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SLR ABOUT THE COSTS OF PRIVATE BLOCKCHAIN TECHNOLOGY FOR BUSINESSES

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Abstract

Since the appearance of Bitcoin (2009), blockchain technology has been used in many fields. Companies use it for financial services, goods tracking, data authentication, and secure storage, among other things, in order to make their operations more transparent and efficient. This technology has revolutionized data management and transaction processing, but the associated costs are also significant and relevant to understand. The costs of blockchains vary and depend on the type of blockchain and how it is used. In this article, we examine the costs of using blockchain technology based on international literature, studies, and reports with a systematic literature review. In the results, the range of possibilities offered by technology is presented, as well as the technology-related cost types and expenditures that companies must deal with.

1. INTRODUCTION

According to Vitale (2023), blockchain technology has seen a surge of interest globally in recent years. Initially associated with cryptocurrencies, the system is increasingly prevalent in numerous other sectors, making it an alluring prospect for firms and institutions. One key advantage is its ability to minimize the number of intermediaries while bolstering transaction transparency. However, this doesn't necessarily translate into instant cost savings. The solution is a distributed database system that guarantees transparency, authenticity, and data security. It achieves this by distributing data across multiple nodes, ensuring that no single point of failure can compromise the system. This approach also allows for real-time data updates and enhances collaboration between different parties. Additionally, the system supports robust access controls and encryption protocols to safeguard sensitive data [49]. Sadiku et al. (2023) note that blockchain technology enables the tracking of transactions and verification of data without intermediaries such as banks and lawyers. Its significance for businesses lies in providing a dependable and secure operational model. Blockchain technology raises data security to an unprecedented level, as data held on these networks cannot be tampered with or removed, guaranteeing data integrity [31].

In this article, we will analyze the expenses associated with implementing blockchain technology on a global scale. The technology is predominantly utilized in the financial industry, where it can achieve the most significant reductions in costs. Traditional banking transactions necessitate intermediaries to execute and document the transactions, resulting in multiple expenses. However, the implementation of blockchain technology can drastically decrease the number of intermediaries and lower transaction costs. It should be noted that blockchain technology provides more than just the opportunity to reduce costs for the financial sector. Andrew et al. (2023) summarize that the healthcare sector can also benefit significantly, and it can increase the efficiency of the related companies [42]. Concerning patient data management, blockchain technology enables the secure storage and sharing of patient data among stakeholders [6]. The implementation of this technology provides

companies with the potential to strengthen their logistics and supply operations. With the ability to monitor all shipments and promptly detect any issues, firms can optimize their processes. As businesses become more aware of the advantages, an increasing number are integrating this technology into their operations [4]. However, blockchain technology does not only offer the possibility of reducing costs in the financial sector. Blockchain, artificial intelligence, cloud computing, and high-performance computers may significantly boost competitiveness [23]. In this aspect, the study fills a notable gap in the existing literature by providing a detailed cost-related review of blockchain implementation, which is paramount for companies aiming to adopt this technology for enhanced operational efficiency and security. In the course of the research, we formulated the following research questions:

RQ1: What are the main cost elements for companies to implement blockchain technology?

RQ2: What are the factors that influence blockchain-related costs?

2. LITERATURE REVIEW

2.1. Applications of the blockchain

Blockchain technology can be applied in many areas and can have a significant impact on businesses. A summary of these areas at a global level is shown in Table 1.

Table 1: Applications of blockchain technology in companies

Field	Application field	Company
Finance	Payment solutions, authentication, data storage	Bank of America, Wells Fargo, Goldman Sachs
Retail	Supply chain, authentication	Amazon, Walmart, Alibaba
Automotive	Supply chain, payment solutions	BMW, Daimler, Toyota
Food	Supply chain	Dole Foods, Nestlé
Computing	Supply chain, authentication, data storage	IBM, Samsung, Coinbase
Insurance	Authentication, data storage	Anthem, AXA

Source: own edit [10, 14, 22].

The following section provides a detailed explanation of the applications and examples listed in the table.

- Supply chains: Blockchain enables full traceability and transparency of supply chains, thus reducing prices and risks. With the help of blockchain, it becomes easier to check the origin, quality, and authenticity of products and services in supply chains [13]
- Data management: Blockchain enables safe and efficient data management. Blockchain-based methods allow data to be shared between appropriate parties while ensuring data security and real-time tracking [39].
- Financial services: Blockchain enables secure, reliable, fast transactions without transferring data. Blockchain technology can significantly reduce the costs and time required for financial transactions [24].
- Healthcare: Provides secure storage and sharing of healthcare data. Healthcare blockchain systems allow doctors and patients to share health data securely and efficiently and can improve the quality of patient care [52].

- Public services: Helps the registration of documents and other important documents such as birth and marriage certificates. Blockchain systems allow citizens to securely and efficiently access such documents and simplify administration [54].

