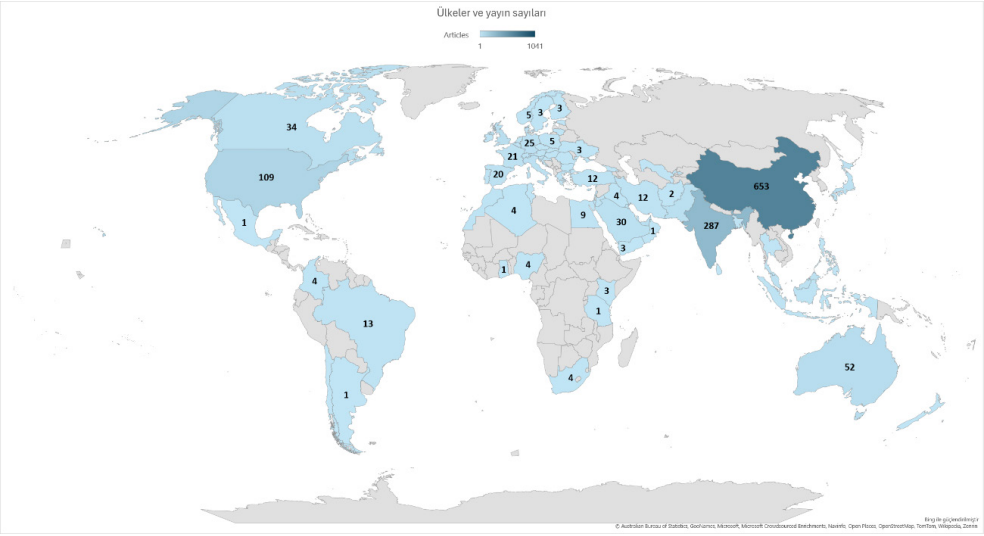

Figure 3. *Number of publications of countries.*

Table 2. *Number of publications in the top 10 countries and distribution of single (SCP) and multi (MCP) corresponding authors by Country.*

Country	Article	SCP	MCP
CHINA	653	500	153
INDIA	287	240	47
USA	109	76	33
AUSTRALIA	52	24	28
KOREA	49	33	16
UNITED KINGDOM	42	20	22
United Arab Emirates	38	26	12
CANADA	34	21	13
PAKISTAN	34	9	25
TOTAL	**1041**	**823**	**218**

As illustrated in Table 2 and Figure 3, China is the country with the highest number of publications on blockchain and failure. Of the 653 publications originating from China, 500 were single-authored, while 153 were multi-authored. This indicates that researchers in China engage in both independent and collaborative research activities. While India ranks second with 287 publications, 240 of these are single-authored and 47 are multi-authored. This indicates that blockchain and failure research in India is primarily conducted as individual studies. In the United States, 76 of the 109 publications are single-authored, while 33 are multi-authored. In other countries, although the number of publications is lower, it is generally observed that multi-author publications exceed single-author publications. This demonstrates

that international collaboration on blockchain and failure-related matters is pervasive, with researchers from diverse countries engaged in joint endeavours, disseminating and exchanging their insights and expertise.

