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Research Article

Systematic Mapping Study of Blockchain Integrated Supply Chain Management

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With globalization and emerging competition, there is an intense rise in using trending technologies. One of them is blockchain technology. It is incorporated in various fields, focusing on benefits such as decentralization, security, and transparency. Data, transaction information, time, and money are all captured and saved in the system from beginning to end. This guarantees security and prevents data corruption. Multiple patterns are involved that ensure security throughout the process of various sectors; one is supply chain management. BCT can potentially restructure the concept of data trust by having only "one trusted ledger," which can tackle the rising problems among members involved in the supply chain. This study aims to describe and comprehend how BCT can impact supply chain management, members of the supply chain's willingness to adopt blockchain, the role of blockchain in making the entire supply chain process clear, and challenges to BCT adoption. It is crucial to comprehend the complexity of blockchain to prepare for its effective implementation in supply chain management. We admit that our method for choosing the literature for our systematic review may have left out some literature. Nevertheless, we tried to add as much pertinent literature as possible. The paper contributes to achieving 4 aims related to supply chain management: (1) to highlight the reason for BCT in supply chain management, (2) to analyze the sentiments of people in adopting blockchain in supply chain management, (3) to expedite the need of blockchain for ensuring transparency in SCM, and (4) to pinpoint various issues and challenges in integrating BCT in supply chain management.

1. Introduction

With the existence of this world, businesses came into existence. Every business has been initiated with the incorporation of supply chain management. Supply chain management (SCM) is a process that involves consecutive steps of production, distribution, storage, and transportation of goods and services produced. Every step in SCM is controlled by one or more companies that can be either suppliers or stakeholders. SCM is essential to the world economy. The International Trade Administration estimates that supply chain transactions account for more than 76% of all international trade. Many businesses outsource their assembly lines to low-cost regions to reduce production expenses. Processes involved in SCM are divided and controlled by an increasing number of agents involved in SCM.

With rapid economic globalization and the intense need for market competitiveness, supply chains have become more dynamic and complex. The primary reason is that people are becoming more focused and demanding better personalized products and customer service at a reasonable price and velocity. To effectively respond to market changes and maintain competitiveness, businesses are now focusing on their core competencies and shifting toward activities like outsourcing, developing complex value chains, and open innovation. This has resulted in an increased number of members involved in SC [1]. Such members involved are scattered across the globe, so the information is highly distorted.

Consequently, a higher coordination cost is required, such as for quality systems, production standards, etc., to better manage and enable information sharing among the participants in a complicated SC [2]. Supply chains are

gradually getting more complicated. Organizations focus on addressing the supply chain's growing complexity by implementing various technologies. Supply chains in the modern day are required to be more trustworthy than before. Supply chain disruptions can result in severe short- and long-term business losses and raise consumer costs. Data is the most important element of SCM. Data must be kept visible and immutable to address the majority of supply chain concerns. The potential of BCT to address numerous supply chain problems makes it a promising solution [3].

BCT is a developing collection of interconnected blocks that grows as new transactions are added to the nodes. It uses a decentralized approach that enables data transmission and joint ownership of each node of accessible data, also known as data. They are managed through social networking and hold collections of encrypted transactions, assuring security. Confidentiality, anonymity, and maintainability without additional interference from a third party, such as a government, bank, enterprise, etc., are certain benefits of a blockchain. Due to its design, BCT is very resistant to data modification. The broad usage of BCT, initially envisioned in Nakamoto's studies, started in 2008. A new block is created when a user transmits a new transaction across the blockchain network. On the blockchain, transactions are kept in blocks and then sent to every system connected to the network. All systems in the network are informed of this transaction, which is included within a block. Every intermediate node has a copy of the entire blockchain, which helps with authentication. All network participants examine if a block containing a user activity has been interfered with in any way when it is broadcast to them all. The miners upload the block to their respective blockchain copy if the confirmation is successful [4].

Blockchain technology offers transparency, traceability, reduced transaction costs, and fraud protection in supply chain management. However, its adoption is gradual, with organizations starting with trial initiatives. Trust and cooperation among peers, industry consortia, trade groups, and SCM platforms are essential for data protection, governance, and compliance. Regulatory issues also impact businesses' compliance with transparency, data privacy, and product safety. The scalability and maturity of blockchain technology in supply chain management are interdependent. A systematic literature review is carried out to focus more on current exploration and research efforts on BCT in the context of SCM. By highlighting the ambiguous potential benefits, barriers in the development of BCT, and limitations in SCM, this research will give practitioners an in-depth understanding of this revolutionary advancement in business corporations. The presented study aims to answer the following research questions:

RQ1. What is the need for integrating BCT in SC Management?

RQ2. Are members of the supply chain willing to agree/rely on blockchain adoption?