These are just a few examples of the traditional processes that blockchain technology can improve. Basically, the engine of the solution is the smart contract, which automates the system. Any business process can be digitized and automated with smart contracts on the blockchain. A smart contract is a self-executing program that automates the actions required by an agreement or contract. Once completed, transactions are traceable and irreversible. Imagine that when buying a car, if the buyer does not make the installment payment for some reason, the car is automatically blocked until the payment is made. This automation could be programmed without blockchain technology, but it would not guarantee perfect transparency, irreversibility, and 100% reliability, and it is inevitable in the future [48].

2.2. Blockchain regulation

The regulatory landscape surrounding the use of blockchain technology is intricate due to its novelty and constant evolution, alongside its diverse applications across finance, logistics, healthcare, education, and energy sectors. Its decentralized nature presents a significant hurdle to its regulation, as no centralized oversight or control exists. However, this differs from conventional regulatory models, which depend on central authorities and legislation. Another significant obstacle in the legal and regulatory landscape concerns data preservation and securing personal information. Blockchain-based applications regularly hold personal data, emphasizing the need to prevent unauthorized access and protect such information. Data protection legislation can differ between countries, posing additional challenges to regulating blockchain technology [38]. Moreover, blockchain regulation can significantly impact the application cost. For instance, if the regulation of blockchain technology is more stringent in one country than in others, developers may face greater expenses to keep their apps running efficiently. Moreover, the absence of blockchain technology regulation can lead to increased expenses for developers who may face challenges ensuring the secure operation of their applications without clear business rules and legal prerequisites [26].

2.3. Types of blockchain systems

In this section, I will present the different types of blockchain systems. This overview will help clarify the unique features and applications of each type.

Public*:* According to Chandel et al. (2023), a public blockchain is an unrestricted distributed ledger accessible to anyone with an internet connection. This open structure allows users to participate in transactions without prior authorization. A prime example is voting. Governments can utilize the public blockchain for voting, ensuring transparency and trustworthiness. Public blockchains provide various benefits, such as transparency, immutability, and heightened security. Offer resistance to censorship and enable peer-to-peer transactions without intermediaries. However, they also have disadvantages, such as scalability issues, high energy consumption, and potential privacy concerns [12].

Private: On the other hand, private blockchains operate within a restricted or controlled network controlled by a single identity. Although similar to a public blockchain network in terms of peer-to-peer relationships and decentralization, private blockchains are smaller in size and often operate on a company or organization's small network, such as in supply chain management. They offer greater control and privacy than public blockchains, making them ideal for organizations requiring a more contained approach to data management. Private blockchains also enable faster transaction processing and reduced operational costs. However, they are more susceptible to single points of failure and generally lack the transparency and trust associated with public blockchains [21, 1].

Consortium: The consortium blockchain, also called a federated blockchain, includes both private and public blockchain functions. However, this differs from having various organizational members collaborating on a decentralized network. Predetermined nodes oversee consensus methods in consortium blockchains. A validation node initiates, receives,

and validates transactions, which member nodes can initiate or receive. Examples include banking and payment services. Banks can collaborate to form a consortium. Organizations have the ability to manage which nodes validate transactions [9].

Hybrid: This blends the features of both public and private blockchains, offering companies the best of both fields. They accommodate creating a private, permission-based system coupled with a public, permissionless one. As a result, companies have the option to determine which individuals have access to specific blockchain data and which data is exposed to the public. In a hybrid blockchain, transactions and records are generally not publicized but can be authorized through a smart contract when required—for instance, real estate trading. Hybrid networks can enable real estate firms to utilize their systems and disseminate information to the public [2].

The cost of building and operating a system depends on how the blockchain is used. Each businesses and projects are different, depending on size and objectives; it is not possible to map a general cost scheme of the process of creating a blockchain, so to isolate the costs, we need to look at our own project, our own business processes, and objectives.

3. RESEARCH METHODOLOGY

Table 2: Steps of the systematic literature review

Step	Step content
Defining focus	As a first step, we defined the focus of the research, which is to present the costs of Blockchain technology in the light of companies. The focus of the study does not include a detailed implementation of Blockchain or a report of the exact costs of building blockchain (there is no general pricing).
Conceptual overview	As a second step, we identified the most relevant research on the topic, which we used to define the search keywords.
Literature review	We used the Google Scholar database for the following keywords and combinations of keywords: blockchain, blockchain in business, expenditures, and company. We applied the following filtering criteria to the database: Year: from 2023, Language: English, Type: Open Access.
Literary analysis and synthesis	In Step 4, we grouped the researches found using the keywords and filtering options above by publication chapter. In total, 121 scientific publications were found. Of the 121 results, 69 were excluded as they were not closely related to the area to be explored or, if they were, there was higher quality research in the topic among those found, so we used 52 research papers for the present research.
Finalization	As a final step, the chapters were finalized based on the topic statement, the area to be investigated and the publications identified: The application of blockchain, Blockchain regulation, Types of blockchain systems, General cost elements of a blockchain within a company, Determination of cost ratios, Influence on the costs of a private blockchain, and a Summary of the research.