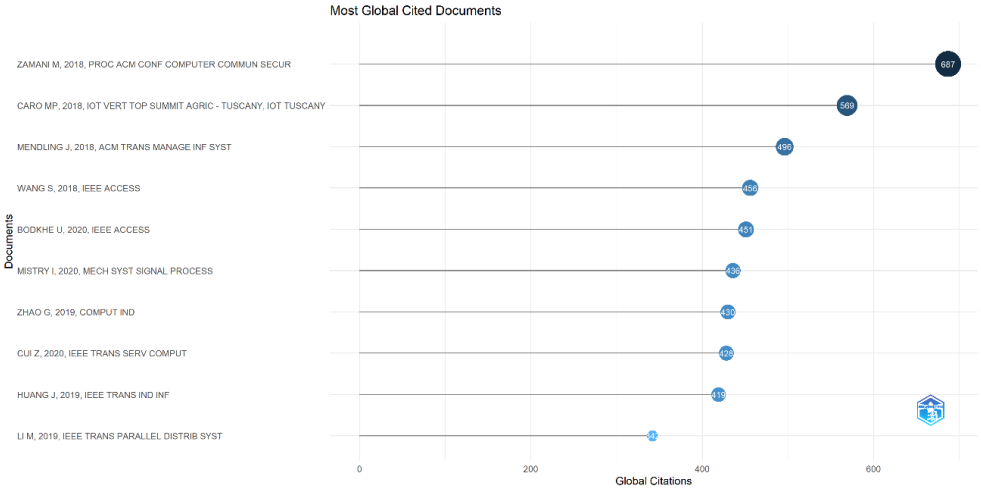

Figure 4. *Most globally cited documents*

Table 3. *Review of the most cited articles*

Article Name	Authors	Abstracts
RapidChain: Scaling the Blockchain via Full Sharding	Mahdi Zamani, Mahnush Movahedi, and Mariana Raykova.	This paper introduces RapidChain, the inaugural Byzantine fault-tolerant public blockchain protocol that employs comprehensive sharding to overcome the performance and scalability constraints of extant blockchain protocols. RapidChain fully shards the transaction processing, communication, computation, and storage overhead without assuming a trusted setup (Zamani et al., 2018).
Blockchain-based Traceability in Agri-Food Supply Chain Management: A Practical Implementation	Miguel Pincheira Caro, Muhammad Salek Ali, Massimo Vecchio, and Raffaele Giaffreda.	This paper presents a fully decentralised, blockchain-based traceability solution for agriculture and food supply chain management, designated as AgriBlockIoT. The solution was evaluated and benchmarked using the Ethereum and Hyperledger Sawtooth blockchain applications (Caro et al., 2018).

Table 3 (Continue). *Review of the most cited articles*

Article Name	Authors	Abstracts
Blockchains for Business Process Management: Challenges and Opportunities	Jan Mendling, Ingo Weber, Wil Van Der Aalst, Jan Vom Brocke, Cristina Cabanillas, Florian Daniel, Søren Debois, Claudio Di Ciccio, Marlon Dumas, Schahram Dustdar, Avigdor Gal, Luciano García-Bañuelos, Guido Governatori, Richard Hull, Marcello La Rosa, et al.	This paper provides a summary of the challenges and opportunities presented by blockchain technology for business process management (BPM). It discusses the potential for blockchains to be used within the traditional BPM lifecycle and considers their potential to become a significant factor in BPM beyond the scope of BPM. (Mendling et al. 2018).
A Blockchain-Based Framework for Data Sharing With Fine-Grained Access Control in Decentralised Storage Systems	Shangping Wang, Yinglong Zhang, and Yaling Zhang.	This paper examines the data storage and sharing scheme for decentralised storage systems and proposes a framework that integrates the decentralised storage system, the interplanetary file system, the Ethereum blockchain and the ABE technology. In this framework, the data owner is able to encrypt shared data by defining the distribution of secret keys and access policy for data users, and the scheme provides detailed control over data access (Wang et al., 2018).
Blockchain for Industry 4.0: A Comprehensive Review	Umesh Bodkhe, Sudeep Tanwar, Karan Parekh, Pimal Khanpara, Sudhansu Tyagi, Neeraj Kumar, and Mamoun Alazab.	This paper presents a systematic review of various blockchain-based solutions and their applicability in various Industry 4.0-based applications. It explores the latest solutions in blockchain technology for smart applications, demonstrates the reference architecture used for blockchain applicability in Industry 4.0 applications, discusses the advantages and disadvantages of traditional security solutions in comparison with their countermeasures, and compares existing blockchain-based security solutions using various parameters (Bodkhe et al., 2020).
Blockchain for 5G-enabled IoT for industrial automation: A systematic review, solutions, and challenges	Ishan Mistry, Sudeep Tanwar, Sudhansu Tyagi, and Neeraj Kumar.	This paper provides an overview of the integration of 5G-enabled IoT into blockchain-based industrial automation and discusses its potential industrial applications. Furthermore, it addresses the issues of scalability, interoperability, and other research challenges in 5G-enabled IoT for blockchain applications (Mistry et al., 2020).
Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions	Guoqing Zhao, Shaofeng Liu, Carmen Lopez, Haiyan Lu, Sebastian Elgueta, Huilan Chen, and Biljana Mileva Boshkoska.	This study makes a significant contribution to the existing literature on the applications, challenges, and future research directions of blockchain technology in agri-food value chain management. The findings demonstrate that blockchain technology, in conjunction with advanced information and communication technology and the Internet of Things, has been adopted in four main areas (traceability, information security, production and sustainable water management) for the enhancement of agri-food value chain management (Zhao et al., 2019).