RQ3. How blockchain can identify fraud/counterfeit products, creating transparency in SCM?

RQ4. What are the challenges/Issues in integrating BCT in SCM?

2. Research Methodology

A systematic literature review (SLR) was conducted to thoroughly assess the contributing entities, importance, and limitations of blockchain and capitalize on the research on supply chain management. SLR is "a method for identifying, assessing, and understanding all relevant research to a certain research question, topic area, or subject of interest" [5]. The key purpose of SLR is to minimize the number of studies in the scope of the study, ensuring that relevant, adequate, and quality studies are involved in the research. This technique is designed to stop findings from being evaluated in part. However, it cannot be prevented from discrimination in primary research efforts.

A systematic literature review involves planning, conducting, and evaluating. A review paradigm is applied throughout the planning process to direct all subsequent actions, help structure the unclear data, and lessen researcher bias. The paradigm outlines several search issues. Sources, the proposed research's conducting period, the justification for choosing particular sources, search criteria and other limitations, quality assurance criteria that specify whether the research is to be included or excluded, the process of data extraction and acquisition, as well as procedures for storing the search files and data extraction, are all included in the search strategy. A systematic literature review is a combined effort of authors. Authors have analyzed, reviewed, and evaluated multiple studies based on their judgments. Relevant studies are arranged systematically based on specific criteria, and irrelevant studies that do not justify the assessment criteria are rejected.

Following review guidelines by Kitchenham and Brereton [6], this SLR process is carried out. It includes the overview of the topic selection, the research questions, the search strategy, the inspection and retrieval of articles, the evaluation of the articles' quality, and data synthesis.

2.1. Research Domain. A thorough investigation of blockchain integration in SCM was carried out to understand SCM with BCT better. Research articles from various digital information sources were thoroughly investigated to comprehend the concept of BCT development, identify challenges in the domain, and discover what experts have done thus far to tackle the recognized issues occurring during particular times.

2.2. Developing Research Questions. To make this review more compact, the study concentrated on responding to specific research questions developed through examining multiple studies.

2.3. Search Strategy. The search strategy comprises search keywords and methods. Descriptions are presented below.

For keyword formulation, the following steps are carried out:

(i) Important keywords were gathered from the suggested research questions.

(ii) The synonyms of key terms were sorted for efficacy.

(iii) We looked at the wording of keywords in books and articles.

(iv) Boolean OR was used to line up the synonyms.

(v) The essential terms are linked together using Boolean AND.

2.3.1. Search Process. Four digital libraries were evaluated thoroughly and systematically to gather information from various researchers' works in BCT-based SCM. ACM digital library, ScienceDirect, Taylor and Francis and Wiley are the libraries focused on getting the relevant research. The title, abstract, and key words of published works including journal articles, conference papers, and book chapters were analyzed to complete the planned research. Figure 1 presents the entire process of our research, whereas Table 1 presents the names of libraries that were selected in this process, along with the total number of articles searched, selected on a tile and content basis.

Table 1 presents the names of libraries and the selection of articles from such libraries (ACM, ScienceDirect, T&F, AND WILEY) based on their title and content.

About 201 articles of the total search came from ACM, 1770 from Science Direct, 554 from Taylor and Francis, and 487 from Wiley, as shown in Table 2.

In the process of title-based selection, 26 articles were selected from ACM, 155 from ScienceDirect, 63 from T&F, AND 27 from Wiley, shown in Table 3.

Finally, when the content-based selection was done, 13 articles from ACM, 31 from ScienceDirect, 20 from T&F, and 6 from Wiley were selected.

3. Scrutinization and Acquisition of Significant Research

In the execution of the search, 3012 research studies from the four digital databases listed in Table 1 were retrieved. The initial search returned 3012 randomized research; thus, scrutiny was necessary to locate relevant study papers. Authors carefully examined and checked the titles of pertinent studies after collecting metadata, which will aid in minimizing the articles by skipping over those not pertinent to our research area and considering those for future research. Figure 2 presents the percentage of total searched papers from selected libraries, whereas Table 2 presents the number of articles that came in search from these libraries. The scrutinization was carried out according to acceptance and rejection criteria represented in Table 4.

Figure 3 presents the value of articles selected based on their title from our selected libraries, whereas Table 3 presents the actual number of these articles.

Figure 4 presents the percentage of articles selected based on their content, and Table 5 shows the actual number of articles selected based on their content.