Source: Edited based on the methodology and materials outlined by Webster and Watson (2002) [51]

A systematic literature review was used to process the references. This method differs from the traditional review in following a transparent and reproducible process [32]. The method helps to properly delineate the topic and avoid the risk of bias and bias in or-der to increase the quality and reliability of the research [53]. According to Liberati et al. (2019), the main purpose of a systematic literature review is to ensure transparency and objective evaluation of studies [27]. For this research, we applied the five-step systematic literature review method by Webster and Watson (2002), summarized in Table 2 for greater clarity and transparency [51].

4. RESULTS AND DISCUSSION

4.1. General cost elements of a blockchain within a company

The cost of blockchain technology can vary significantly and depends largely on the project's objectives and requirements. Specifically, it would be very difficult to capture this area by setting up actual cost tables. However, in general terms, the possible cost categories can be narrowed down to help the companies assume the potential expenditures based on our research.

1) Development: This includes the costs of hiring developers and blockchain experts to design, develop, and implement a private blockchain solution. The complexity of the project and the time required for development will affect these costs [45].
2) Infrastructure: Setting up the infrastructure necessary to operate a private blockchain network can also be a significant cost. This includes servers, nodes, data storage, and network equipment [43].
3) Security: This is a critical aspect of any blockchain project. It is essential to invest in robust security measures, encryption, and access control to protect the private blockchain from unauthorized access and attacks [47].
4) Smart contracts: If the private blockchain requires smart contracts (self-executing contracts with pre-defined terms), they will incur additional costs to develop and audit [16].
5) Integration: Integrating a private blockchain with existing systems or applications may incur integration costs to ensure seamless communication between the blockchain and other systems [21].
6) Training and support: Once a private blockchain is deployed, there may be costs associated with training staff to use and maintain the system. In addition, ongoing technical support and maintenance costs should be considered [46].
7) Legal and regulatory compliance: Depending on the jurisdiction and the nature of the blockchain application, it may incur legal and regulatory compliance costs to comply with applicable laws and regulations [11].
8) Testing and quality assurance: Rigorous testing and quality assurance are key to identifying and resolving potential issues before private blockchain goes live. These testing costs should be included in the total cost [30].
9) Upgrades and scalability: Private blockchain may require upgrades and scalability improvements over time. Planning for future upgrades and updates will incur additional costs [34].
10) Administration: Depending on the complexity and size of the private blockchain network, governance, and administration mechanisms may need to be established to manage consensus protocols, access permissions, and decision-making processes. This may involve additional costs to organize and maintain these structures [56].
11) Costs for network participants: If a private blockchain involves multiple participants, such as a consortium member or a node, there may be costs to connect and maintain these participants on the network. This may include membership fees, hardware requirements, and software licenses [33].
12) Compliance audits: Regular compliance audits may be required if private blockchain is used in regulated industries. These audits ensure that the network complies with

industry-specific regulations and standards. The costs associated with these audits should be taken into considered [37, 45].

13) Data management and storing: Maintaining data on a blockchain involves costs in terms of hosting, and transaction fees may occur [38].
14) Customization and special features: Depending on the specific requirements of the private blockchain project, there may be costs associated with customization and development of application-specific special features [17]
15) Reputational risks: Building and maintaining a private blockchain involves reputational risks. If the project faces significant problems or fails to deliver on its promises, there may be indirect costs in terms of damage to the organization's reputation [57].
16) Hardware costs: Powerful servers to store and process data may be necessary for blockchain networks. The cost of servers depends largely on their performance and configuration. Storage devices required to store blockchain data may include hard disks, SSDs and cloud storage [30].
17) Software requirements for blockchain technology include specialized blockchain software to securely capture and share data. Some of these may be open source and free, while others may require a paid license. Many applications and programs for blockchain technology can be used in various projects. These may vary in price and depend on the type of application [28]
18) Network maintenance: Running a blockchain network requires servers, data centers, and other infrastructure to be operated and maintained. These costs are usually borne by the developers of the blockchain network [3].
19) Energy-related expenses: Blockchain technology requires enormous computing power to keep the network running (depending on the consensus). The energy required to mine the data blocks can be a significant cost, as the computers in the blockchain network consume large amounts of energy. Energy costs can often be particularly high in countries where much of the electricity system still comes from fossil fuels [3, 38].

It is important to note that the costs of building and maintaining a private blockchain can be significant, especially compared to using existing public blockchain platforms. Private blockchains are often chosen when privacy and data management are critical requirements for certain use cases, such as enterprise applications or consortium-based networks. In some cases, organizations may explore hybrid blockchain solutions that combine elements of both public and private blockchains to strike a balance between cost and functionality. The cost will also depend on the technology, the network, and the service provider or company that is entrusted with creating the blockchain [8].