Table 3 (Continue). *Review of the most cited articles*

Article Name	Authors	Abstracts
A Hybrid BlockChain-Based Identity Authentication Scheme for Multi-WSN	Zhihua Cui, Fei Xue, Shiqiang Zhang, Xingjuan Cai, Yang Cao, Wensheng Zhang, and Jinjun Chen.	This paper proposes a blockchain-based authentication scheme for multiple wireless sensor networks (WSNs) in the context of the Internet of Things (IoT). A hierarchical network is constituted by the division of IoT nodes into three categories: base stations, cluster head nodes, and ordinary nodes, according to their differing capabilities. A hybrid blockchain model comprising a local chain and a public chain between different types of nodes is established. In this hybrid model, the identity of the nodes is authenticated in various communication scenarios (Chu et al., 2020).
CrowdBC: A Blockchain-Based Decentralised Framework for Crowdsourcing	Ming Li, Jian Weng, Anjia Yang, Wei Lu, Yue Zhang, Lin Hou, Jia-Nan Liu, Yang Xiang, and Robert H. Deng.	This paper introduces CrowdBC, a decentralised crowdsourcing framework. CrowdBC permits a group of workers to complete a requester's task without the necessity of entrusting it to a third party. It ensures user privacy and necessitates only minimal transaction fees. The framework provides a concrete scheme where smart contracts are used to facilitate the entire crowdsourcing process, including tasks, rewards, and other aspects. The usability and scalability of CrowdBC have been demonstrated through the implementation of a prototype on the Ethereum tested (Li et al., 2019).
Towards Secure Industrial IoT: A Blockchain System With a Credit-Based Consensus Mechanism	Junqin Huang, Linghe Kong, Guihai Chen, Min-You Wu, Xue Liu, and Peng Zeng.	This paper presents a blockchain system with a credit-based consensus mechanism for the Industrial Internet of Things (IIoT). The proposed mechanism is a credit-based proof-of-work (PoW) mechanism for power-constrained IoT devices, which can simultaneously guarantee security and transaction efficiency (Huang et al., 2019).

Figure 4 shows the names of the 10 most cited authors and the number of citations. Furthermore, also Table 3 shows the names, authors, and abstracts of the 10 most cited documents. The most cited study is Mahdi Zamani et al. with 687 citations and it introduces RapidChain. The top 10 most cited documents were written between 2018 and 2020.

Figure 5. *Index keyword cloud (Keywords Plus)*

Table 4. *Top 10 words in ındex keyword cloud*

Words	**f**
Internet of Things	524
Network security	461
Digital storage	350
Smart contract	292
Authentication	276
Decentralised	272
Cryptography	245
Single point	231
Security	201
Knowledge Management	196

As illustrated in Figures 5 and Table 4, the journals in question have identified a set of keywords that are used to categorise the publications. The keywords were obtained by content analysis of the articles and are therefore independent of the author's determination. They are defined as keywords plus. The terms "blockchain" and "block-chain" have been excluded from the list of keywords. The rationale for the exclusion of these terms is that the term "blockchain" lacks semantic coherence, as it is rendered superfluous by the existence

of alternative equivalents in the literature. Table 4 presents the ten most frequently occurring terms. The term “Internet of Things” (IoT) is referenced 524 times. This demonstrates a notable interest in the conjunction of blockchain and the concept of the Internet of Things. As the concepts of failure and error are also included in the search, it can be assumed that most applications within this field may be defective, with examples of failed applications readily available. The second most frequently occurring term is “network security,” which was referenced 461 times. This is pertinent to the security aspect, which is a fundamental feature of blockchain technology. Blockchain technology is employed to enhance security. It is evident that this is a highly preferred option. It may also be assumed that some applications in question are unsuccessful because of being searched with the concepts of failure and error. The third word is “digital store.” The term was employed 350 times. The preference for storing digital data with blockchain technology is based on the assumption that it is a secure method of data storage. If the storage of important data in this way is not adequately planned, it can result in significant financial implications. The fourth term smart contracts represents a fundamental pillar of the blockchain, with a documented usage of 292 instances. The development of smart contracts requires collaboration between individuals and businesses. The irreversible nature of the blockchain recording system underscores the necessity for businesses and individuals to exercise caution when preparing such contracts. Errors or failures have been observed in this context. A review of the remaining six words reveals that the first is “authentication,” occurring 276 times. The seventh word is “Decentralised.” The term was referenced 272 times. The term “cryptography” is referenced 245 times, “single point” is mentioned 231 times, and “security” is discussed 201 times. These words share a commonality in that they pertain to the security of data. The necessity of encrypting data and avoiding the storage of data at a single point is underscored. In the absence of these considerations during the creation of a blockchain, the security of the data may be compromised, and errors may be introduced. The term “information management” is referenced 196 times. The decentralised structure of blockchain technology and the formation of secure blocks are important concerning information management. In this context, an error that may occur or an unsuccessfully developed application may present challenges to the effective management of information.