4. Quality Assessment and Data Synthesis

Quality evaluation criteria were applied based on the studies that had been filtered after careful consideration and retrieval of pertinent publications. Each article was carefully reviewed to see if it provided answers to at least one of the predetermined questions. In this stage, each of the papers is reviewed for its contributions to the research carried out in our proposed area. Figure 5 represents the quality assessment of the selected studies. It shows the range of studies from 2012 to 2022. Zero (0) represents that the article is not answering that specific question, one (1) represents that the selected article is answering at least one proposed research question, two (2) represents that the article is capable of answering at least two proposed research questions and references of the selected articles are shown in another column. Table 6 represents the research questions and answers from the selected articles. 0 shows that the article has not answered that question, and 1 shows it has answered one question. In the table, score 1 shows that one article has answered the proposed question, and scores 2 and 3 show that one article has responded to two or three proposed questions.

The research was assessed using a manual grading method to ensure the data was suitable for specific research questions. The study was validated by answering at least one RQs, with responses being either yes = 1 or no = 0 (represented in Table 6). This method ensured the validity of the proposed study.

4.1. RQI. What Is the Need for Integrating BCT in SCM? The performance of the supply chain can be improved by implementing BCT. Implementing BCT in SCM will boost efficiency in terms of quality, cost, speed, risk mitigation, and sustainability. The use of BCT can help a business gain a competitive edge against its competitors [74]. The use of blockchain technology in supply chain management has several advantages and successfully solves a number of problems for the sector. The significance of using blockchain in supply chain management is demonstrated in various studies presented in Table 7. Some main reasons for the integration of BCT in SCM are described in studies [75–79] are that blockchain offers a decentralized, unchangeable ledger for keeping track of all supply chain transactions and occurrences. This improves transparency and traceability along the whole supply chain, from the procurement of raw materials to the final user. The danger of fraud, forgery, and unauthorized actions is greatly diminished by the capacity to trace, verify, and audit each transaction or transfer of commodities in real-time. Blockchain uses sophisticated cryptography methods to protect transactions and data. It becomes very difficult for hostile actors to modify or manipulate records when data is stored in a decentralized, tamper-resistant fashion. Preventing data breaches and assuring the veracity of the information shared across stakeholders assures the authenticity and integrity of supply

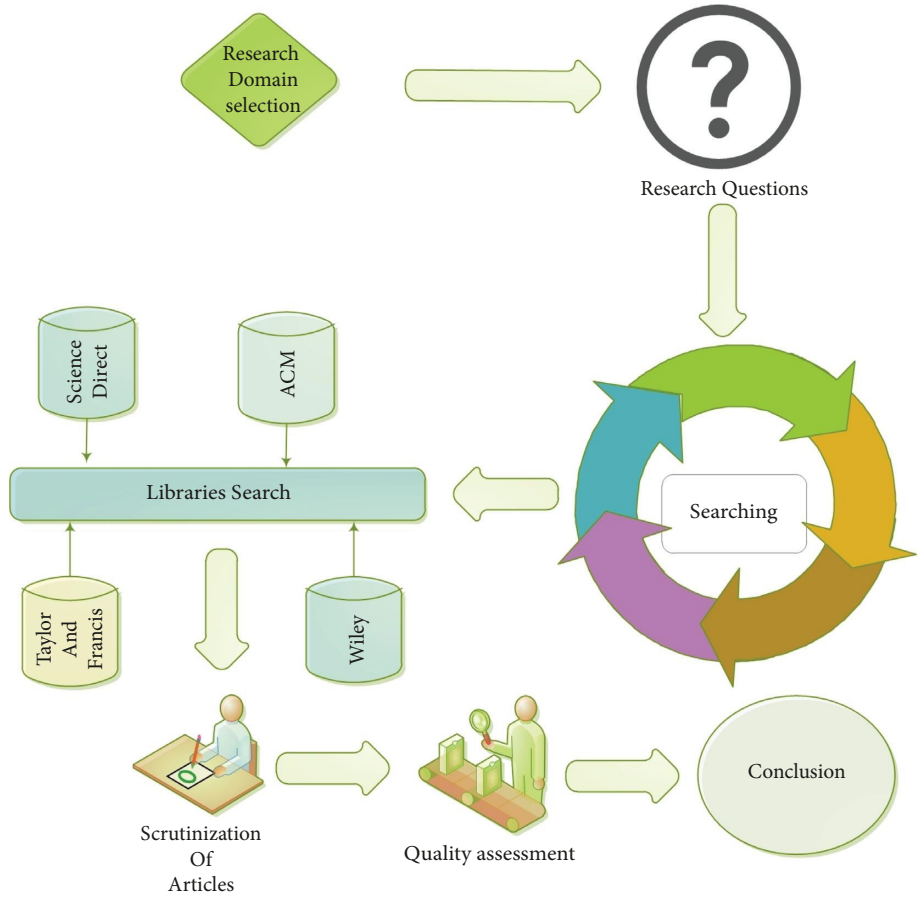

Figure 1: Article retrieval process.

Table 1: Representation of Articles from digital libraries.