4.2. Determination of cost ratios

Its complexity and lack of understanding hamper the spread of blockchain. Large companies have already recognized its potential, and more and more areas are opening their doors to the blockchain. At the time of writing, we have not found any publications that would like to present this topic, as it is almost impossible to outline an exact cost scheme when so many factors influence pricing, as we mentioned before. It is not even transparent to the layman what exactly the costs of blockchain technology can be, so we have created a cost ratio summary based on existing data sources and case studies to help understand the topic for the companies.

Cost allocation according to the revised use cases [5, 9, 10, 17, 18, 20, 29, 40, 46, 48].

1. Consulting: 10-15%
2. Designing: 15%
3. Development: 50%
4. Quality Assurance: 20-25%
5. Maintenance: 15-25% of total project cost per year

4.3. Key Expenses in Implementation

This section will explore the main expenses involved in implementing blockchain technology. Each expense category is analyzed to highlight the essential cost factors in the adoption process.

1. Design: Covers system blueprint, UI/UX design (wireframes, high and low-fidelity designs, and prototypes).
2. Development: Encompasses coding and testing.
3. Deployment: Costs associated with cloud deployment, delivery, and DevOps.
4. Migration: Transitioning existing solutions to blockchain platforms.
5. Maintenance: Ensuring app compatibility with every OS release and handling updates.
6. Upgrade: Implementing new features and smart contract adjustments.
7. Third-Party Tools: Costs related to hosting, storage, notifications, and collaboration.

4.4. Influence on the costs of a private blockchain

The cost of creating a blockchain can vary based on different factors. The blockchain size affects the cost of the needed hardware and software. The blockchain's features will also impact the development costs required. In addition, the hardware and software costs required can be influenced by the security requirements of the blockchain. It is essential to carefully consider the costs involved in implementing blockchain technology. The expenses can be categorized into three primary components: development, maintenance, and operation costs. Development costs include the recruitment of proficient experts, the creation of infrastructure, and the development of essential software. Ongoing enhancements and updates to ensure the security and competence of the blockchain network pertain to maintenance costs. Operational costs encompass expenses related to managing and operating the blockchain system ([12, 44].

Private blockchain solutions are gaining significance in the corporate world, providing enhanced security and efficiency for internal transactions and data management. They are an exclusive version of blockchain technology that is intended for a limited number of participants. These participants have predetermined roles and are authorized to use the blockchain for capturing and validating data and transactions [50]. This provides the advantage of enhancing data security and dependability, as all transactions can be traced back to the original participant, and every participant can access the data. Furthermore, private blockchains permit faster transactions since it is not obligatory to validate the entire network, as it is mandatory for public blockchains. Establishing and sustaining the system can incur expenses, as the company must construct and manage its own infrastructure. The system's regulation and legal framework are not yet completely developed and are possibly open to legal disputes. To evade legal risks, companies should hire attorneys with insights into blockchain technology and associated legal concerns, which could result in supplementary costs [25].

4.5. Influence factors

Although we addressed initial build, hardware, computing, and cloud costs linked with blockchain, governance costs are frequently overlooked. Due to the scarcity of well-documented governance costs, we made assumptions based on similar IT projects, adjusting for blockchain's unique aspects. Limited historical data was provided by the systematic literature review on private blockchain exact costs, and their cost structure varies greatly from public blockchains. To develop a cost framework, We:

- Compared cost types with existing use cases
- Used data from publications used blockchain data

As a result, we defined 5 factors:

1. Transactions Volume: Indicates blockchain activity. Its requirements show how scalable a blockchain should be for specific applications [41, 58].
2. Transactions Throughput: Measures the speed of a database by calculating transaction volume per second [19, 44].
3. Transaction Size: It is about the storage needs for a single transaction. Factors like transaction review costs are affected by this. Transaction size data was obtained from the ownership costs of private blockchains. Different blockchains have different sizes based on their purposes. For instance, smart contract applications generally result in more significant transactions than value transfer apps [43].
4. Node Hosting Method: The way a blockchain platform is stored. Options include on-premises (new or existing tech) or cloud-based. This factor is vital for pricing private blockchains but less for public ones [35, 55].
5. Consensus Protocol: The technique for confirming transaction block legitimacy. Key types:
    - Proof of Work: Requires extensive computing to mine transaction blocks.
    - Proof of Stake: Uses financial assets to promote honest block mining.
    - Proof of Authority: Gives specific participants block verification responsibility.

The chosen consensus depends on an organization's needs and aims. Each method varies in decentralization, security, energy consumption, and hardware needs. For instance, proof of work, although secure, can lead to higher costs and slower transaction times due to its computational intensity [7, 15].

5. CONCLUSIONS

In conclusion, our research has provided comprehensive insights into the main cost elements and influencing factors associated with implementing private blockchain technology for companies.

RQ1: Regarding the main cost elements, we have identified various expenses that organizations need to consider when embarking on blockchain projects. These include development costs for designing and implementing the blockchain solution, infrastructure costs for setting up the necessary hardware and software, security costs to protect the network from unauthorized access, and ongoing expenses for maintenance, compliance, and administration. Our findings highlight the multifaceted nature of blockchain costs and underscore the importance of thorough planning and budgeting for successful implementation. It is important to note that as the technology evolves, additional costs may arise over time.