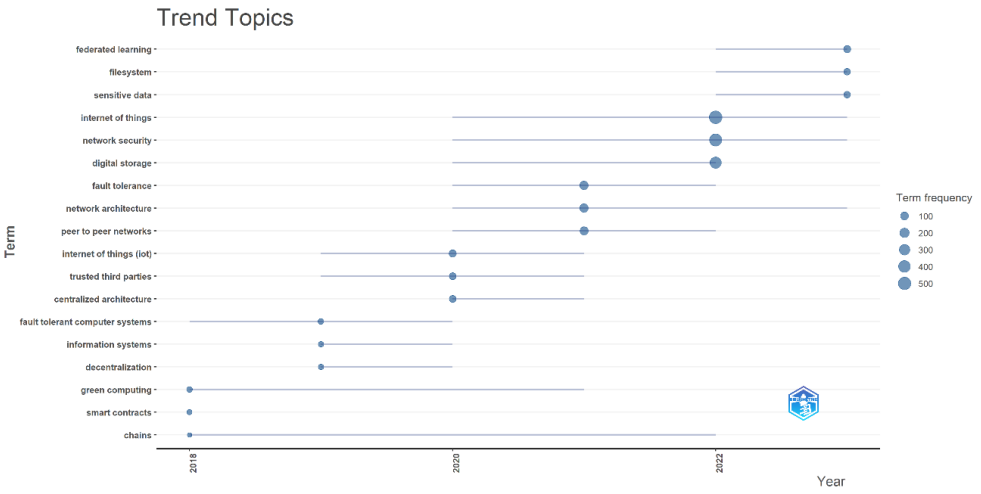

Figure 6. *Periodic distribution of the most used concepts (trend topics)*

Figure 6 illustrates the variable frequencies of concepts in publications employing the terms "blockchain" and "fail" and "failure" according to the year of publication. It is evident that certain concepts have declined in usage over time, while new concepts have emerged and gained prominence. While the frequency of certain concepts, such as "security" and "decentralisation," was high in 2018, it subsequently declined towards 2022. This illustrates the maturation of blockchain technology over time, accompanied by a shift in the focus of researchers from fundamental concepts such as security and decentralisation towards more specific and application-oriented issues. The emergence of concepts such as "sensitive data," "unified learning," and "file system" recently indicates the advent of novel applications and potential issues associated with blockchain technology. The storage and processing of sensitive data in blockchain technology presents novel challenges with regard to the protection of privacy and the assurance of security. The emergence of concepts such as unified learning and the file system demonstrates the potential of blockchain technology to be utilised in a multitude of domains, while also highlighting the potential challenges and failure scenarios that may arise. These developments demonstrate that blockchain technology is undergoing constant evolution and that its integration into diverse sectors is ongoing.