Libraries	Total searched papers	Title wise selection	Content wise selection
ACM	201	26	13
ScienceDirect	1770	155	31
Taylor and Francis	554	63	20
Wiley	487	27	6
Total	3012	271	72

Table 2: Represents the names of the libraries searched and the number of papers that came in search.

Libraries	Total searched papers
ACM	201
ScienceDirect	1770
Taylor and Francis	554
Wiley	487
Total	3012

Table 3: Represents the number of articles selected on the basis of their title from the selected libraries.

Libraries	Title wise selection
ACM	26
ScienceDirect	155
Taylor and Francis	63
Wiley	27

chain data. Traditional supply chains frequently have inconsistencies, delays, and inaccuracies as a result of human record-keeping and a large number of middlemen. Smart contracts, which are self-executing contracts with established rules, are made possible by blockchain technology, which simplifies and automates several procedures. By automating processes like payment processing, contract fulfillment, and regulatory compliance, smart contracts may cut down on paperwork, do away with middlemen, and improve operational effectiveness. Blockchain technology makes collaboration between parties involved in the supply chain safe and transparent. As a result, the shared blockchain ledger becomes a single source of truth for all parties involved and is accessible by suppliers, manufacturers, distributors, retailers, and customers. Since everyone has access to accurate and timely information, this shared visibility promotes trust and collaboration, resulting in better

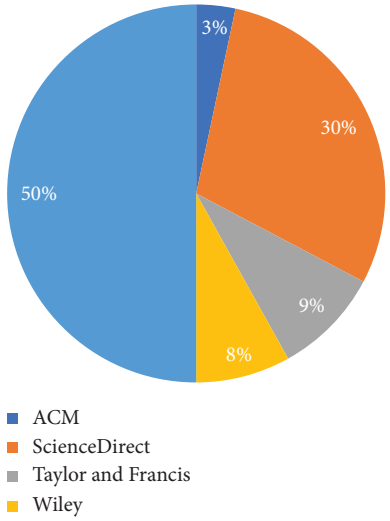

Figure 2: Represents the details of the total papers searched for by the selected libraries.

decision-making, fewer disagreements, and greater supply chain coordination as a whole [29]. Blockchain technology improves quality assurance and guarantees adherence to industry standards, laws, and certifications. It is simpler to trace the origin of items, track their quality, and guarantee adherence to specified standards when every stage in the supply chain is documented and verified. This is especially crucial in sectors like the food and pharmaceutical industries, where compliance, safety, and authenticity are crucial. Supply chain platforms built on blockchain can help with supply chain financing by offering transparent and auditable records of transactions and assets. Financiers now have improved visibility into the functioning of the supply chain, inventory levels, and payment history, which helps lower lending and financing risks. The use of blockchain technology in supply chain management can completely transform the industry by enhancing, transparency enhancing security, improving efficiency, fostering collaboration, ensuring compliance, and enabling new business models [32].

4.2. RQ2. Are Supply Chain Members Willing to Agree/Rely on Blockchain Adoption? BCT is a revolutionary change supporting supply chain management by facilitating strategic collaboration between businesses and supply chain partners [74]. Blockchain technology is poised to revolutionize supply chain operations by enhancing transparency, decentralization, and trust. It addresses information imbalance, promotes cooperation, and improves process management efficiency. It strengthens data integrity and builds stakeholder trust through secure information exchange and service integration. Securely distributed ledgers and smart contracts allow for rule enforcement, transparency, and privacy. Supply chain stakeholders are actively embracing blockchain technology.

Several variables can influence how eager supply chain participants are to accept and rely on blockchain adoption in supply chain management. These key aspects are presented in Table 8 and are explained as follows: Participants in the supply chain will adopt blockchain technology based on a clear value proposition and potential benefits for their businesses. These advantages might include enhanced security, efficacy, affordability, increased collaboration, and competitive advantages. It is necessary to present these benefits and provide solutions to the unique issues supply chain players encounter to win their approval and support. Collaboration amongst various stakeholders, including suppliers, manufacturers, distributors, retailers, and customers, is necessary to implement blockchain in supply chain management [58] successfully. Forcing involvement and agreement requires building trust and fostering a collaborative atmosphere. By maintaining data integrity and lowering the possibility of disputes or fraud, blockchain's ability to create a visible and impenetrable shared ledger can help to increase confidence among supply chain parties. Members of the supply chain who have a thorough grasp of blockchain's inner workings, possible advantages, and consequences for their operations are more inclined to adopt it. Initiatives centered on education and awareness that present successful use case best practices and offer training or resources to assist in ease worries and promote acceptance. Participants in the supply chain may be more likely to concur and participate if benefits are provided for adopting blockchain technology. These rewards might be monetary, such as cost savings or revenue sharing, or nonfinancial, such as improved reputation or access to new markets. It is also crucial to consider the costs associated with deploying a blockchain, including infrastructure, integration, and maintenance, to ensure that the benefits outweigh the required expenditures. It is important to remember that not all participants in the supply chain may be equally eager or ready to utilize blockchain technology. Depending on organizational culture, risk tolerance, technology preparedness, and legislative restrictions, they may be more or less willing to engage. The key to reaching an agreement and attaining widespread acceptance of blockchain in supply chain management is to create open communication, answer concerns, and provide concrete advantages [80].