RQ2: Furthermore, our analysis has revealed several key influencing factors that impact blockchain-related costs. These factors encompass various aspects, such as transaction volume, throughput, and size, which dictate the scalability and performance requirements of the blockchain solution. Additionally, considerations such as node hosting method and consensus protocol selection play a crucial role in determining the infrastructure and operational costs associated with blockchain deployment.

Our study emphasizes the need for companies to conduct careful cost analysis and strategic decision-making when adopting blockchain technology. By understanding the cost elements and influence factors outlined in our research, organizations can better navigate the complexities of blockchain implementation and optimize their investment in this innovative technology.

Implementing blockchain technology carries several advantages for businesses; nevertheless, weighing the costs and related factors is crucial. Companies must contemplate critical details when adopting this technology, including:

1. Application field: It is imperative to scrutinize the context where blockchain technology will be utilized and confirm if it would be of value to the organization.
2. Regulatory considerations: The application of blockchain technology presents numerous regulatory challenges, making it crucial to examine the legal environment carefully.
3. Security measures: The security of blockchain systems is paramount, and it is important to assess the necessary measures to ensure the safe usage of the system.
4. System integration: Integration with other systems is often necessary for blockchain systems, and examining the potential options and associated costs is vital.
5. Scalability: As business needs may increase, it is important to consider the scalability of blockchain systems.
6. Impacts: It is crucial to consider the significant environmental impacts that the use of blockchain technology can have.

Blockchain technology may bring about a bigger breakthrough in the business world than we have witnessed thus far. However, technological advancements can be influenced by various trends and factors that could impact the future of blockchain technology and its costs:

- One notable challenge is scalability, which refers to how well blockchain networks can manage high transaction volumes.
- Secondly, interoperability remains a challenge for blockchain networks. However, it is increasingly critical as businesses require interconnection between blockchain solutions. While such solutions may come with high costs in the short term, they can generate substantial savings in the long run.
- Moreover, the regulation of blockchain technologies varies worldwide. The approach varies across countries, and the presence or imposition of government regulations may considerably influence the growth of blockchain technology and the expenses for enterprises.

This field offers numerous advantages and opportunities for various industries. Understanding the costs and different types of blockchains is crucial for making informed decisions regarding their adoption. Organizations should carefully assess their requirements, consider potential challenges, and weigh the pros and cons to determine the most suitable blockchain solution for their needs. By doing so, they can unlock the transformative potential of blockchain technology in a responsible and efficient

manner.

5.1. Research limitations

While our systematic literature review provides valuable insights into the costs associated with private blockchain technology for businesses, several limitations exist. Firstly, our research primarily focused on quantitative analysis, utilizing a systematic review methodology outlined by Webster and Watson (2002). While this method ensures transparency and reproducibility, it may overlook qualitative nuances that could provide further depth to our understanding of blockchain costs. Secondly, our study relied on a specific set of research papers (52 of 121 in total) identified through our systematic literature review process. Despite our efforts to include a diverse range of sources, there may exist relevant studies that were not captured within our search parameters. Thirdly, the rapidly evolving nature of blockchain technology presents a challenge in maintaining the currency of our findings. While we have endeavored to provide up-to-date insights, the landscape of blockchain solutions and associated costs may have shifted since the completion of our research. Lastly, while we have outlined key factors for

businesses to consider when evaluating blockchain costs, other unforeseen variables or externalities may influence the overall cost-benefit analysis.

5.2. Findings

In the results, the range of possibilities offered by technology is presented, as well as the technology-related cost types and expenditures that companies must deal with. We summarized the fields, regulations, and types of blockchains that companies can consider, and a general cost ratio scheme was determined by the use cases from the research articles. To help to understand better the fields of costs for companies, we analyzed the blockchain technology cost influence factors in our results.

5.3. Implications & Recommendations

Implementing blockchain technology carries several advantages for businesses; nevertheless, it is crucial to weigh the costs and related factors. Companies must contemplate critical details when adopting this technology, including Application field, Regulatory considerations, security measures, system integration, environmental impacts and scalability.

5.4. Contribution & Value Added

Through our systematic literature review, we have delved into a current and dynamic research area to help companies to better understand blockchain related costs. The applied methodology facilitates the replication of this research on an annual basis, which we highly advise, given the emergence of an expanding body of research in this area to support corporations, SMEs and organizations as well.

5.5. Suggestions for future research directions

Through our systematic literature review, we have delved into a current and dynamic research area. The applied methodology facilitates the replication of this research on an annual basis, which we highly advise, given the emergence of an expanding body of research in this area, to support corporations, SMEs, and organizations as well to help better understand blockchain-related costs. Acknowledging these limitations, we encourage further research to explore the multifaceted aspects of blockchain technology costs, incorporating both quantitative and qualitative approaches to provide a more comprehensive understanding for businesses and practitioners.