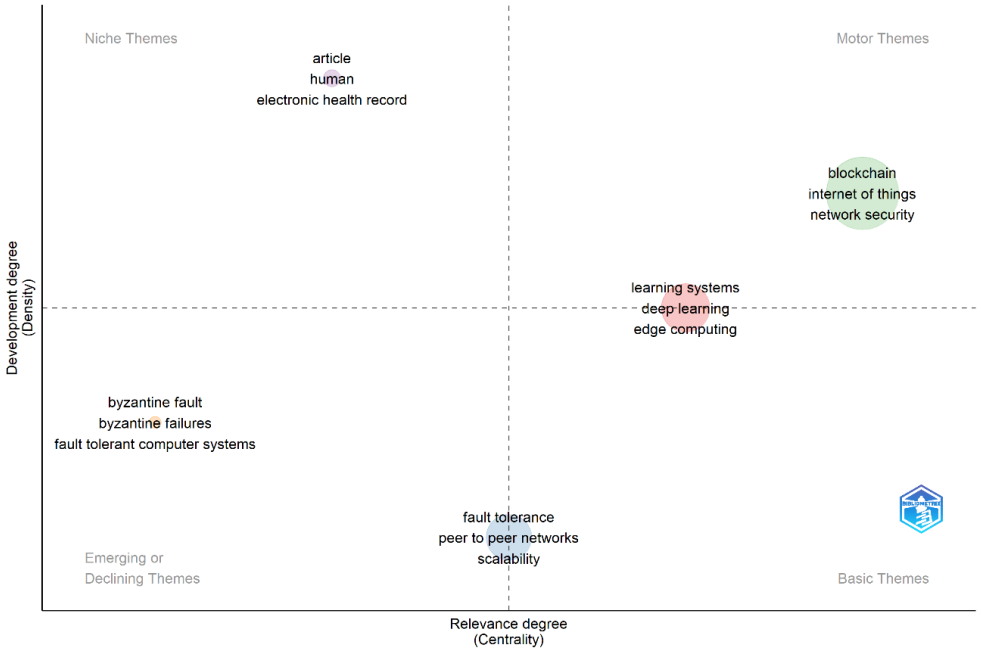

Figure 7. *Index keywords thematic map.*

Figure 7 illustrates the thematic map, which forms a cluster comprising the KeyWord Plus indexes of the publications in the dataset that emerged by searching the terms (fail) and "failure" together with the blockchain. In this instance, the terms "blockchain" and "Blockchain" are once again combined. Thematic map analysis is a form of word analysis that focuses on the examination of auxiliary words. Thematic representation of a research area is achieved through its ecentraliz (Waltman & Van Eck, 2013). As illustrated in Figure 7, the terms employed in this investigation have been classified into five distinct categories. The word groups were observed to fall into one of four categories: niche, motor, basic, and rising or falling themes.

The terms "article," "human," and "electronic health record" in the "niche themes" category in the upper left quadrant are topics that have undergone significant development but are of limited relevance. It is possible that the article and people themes will not be concentrated in specific research areas, given that they are generally very broad and abstract topics. Although the electronic health record is a significant topic within the healthcare sector, it may not be as central a theme as other technological innovations. These topics appeal to specific areas of expertise and thus do not receive widespread attention and are therefore ecentraliz as niche themes.

The upper right corner of the motor theme category illustrates the high degree of development and relevance of the terms “blockchain,” “IoT,” and “network security.” These themes occupy a prominent position within the fields of technology and digital security, exerting a significant influence over a range of related subjects. Blockchain technology is transforming numerous sectors, including finance and data security. The Internet of Things (IoT) offers a plethora of applications through the interconnection of devices, and the security of these connections is of paramount importance. These subjects occupy a central position in the field of technology and are acknowledged as being at the vanguard of innovation.

The terms “Byzantine error,” “Byzantine failures,” and “fault-tolerant computer systems,” located in the lower left-hand corner and classified as emerging or discredited themes, pertain to significant challenges encountered in domains such as distributed systems and blockchain technology. The terms “Byzantine error” and “Byzantine failure” collectively refer to errors that arise from malfunctioning or malicious system components, which can result in the rest of the system providing incorrect information. The management of such errors is a complex process, and the range of available solutions is limited. Fault-tolerant computer systems are defined as systems that are capable of maintaining operational integrity even in the event of the failure of one or more components. Nevertheless, the intricacy and expense of these systems render their extensive implementation challenging. These subjects are classified as either emerging or discredited themes, given that they represent issues that have not yet reached a sufficient level of maturity or gained sufficient acceptance due to the technical challenges and research requirements involved.

The terms “fault tolerance,” “peer-to-peer networks,” and “scalability,” which are ecentraliz as core themes in the bottom right corner, are core topics of high relevance, although they have a low degree of development. Fault tolerance can be defined as the resilience of systems to failures, and it is a vital quality for systems that are required to function reliably. Peer-to-peer networks represent a distributed network structure and play an important role in the sharing and communication of data. The term “scalability” is used to describe the capacity of systems to maintain their performance despite increasing loads. These topics are fundamental to the development of technology and computing infrastructure and have a wide range of potential applications, which is why they are ecentraliz as core themes.

The terms “learning systems,” “deep learning,” and “edge computing,” which are situated centrally within the table, are topics of high relevance but relatively moderate development. The development of learning systems and deep learning is of great importance in the fields of artificial intelligence and machine learning. Edge computing facilitates the decentralized processing of data on local devices, which is particularly pertinent for the Internet of Things (IoT) and time-critical applications. These topics occupy a significant position within the technological domain, yet they are at a central point due to their relative immaturity.

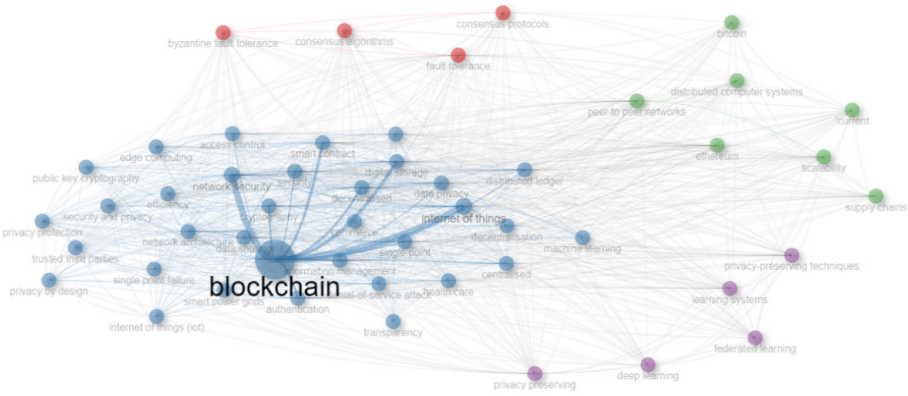

Figure 8. Co-occurrence network.