4.3. RQ3. How Blockchain Can Identify Fraud/Counterfeit Products, Creating Transparency in the Supply Chain. Blockchain technology offers numerous benefits to traditional supply chain management (SCM) systems, including detecting fraudulent or counterfeit items and improving transparency as depicted in Table 9. Companies like Everledger and Provenance use distributed ledgers and blockchain to establish trust by creating permanent records on ledgers, enabling verification of product authenticity. Blockchain enhances security through data encryption and decentralized structures, promoting accountability, traceability, and accurate information sharing. Integrating

Table 4: Scrutinization criteria (acceptance and rejection criteria of past research).

Acceptance criteria	Rejection criteria
Studies that are published in the English language only	Studies published in languages other than English
Articles that are relevant to blockchain technology and supply chain management	Articles that are not relevant to blockchain technology and supply chain management
Articles published in the range of 2012 and 2022	Articles published before 2012
Articles that answer at least two proposed research questions	Articles that do not answer at least two proposed research questions

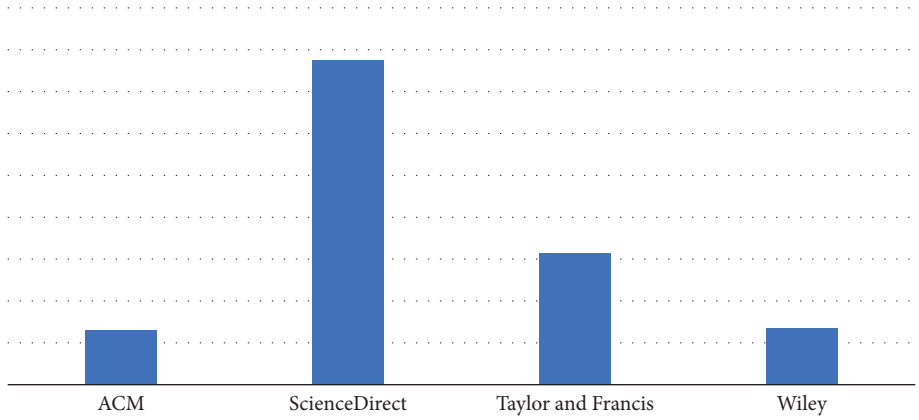

Figure 3: Represents the articles selected based on their title from the selected libraries.

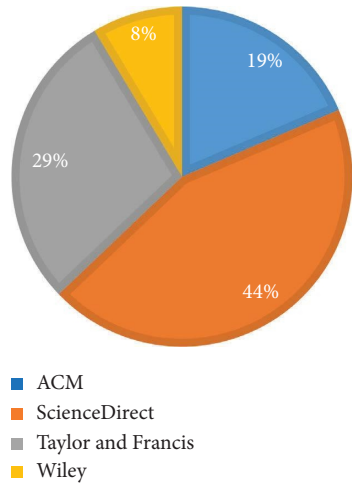

Figure 4: Depicts the percentage of articles that are selected on a content basis.

Table 5: Presents the number of articles selected on content basis.

Libraries	Content wise selection
ACM	13
ScienceDirect	31
Taylor and Francis	20
Wiley	6

blockchain into SCM systems can enhance transparency, efficiency, and stakeholder trust. It can help identify fraudulent and counterfeit products, combat commercial fraud, and ensure the authenticity of products throughout the supply chain, significantly improving the efficiency and trustworthiness of SCM systems [81]. Blockchain offers a decentralized and persistent ledger tracking all supply chain transactions and activity. Each transaction is safely saved in blocks, creating an unalterable chain of data. With everyone able to see the complete transaction history thanks to this transparent ledger, it is more difficult for fraud to go unnoticed. The blockchain may be used to provide each product a special ID or digital token that is stored on the blockchain. This identity may be checked at every stage of the supply chain to confirm the legitimacy of the goods. Participants may verify that the product is authentic and has not been tampered with by scanning the product's digital token or by utilizing other verification techniques. Items may be tracked through the whole supply chain due to blockchain technology. The origin, manufacture, and transit of each movement or transfer of products are all recorded on the blockchain. Participants can follow the path of a product from its source to the final customer thanks to the clear trail this produces. By contrasting the recorded data with the real course of the goods, any inconsistency in the supply chain caused by a counterfeit product may be quickly found [14]. Automating the authentication of a product's validity is possible using smart contracts. It is possible to program predetermined rules and conditions into these self-executing contracts. The smart contract may instantly confirm the product's validity by comparing the received or transferred product's metadata to the data stored on the blockchain. The smart contract can provide an alert if any differences are found, perhaps signaling fraud or the sale of a fake product. In the supply chain, blockchain fosters cooperation and trust. Everyone who is a stakeholder has access to the same information thanks to the blockchain's shared, transparent, and auditable nature. As individuals can cross-verify