REFERENCES

[1] Abdollahi, A.; Sadeghvaziri, F.; Rejeb, A. (2023). Exploring the role of blockchain technology in value creation: a multiple case study approach. *Quality & Quantity,* 57(1), 427-451. [Google Scholar]

[2] Abidemi, A. E.; Jinmisayo, A.; Shadab, A.; Salil, B.; Praise, A.; Mohammed, S.; Rafeeq, A. (2023). A Hybrid Framework of Blockchain and IoT Technology in the Pharmaceutical Industry: A Comprehensive Study. DOI: 10.1155/2023/3265310. [Google Scholar]

[3] Alazzam F.; Salih A.; Maher A. M. A.; Fadiah S. A. K. (2023). The Nature of Electronic Contracts Using Blockchain Technology – Currency Bitcoin as an Example. DOI: 10.24857/rgsa.v17n5-014. [Google Scholar]

[4] Alessia, S.; Kavasidis, I.; Vincenzo, C.; Raffaele, M.; Francesco, R.; Palazzo, S.; Spampinato, C.; Giordano, D. (2023). BioTrak: A Blockchain-based Platform for Food Chain Logistics Traceability. *IEEE* DOI: 10.1109/ICCNS58795.2023.10193341. [Google Scholar]

[5] Almutairi, K.; Hosseini Dehshiri, S. J.; Hosseini Dehshiri, S. S.; Hoa, A. X.; Arockia Dhanraj, J.; Mostafaeipour, A.; Techato, K. (2023). Blockchain Technology application challenges in renewable energy supply chain management. *Environmental Science and Pollution Research*, 30(28), 72041-72058. [Google Scholar]

[6] Andrew, J.; Isravel, D. P.; Sagayam, K. M.; Bhushan, B.; Sei, Y.; Eunice, J. (2023). Blockchain for healthcare systems: Architecture, security challenges, trends and future directions. *Journal of Network and Computer Applications*, 103633. [Google Scholar]

[7] Anupama, K., S.; Anusha, M. (2023). Blockchain Enabled Supply Chain Management. S*N Computer Science, 4(2), 179.* [Google Scholar]

[8] Attilio D. P. (2023). Blockchain and Freedom to Conduct a Business: Between Myth and Reality. DOI: 10.17561/tahrj.v21.7971. [Google Scholar]

[9] Molnár B.; Pisoni, G.; Meriem, K., Yossra, Z. (2023). Blockchain-Based Business Process Management (BPM) for Finance: The Case of Credit and Claim Requests. DOI: 10.3390/smartcities6030061. [Google Scholar]