Figure 8 illustrates the network cluster of authors' fields of study in publications that encompass the themes of blockchain and error or failure. The terms "blockchain" and "block-chain" are used interchangeably. The network comprises four distinct clusters, which are represented by different colours. Blockchain, the Internet of Things, network security and smart contracts are all part of a more dense and interconnected structure, indicating that these areas are used more frequently than others. An evaluation of these areas based on a dataset derived from the failure literature reveals that they are the areas that require the most attention. The blue association network demonstrates the close relationship between these terms.

In the context of the green theme, the use of peer-to-peer networking with distributed ledger technology reveals that the structure between businesses and individuals can be intricate and multifaceted. Such relationships are frequently intended to be conducted using smart contracts, with Ethereum being the most commonly known smart contract provider. In the context of the green area, the supply chain theme also demonstrates that this technology is most extensively utilised within this sector.

In the red area, studies on the prevention of further technical errors in the context of error and failure have been conducted. A high degree of fault tolerance, attributable to its decentralised structure, characterises blockchain technology. This enables it to maintain operational continuity even in the event of the failure of some nodes within the network. Blockchain offers fault tolerance through the utilisation of consensus protocols and algorithms. The aforementioned protocols and algorithms guarantee that all nodes within the network possess identical information and that transactions are duly verified. In particular, Byzantine fault tolerance ensures the correct operation of the blockchain in the presence of malicious or faulty nodes.

The purple area encompasses studies that concentrate on the issues of privacy and security as they pertain to the applications of blockchain technology. In particular, the protection and security of sensitive data is of paramount importance for the adoption and diffusion of blockchain technology. The objective of studies in this area is the development of techniques that ensure the confidentiality of data and thus increase the reliability of blockchain technology while simultaneously minimising potential risks. The application of machine learning methods, including deep learning and machine learning, can facilitate the detection of anomalies and the identification of vulnerabilities through the analysis of data stored on the blockchain. In this manner, blockchain systems can be rendered more secure and users' privacy can be safeguarded in a more comprehensive manner.

Discussion and Conclusion

This study aims to analyse the extant literature on blockchain and failure by bringing together the concepts of blockchain and failure. In this context, the study will analyse the reasons for the failure of blockchain applications and provide ideas to other researchers who will contribute to this field. For this purpose, 2779 documents in the Scopus database were examined using the Biblioshiny library of the R studio programme. The analysis of the downloaded documents revealed that the earliest study was conducted in 2011, while the most recent was conducted in 2023. documents written in languages other than English were excluded from the analysis. Scopus was selected as the primary database due to its status as one of the largest databases available. The tables obtained from the downloaded data were analysed in the finding section.

As demonstrated in the findings related to blockchain technology, there has been a substantial increase in the number of publications utilising the terms "blockchain" and "failure" since 2017. Despite the rapid advancements in blockchain technology and the expanding range of its applications, meticulous observation of its development is imperative to ensure the optimal utilisation of the technology (Carson et al., 2018).

Blockchain networks are subject to considerable limitations, particularly about processing capacity and speed. These limitations result in a restriction of the number of transactions that the network is capable of processing per second, leading to network congestion and delays, particularly during periods of high demand. The aforementioned issues are compounded by the increasing number of nodes and transactions within the blockchain network, as well as the requirement for each node to verify and store every transaction. To illustrate this point, consider the fact that Bitcoin's transaction throughput is limited to just 7 transactions per second (TPS), in contrast to the up to 400 TPS achieved by traditional payment systems such as Visa. Moreover, the validation of blocks in Bitcoin can require up to 10 minutes, resulting

in transaction delays (Khan et al., 2021). The analysis reveals that concepts such as scalability and network security are frequently cited in publications related to blockchain and failure. This observation indicates that scalability issues play a pivotal role in the failure of blockchain applications. A further analysis of the periodic distribution graph reveals a notable increase in the use of the term 'scalability' since 2021, suggesting that scalability problems have begun to garner increased attention with the expanding use of blockchain technology.