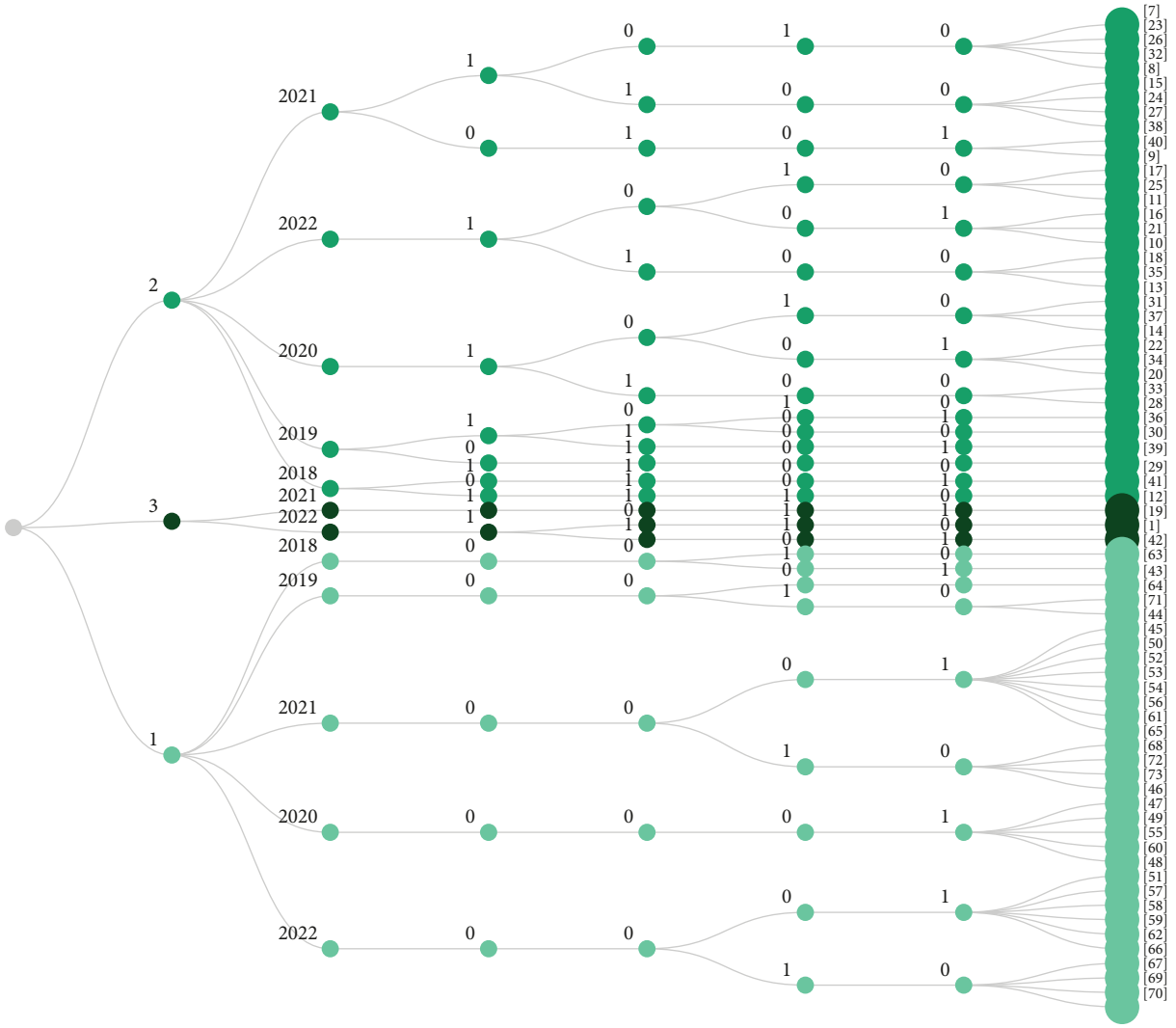

Figure 5: Quality assessment of articles.

Table 6: Quality assessment table.