[10] Calandra, D.; Secinaro, S.; Massaro, M., Dal Mas, F.; Bagnoli, C. (2023). The link between sustainable business models and Blockchain: A multiple case study approach. *Business Strategy and the Environment, 32(4), 1403-1417*. [Google Scholar]
[11] Catea, R. M. (2023). BLOCKCHAIN IN COMPANIES LAW. *Challenges of the Knowledge Society, 123-129*. [Google Scholar]
[12] Chandel, A.; Bhanot, N.; Sharma, R. (2023). A bibliometric and content analysis discourse on business application of blockchain technology. *International Journal of Quality & Reliability Management*. [Google Scholar]
[13] El Fellah, K.; El Makrani, A.; El Azami, I. (2023). Improving the Application of Blockchain Technology for Tracking Processes in the Supply Chain Integrated Business Intelligence. In Modern Artificial Intelligence and Data Science: Tools, *Techniques and Systems (pp. 201-211). Cham: Springer Nature Switzerland*. [Google Scholar]
[14] El-Chaarani, H.; El-Abiad, Z.; Badawy, H. A. E. S. (2023). Blockchain and Performance: A Literature Review in Business and Management Fields. A*vailable at SSRN 4516929*. [Google Scholar]
[15] Gitelman, L. D.; Isayev, A. P.; Kozhevnikov, M. V.; Gavrilova, T. B. (2023). Cluster competencies Examples of specific competencies. *decisions, 183*. [Google Scholar]
[16] Gulfam A.; Mariam F. (2023). SMART CONTRACT IMPLEMENTATION USING BLOCKCHAIN IOV FOR VEHICLE ACCIDENT INVESTIGATION. DOI: 10.32010/26166127.2023.6.1.77.90. [Google Scholar]
[17] José, A.; Mateo C.; Enrique A-A.; Diego C.L. (2023). Impact of Blockchain Technology for Business and Information Systems: Automation of Inter-Company Debt Compensation Case Study. DOI: 10.3390/app13084805. [Google Scholar]
[18] Junaid, L.; Bilal, K.; Khalid, O.; Erbad, A. (2023). Blockchain-Enabled land management systems. *Telecommunication Systems,* 1-22. [Google Scholar]
[19] Kaur, B.; Kaur, R.; Sood, K. (2023). Application of Blockchain in the Insurance Sector. In Contemporary Studies of Risks in Emerging Technology, P*art A (pp. 173-181). Emerald Publishing Limited*. [Google Scholar]
[20] Keren, L. (2023). Innovation Analysis on Business Model of Live Music Performance Integrated with Web 3.0—A Case Study of Modern Sky, A Music Company. DOI: 10.26855/jhass.2023.05.014. [Google Scholar]
[21] Khan, M. R.; Nallaluthan, K. (2023). Blockchain Supply Chain Management and Supply Chain Sustainability. In Blockchain Driven Supply Chain Management: A Multi-dimensional Perspective *(pp. 155-180). Singapore: Springer Nature Singapore*. [Google Scholar]
[22] Khare, A.; Jain, S. K.; Rathore, V. (2023). KNOWLEDGE MANAGEMENT WITH BLOCKCHAIN TECHNOLOGY IN BUSINESS: *ATheoretical PERSPECTIVE*. [Google Scholar]
[23] Kovács, T.Z., Nábrádi, A., Bittner, B. (2023): Digital Technology Integration among Eastern European Companies, based on Digital Economy and Society Index Interdisciplinary *Description of Complex Systems 21 : 5 pp. 421-440., 20 p. (2023)* DOI: 10.7906/ indecs.21.5.1 [Google Scholar]
[24] Kshetri, N.; Miller, K.; Banerjee, G.; Upreti, B. R. (2023). FinChain: Adaptation of Blockchain Technology in Finance and Business-An Ethical Analysis of Applications, Challenges, Issues and Solutions. International Journal of Emerging and Disruptive Innovation in Education: *VISIONARIUM, 1(1), 4*. [Google Scholar]
[25] Leśniak T.; A. Kustra. (2023). Directions for using the Blockchain technology in the raw materials industry. DOI: 10.24425/gsm.2021.139738. [Google Scholar]
[26] Li, Z. .; Liang, F.; Hu, H. (2023). Blockchain-based and value-driven enterprise data governance: A collaborative framework. *Sustainability, 15(11), 8578*. [Google Scholar]
[27] Liberati, A.; Altman, D. G.; Tetzlaff, J.; Mulrow, C.; Gøtzsche, P. C.; Ioannidis, J. P. A.; Clarke, Devereaux M.; Kleijnen, J..; Mohe, D. (2009): The PRISMA statement for reporting systematic reviews & meta-analyses of studies that evaluate healthcare interventions: explanation & elaboration. *BMJ, 339*. [Google Scholar]
[28] Lihua, S.; Zhibin Z.; Youmei Z.; Yingying X. (2023). Applying Blockchain Technology and the Internet of Things to Improve the Data Reliability for Livestock Insurance. DOI: 10.3390/s23146290. [Google Scholar]
[29] Liu, H.; Jiang, N.; Ortiz, G. G. R.; Cong, P. T.; Phuong, T. T. T.; Wisetsri, W. (2023). Exploring tourism business model importance with the emergence of blockchain system: directions for tourism industry of China. *Environmental Science and Pollution Research, 30(16), 46647-46656*. [Google Scholar]
[30] Luke T.; Banu A.; Turetken, O. (2023). Elements of Blockchain-based Circular Business Models in Manufacturing: A Synthesis of the Literature. DOI: 10.26481/mup.2302.01. [Google Scholar]
[31] Marengo, A.; Pagano, A. (2023). Investigating the Factors Influencing the Adoption of Blockchain Technology across Different Countries and Industries: A Systematic Literature Review. DOI: 10.3390/electronics12143006. [Google Scholar]
[32] Mengist, W.; Soromessa, T.; Legese, G. (2020). Method for conducting systematic literature review and me¬ta-analysis for environmental science research. *Met¬hodsX, 7, 100777*. [Google Scholar]
[33] Miranda, Y. R.; Alves, P.; Ronnie P.; Nasser R.; Robichez G.; Luiz F.; Roberto T.; Joana S.; Leandro P.; Fernando P. de M. (2023). Enhancing Corporate Social Responsibility with Blockchain-based Trackable ESG Tokens. DOI: 10.5753/wblockchain.2023.777. [Google Scholar]
[34] Purusottama, A.; Simatupang, T. M.; Sunitiyoso, Y. (2023). The coexistence of blockchains and business models (innovation): a systematic review. *International Journal of Innovation Science*. [Google Scholar]
[35] Rao, K. V.; Murala, D. K.; Panda, S. K. (2023). Blockchain: A Study of New Business Model. In Recent Advances in Blockchain Technology: Real-World Applications (pp. 187-214). *Cham: Springer International Publishin*g. [Google Scholar]
[36] Sadiku, M. N.; Chukwu, U. C.; Sadiku, J. O. (2023). Blockchain in Business. *EUROPEAN JOURNAL OF BUSINESS STARTUPS AND OPEN SOCIETY, 3(4), 12-19*. [Google Scholar]
[37] Samar, R. T.; Huma S.; Alhamzah F. A.; Javed A. (2023). Revolutionizing Manufacturing with Blockchain Technology: Opportunities and Challenges. DOI: 10.3991/ijoe.v19i10.41285. [Google Scholar]
[38] Sharma, D. D.; Kumar, R. (2023). Blockchain-enabled energy sector management. In Blockchain-Based Systems for the Modern Energy Grid (pp. 285-310). *Academic Press*. [Google Scholar]