The utilisation of distinct protocols, data formats and smart contract languages by each blockchain platform engenders significant challenges in the transfer of data and assets between disparate platforms, thereby impeding the development of a cohesive blockchain ecosystem. The diverse application domains of blockchain technology have promoted the development of bespoke blockchain systems by various organisations, each tailored to its specific requirements. This has consequently produced a plethora of blockchain projects that employ disparate protocols and architectures. These projects, which rely on varied technologies and consensus protocols, cater to a range of use cases or applications. However, the proliferation of these projects has resulted in the fragmentation of blockchain developments and limited interoperability between different blockchain projects (Mohanty et al., 2022). The thematic map demonstrates that the concept of decentralisation is a prominent feature. The inherently decentralised nature of blockchain technology may impede the assurance of interoperability between disparate platforms. Furthermore, an analysis of the association network reveals that the integration of peer-to-peer and distributed ledger technology concepts poses significant challenges in establishing effective communication and interaction between disparate blockchain networks.

The concept of smart contracts, which is frequently referenced in the extant literature, posits that the absence of standards in the development and implementation of smart contracts, in conjunction with the incompatibility between platforms, may contribute to the failure of blockchain applications, given that each smart contract operates on its own blockchain platform. These findings demonstrate that the incompatibility of different blockchain platforms is a significant factor that can lead to the failure of blockchain applications.

To resolve this issue, it is essential to establish standards between different blockchain platforms and develop protocols to ensure interoperability. Inadequate testing and implementation processes appear to play a significant role in the failure of blockchain applications. Due to the lack of experience in blockchain and the immaturity of the technology, unsuccessful applications are persisting. Consequently, it can be concluded that this technology is still in the development stage (Treiblmaier, 2019). The intricacy of the technology's structure and the challenges associated with its integration into diverse sectors necessitate meticulous testing and implementation processes.

Despite the significant promises of the blockchain, particularly in terms of its decentralised structure and security assurances, it has not lived up to expectations, particularly within the legal context. The technology encounters various challenges and uncertainties in the legal domain due to its decentralised architecture and the anonymity of its users. This results in ambiguities concerning the legal status of blockchain-based organisations and financial assets, national security regulations and the limited liability of shareholders (Quintais et al., 2019). The blockchain's insensitivity to off-chain events, such as fraud, coercion and theft, which may affect the validity and enforceability of legal transactions, results in a discrepancy between the law and the blockchain. While a comprehensive reorganisation of the legal framework is necessary to address this incompatibility, it may jeopardise the key features of the blockchain and hinder its adoption (Schilling, 2021). Furthermore, the reluctance of other nations to adopt this technology, due to concerns regarding its reliability, could potentially result in its prohibition. This ambiguity is a cause for concern for investors and developers, potentially hindering the financial support and progress of blockchain-based projects.

For blockchain technology to realise its full potential, issues must be addressed. Future research should concentrate on developing solutions to increase the success of blockchain applications by focusing on issues such as scalability, interoperability, security, energy efficiency, user experience, standards, testing and verification, regulations, and legal uncertainties. In addition, more case studies should be conducted on the challenges and reasons for the failure of blockchain technology applications in different sectors (finance, health, supply chain, energy, etc.).

Ethics Committee Approval: Authors declared that this study does not require ethics committee approval.

Peer-review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- M.Ş., M.E..; Data Acquisition- M.Ş., M.E.; Data Analysis/ Interpretation- M.Ş., M.E.; Drafting Manuscript- M.Ş., M.E.; Critical Revision of Manuscript- M.Ş., M.E.; Final Approval and Accountability- M.Ş., M.E.; Technical or Material Support- M.Ş., M.E.; Supervision- M.Ş., M.E.

Conflict of Interest: The authors have no conflict of interest to declare.

Grant Support: The authors declared that this study has received no financial support.

References

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive bibliometric analysis of scientific literature. *Journal of Informetrics*, *11*(4), 959-975.

Atzori, M. (2018). Blockchain technology and its potential applications in the real estate industry. *Journal of Corporate Real Estate*, *20*(4), 232-245.

Aydar, M. & Çetin, S. C. (2020). Blokzincir Teknolojisinin Sağlık Bilgi Sistemlerinde Kullanımı. *Avrupa Bilim ve Teknoloji Dergisi*, (19), 533-538.

Bodkhe, U., Tanwar, S., Parekh, K., Khanpara, P., Tyagi, S., Kumar, N., & Alazab, M. (2020). Blockchain for industry 4.0: A comprehensive review. *IEEE Access*, *8*, 79764-79800.

Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018). Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. In *2018 IoT Vertical and Topical Summit on Agriculture-Tuscany (IOT Tuscany)* (pp. 1-4). IEEE. https://doi.org/10.1109/IOT-TUSCANY.2018.8373021

Ceylan, O., & Işık, A. H. (2023). Blokzinçir teknolojisi ve uygulama alanları. *Uluborlu Mesleki Bilimler Dergisi*, 6(1), 129-154.

Cui, Z., Xue, F., Zhang, S., Cai, X., Cao, Y., Zhang, W., & Chen, J. (2020). A hybrid blockchain-based identity authentication scheme for multi-WSN. *IEEE Transactions on Services Computing*, *13*(2), 241-251.