RQI	RQ2	RQ3	RQ4	Score	Reference	Year
1	0	1	0	2	[7]	2021
1	1	0	0	2	[8]	2021
1	0	1	0	2	[9]	2022
1	1	0	0	2	[10]	2022
1	0	0	1	2	[11]	2022
1	1	1	0	3	[12]	2021
1	0	1	0	2	[13]	2020
1	0	0	1	2	[14]	2020
1	1	0	0	2	[15]	2021
1	0	0	1	2	[16]	2022
1	0	1	0	2	[17]	2022
1	1	0	0	2	[18]	2022
1	0	1	1	3	[19]	2022
1	1	0	0	2	[20]	2020
1	0	0	1	2	[21]	2022
1	0	0	1	2	[22]	2020
1	0	1	0	2	[23]	2021
1	1	0	0	2	[24]	2021

Table 6: Continued.

RQI	RQ2	RQ3	RQ4	Score	Reference	Year
1	0	1	0	2	[25]	2022
1	0	1	0	2	[26]	2021
1	1	0	0	2	[27]	2021
1	0	1	0	2	[28]	2019
1	1	1	0	3	[1]	2022
1	1	0	0	2	[29]	2018
1	1	0	0	2	[30]	2019
1	0	1	0	2	[31]	2020
1	0	1	0	2	[32]	2021
1	1	0	0	2	[33]	2020
1	0	0	1	2	[34]	2020
1	1	0	0	2	[35]	2022
1	0	0	1	2	[36]	2019
1	0	1	0	2	[37]	2020
0	1	0	1	2	[38]	2021
0	1	0	1	2	[39]	2019
0	1	0	1	2	[40]	2021
0	1	0	1	2	[41]	2018
0	0	0	1	1	[42]	2018
0	0	0	1	1	[43]	2019
0	0	0	1	1	[44]	2021
0	0	0	1	1	[45]	2021
0	0	0	1	1	[46]	2020
0	0	0	1	1	[47]	2020
0	0	0	1	1	[48]	2022
0	0	0	1	1	[49]	2020
0	0	0	1	1	[50]	2021
0	0	0	1	1	[51]	2022
0	0	0	1	1	[52]	2021
0	0	0	1	1	[53]	2021
0	0	0	1	1	[54]	2021
0	0	0	1	1	[55]	2020
0	0	0	1	1	[56]	2021
0	0	0	1	1	[57]	2022
0	0	0	1	1	[58]	2022
0	0	0	1	1	[59]	2022
0	0	0	1	1	[60]	2020
0	0	0	1	1	[61]	2021
0	0	0	1	1	[62]	2022
0	0	1	0	1	[63]	2018
0	0	1	0	1	[64]	2019
0	0	1	0	1	[65]	2021
0	0	1	0	1	[66]	2022
0	0	1	0	1	[67]	2022
0	0	1	0	1	[68]	2021
0	0	1	0	1	[69]	2022
0	0	1	0	1	[70]	2022
0	0	1	0	1	[71]	2019
0	0	1	0	1	[72]	2021
0	0	1	0	1	[73]	2021

information and spot errors or inconsistencies, there is a lower possibility of fraudulent operations. A more secure and dependable supply chain environment results in growing participant trust. Blockchain empowers customers by giving them comprehensive information about the goods they buy. By scanning its digital token or QR code, consumers may access facts about a product's provenance, legitimacy, and other pertinent information. This promotes a safer market by empowering customers to make educated judgments and steer clear of counterfeit goods. By utilizing

Table 7: Presents the description to the RQ1 answers from various studies.