[39] Sood, S.; Prashar, T.; Shravan, M.; Sivaprasad, K. I.; Lourens, M. (2023). Blockchain and Data Privacy in Human Resource Management. In 2023 3rd International Conference on Advance Computing and Innovative Technologies in Engineering *(ICACITE) (pp. 97-101). IEEE.* [Google Scholar]
[40] Srivastava, P. R.; Zhang, J. Z.; Eachempati, P. (2023). Blockchain technology and its applications in agriculture and supply chain management: a retrospective overview and analysis. *Enterprise Information Systems, 17(5), 1995783*. [Google Scholar]
[41] Stallone, V.; Wetzels, M.; Mahr, D.; Klaas, M. (2023). Enhancing Digital Advertising with Blockchain Technology. *Journal of Interactive Marketing, 10949968231185543*. [Google Scholar]
[42] Szekeres, A.; Orbán, I. (2019): Examination and control of the efficiency of enterprises operating within the health care sector, CORPORATE OWNERSHIP AND CONTROL 17 : 1 pp. 173-182.
[43] Taherdoost, H., Madanchian, M. (2023). Blockchain-Based New Business Models: A Systematic Review. *Electronics, 12(6), 1479*. [Google Scholar]
[44] Tim, G.; Elgazzar S.; Ahmed A. (2023). Blockchain technology in pharmaceutical supply chains: a transaction cost perspective. DOI: 10.1108/mscra-10-2022-0023. [Google Scholar]
[45] Trinh, H. H.; Haouas, I.; Thi Thuy Tran, T. (2023). Navigating Through Sustainable Capital Markets: A Systematic Review of ESG and CSR Research in the Era of Fintech and Blockchain. *Available at SSRN 4448446*. [Google Scholar]
[46] Tseng, F. M.; Liang, C. W.; Nguyen, N. B. (2023). Blockchain technology adoption and business performance in large enterprises: A comparison of the United States and China. *Technology in Society, 73, 102230*. [Google Scholar]
[47] Vaidya, A. (2023). Emerging Technologies and Cyber Security. *India Banking and Finance Report, 145*. [Google Scholar]
[48] Varese, I. (2023). Bitcoin, Blockchain, Smart Contracts, and Real Use Cases. *IEEE Technology and Engineering Management Society Body of Knowledge (TEMSBOK)*. [Google Scholar]
[49] Vitale, G. (2023). Information Technologies for Business Management: From Big Data to Blockchain, a Literature Overview. Understanding Supply Chain Digitalization Through Actor-Network Theory: The Interplay Between Blockchain, *Accounting and Management Control, 1-22*. [Google Scholar]
[50] Wanxin L.; Collin M.; Hao G.; Mark M. N. (2023). Aggregated Zero-Knowledge Proof and Blockchain-Empowered Authentication for Autonomous Truck Platooning. DOI: 10.1109/TITS.2023.3271436. [Google Scholar]
[51] Webster, J.; Watson, R. T. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly, 26(2), xiii–xxiii*. [Google Scholar]
[52] Weixiong Wang. (2023). The role of blockchain technology in advancing sustainable energy with security settlement: enhancing security and efficiency in China's security market. DOI: 10.3389/fenrg.2023.1271752. [Google Scholar]
[53] Xiao, Y.; Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. *Journal of Planning Education & Research, 39(1), 93–112*. https://doi.org/10.1177/0739456X17723971 [Google Scholar]
[54] Yasir H.; Yousuf R.; Atif C. (2023). Security in Health Information Management Records through Blockchain Technology. DOI: 10.26735/qbij3667. [Google Scholar]
[55] Yasmina, G. (2023). The role of blockchain technology in facilitates international trade. *Journal of Financial, Accounting & Managerial Studies, 10(1)*. [Google Scholar]
[56] Yin, X. (2023). Blockchain Technology in Corporate Governance: Advantages and Limitations. *Academic Journal of Business & Management, 5(11), 89-103*. [Google Scholar]
[57] Čekerevac, Z.; Cekerevac P. (2023). BLOCKCHAIN TECHNOLOGY AND APPLICATION – SMEs ASPECT. DOI: 10.12709/mest.11.11.02.04. [Google Scholar]
[58] Zhang, J. (2023). Research on Blockchain-based Information System for Power business archives Co-construction. *In 2023 IEEE 6th International Electrical and Energy Conference (CIEEC) (pp. 2850-2854). IEEE*. [Google Scholar]