Carson, B., Romanelli, B., Walsh, P. and Zhumaev, A. (2018), "Blockchain beyond the hype: what is the strategic business value?", available at: https://www.mckinsey.com/business-functions/digital mckinsey/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value (accessed 7 January 2019).

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285-296.

Güven, C. (2023, 6 July). *Blockchain nedir? Üretimi nasıl etkiliyor?* [Blog yazısı]. ERP.tc. https://www.erp.tc/post/blockchain-nedir-uretimi-nasil-etkiliyor

Huang, J., Kong, L., Chen, G., Wu, M. Y., Liu, X., & Zeng, P. (2019). Towards secure industrial IoT: Blockchain system with credit-based consensus mechanism. *IEEE Transactions on Industrial Informatics*, *15*(6), 3680-3689.

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*, 2901-2925.

Li, M., Weng, J., Yang, A., Lu, W., Zhang, Y., Hou, L., ... & Deng, R. H. (2019). CrowdBC: A blockchain-based decentralized framework for crowdsourcing. *IEEE Transactions on Parallel and Distributed Systems*, *30*(6), 1251-1266.

Mendling, J., Weber, I., van der Aalst, W., vom Brocke, J., Cabanillas, C., Daniel, F., ... & Zhu, L. (2018). Blockchains for business process management-challenges and opportunities. *ACM Transactions on Management Information Systems (TMIS)*, *9*(1), Article 4.

Mistry, I., Tanwar, S., Tyagi, S., & Kumar, N. (2020). Blockchain for 5G-enabled IoT for industrial automation: A systematic review, solutions, and challenges. *Mechanical Systems and Signal Processing*, *135*, 106382.

Mohanty, D., Anand, D., Aljahdali, H.M., & Villar, S.G. (2022). Blockchain Interoperability: Towards a Sustainable Payment System. *Sustainability*, *14*(913), 2-20. https://doi.org/10.3390/su14020913

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system.

Parlar, T. (2022). Blokzincir Teknolojisi ve Merkeziyetsiz Finans Uygulamaları [Blockchain Technology and Decentralized Finance Applications]. *Journal of Politics, Economy and Management*, *5*(2), 165-174

Schillig, M. (2021). 'Lex Cryptographia', 'Cloud Crypto Land' or What? - Blockchain Technology on the Legal Hype Cycle. King's College London Law School Research Paper. https://doi.org/10.2139/ssrn.3804197

Treiblmaier, H. (2018). Blockchain for supply chain management: Opportunities, challenges and research agenda. *Proceedings of the 51st Hawaii International Conference on System Sciences*.

Treiblmaier, H. (2019). Toward More Rigorous Blockchain Research: Recommendations for Writing Blockchain Case Studies. *Frontiers in Blockchain*, 2(3), 1-15. https://doi.org/10.3389/fbloc.2019.00003.

Tüfekçi, A., & Karahan, Ç., (2019). Blokzincir Teknolojisi ve Kamu Kurumlarınca Verilen Hizmetlerde Blokzincirin Kullanım Durumu. *Verimlilik Dergisi*, *4*, 157-193.

Wang, Y., Su, Z., Ni, J., Zhang, N., & Shen, X. (2022). Blockchain-Empowered Space-Air-Ground Integrated Networks: Opportunities, Challenges, and Solutions. *IEEE Communications Surveys & Tutorials*, *24*(1), 160-211. https://doi.org/10.1109/COMST.2021.3131711.

Yıldırım, H. (2018). Açık ve uzaktan öğrenmede blokzincir teknolojisinin kullanımı. *AUAd*, *4*(3), 142-153.

Zamani, M., Movahedi, M., & Raykova, M. (2018). RapidChain: Scaling Blockchain via Full Sharding. In *ACM SIGSAC Conference on Computer and Communications Security (CCS '18)*, October 15–19, 2018, Toronto, ON, Canada. ACM, New York, NY, USA, 18 pages. https://doi.org/10.1145/3243734.3243853

Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., & Boshkoska, B. M. (2019). Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions. *Computers in Industry*, *109*, 83-99. https://doi.org/10.1016/j.compind.2019.04.002.

Zīle, K., & Strazdiņa, R. (2018). Blockchain use cases and their feasibility. *Applied Computer Systems*, *23*(1), 12-20. https://doi.org/10.2478/acss-2018-0002.

Quintais, J. P., Bodo, B., Giannopoulou, A., & Ferrari, V. (2019). Blockchain and the law: A critical evaluation. *Stanford Journal of Blockchain Law & Policy.*