No.	SCM and BCT	Description	Reference
1	Decentralized system	Decentralized systems are typical of supply chains, thus, blockchain technology appears to be a good approach to support them. BCT offers a shared concurrency monitoring method for SCM	[41]
2	Atomicity	The blockchain is beneficial as a benchmarking system by promoting supply chain transparency, pinpointing supply chain weak spots, and detecting significant risks. BCT can automate the supply chain by using automatic invoice creation, payment settlement, as well as delivery and transportation	[42]
3	Smart services provisions	BCT's advantages are visibility, durability, integrity, and automation. We can overcome several obstacles by creating a blockchain suitable for the global supply chain. First, by integrating with smart sensors that follow the delivery process, we can track who handled a specific product during its shipment from the manufacturer to the client and when, where, and how it was stored. Second, the blockchain network is decentralized and can execute and validate transactions automatically rather than depending on a centralized trust system. Third, the blockchain network fully integrates participants by sharing information in real time	[43]
4	Visibility	Blockchain technology can enhance supply chain visibility and transparency by efficiently tracking transactions and information. It prevents human interference and boosts confidence in supply chains, which are human-influenced systems. Supply chain managers can use shared data on blockchain to make informed decisions, enhancing visibility. Blockchain technology can revolutionize supply chain transactions, eliminating trust issues and providing a reliable solution for stakeholders. This fundamental paradigm shift is expected to improve supply chain visibility and transparency significantly	[15, 44, 45]
5	Synchronization	Blockchain is a decentralized database that uses cryptography to store records as interconnected blocks. It consists of elements like timestamps, transaction data, and codes, with copies stored on each node for data synchronization. Blockchains provide trustworthy, tamper-resistant records that offer distributed multinode networking, data alignment, information traceability, and immutable block content. They are ideal for supply chain solutions in supply chain settings	[7, 46]
6	Enhanced security	Blockchain can strengthen multiparty trust and cooperation, increase the credibility of business data in the supply chain's upstream and downstream, make risk management easier, and improve information flow and logistics through the chain's electronic certificate. This has improved funding challenges and financing shortages among multilevel suppliers. Given SC's drawbacks, BCT has gained attention as a practical remedy. It attracts a lot of interest because of its asymmetric encryption, decentralization, nonrepudiation, and even lack of a third party who may be trusted	[8, 47]
7	Transparency	Blockchain technology, is a relatively recent advancement in the security domain, has the potential to improve traceability by providing security and transparency. It can be integrated into supply chain management to enhance efficiency, transparency, and reliability, and reduce operational and logistical expenses. However, blockchain-based supply chain management solutions are still in their early stages, being used by only 9% of enterprises	[9, 48]
8	Authenticity	The ability to monitor authenticity across the healthcare supply chain is minimal to nonexistent. Some companies are already utilizing blockchain technology to improve the global healthcare supply chain's transparency, traceability, and integrity. By eliminating fraud and providing more effective quality control, blockchain technology can ignite a supply chain revolution in the healthcare industry	[10]
9	Traceability	Blockchain technology offers precise traceability, effective recalls, and easier regulatory compliance for global food supply chains. It can overcome information-sharing challenges like fragmented data, dependability, and privacy concerns. Gartner predicts that by 2023, $2 T worth of products and services could be tracked using blockchain, with the industry potentially worth over $3 T by 2030	[11, 49]
10	Social engagement	Using blockchain technology, new opportunities for social and economic systems can be established. The supply chain, manufacturing, and logistics sectors now in place, which appear to be transparent but are complex, can undergo a significant revolution using blockchain. The blockchain-enabled supply chain solutions have clearly proven their ability to reduce costs and boost productivity in the sector	[12]

Table 7: Continued.

No.	SCM and BCT	Description	Reference
11	Monitoring	Blockchain technology can lower supply chain costs by 15%, boosting organization profits and margins. Several firms have taken the initiative to provide the industry solutions for supply chain monitoring connected with blockchain	[50]
12	Compliance management	BCT can transform the digital economy. The information systems and SCM groups are both quite interested in it. Traceability, compliance, adaptability, and stakeholder management are four "pain points" that Deloitte professionals have highlighted, and they believe that blockchain holds the potential to resolve them	[13]
13	Payment scheme	Blockchain technology can revolutionize logistics and supply chain management by integrating order fulfillment, distribution, various payment schemes for intermediary items, information sharing, and environmental and human rights management. However, due to the instability of the global economy and the lack of a clear framework, the adoption of blockchain in supply chain management is severely limited, affecting both small and large chains. Despite the wealth of information on blockchain, there is no clear framework to determine if a supply chain should implement it	[14, 51, 52]
14	Reliability	According to the world economic Forum, blockchain will be one of the top computer "mega-trends" that will impact the world in the next ten years. According to researchers, blockchains are expected to revolutionize supply chain management in the future	[53]
15	Virtualization	BT claims supply chain management and logistics will significantly improve sustainability, traceability, and verification. It can be used to provide the end user with location, amount, quality, type, and ownership data to trace the product	[54]
16	Operational efficiency	The supply chain could benefit immensely from applications based on blockchain in terms of improved operational effectiveness and efficiency. Blockchain, the technology underpinning Bitcoin, has recently attracted significant interest from businesses and academics. It is commonly acknowledged that the disruptive innovations brought by blockchain technology enable supply chains to overcome challenges in implementing information exchange, upholding process visibility, and enhancing operational effectiveness	[16, 32]
17	Wide applications	SCM is widely accepted due to its various applications, such as inventory management systems, supplier relationship management systems	[34, 55]
18	Credibility	The corporate landscape has been completely transformed by blockchain technology. It is regarded as an important invention of the 21st century for enhancing SCM transparency. Benefits of BC include better credibility, traceability, documentation, increased security, and reduced "Know Your Customer" costs due to the sharing of identity information. The credibility between the parties involved in various supply chains must be upheld with the partners in the supply chain and consumers in this era of consumption	[17]
19	Immutability	Using blockchain in SCM will make it possible to create traceable, sustainable supply chain systems while securing the immutability of all the recorded data	[18]
20	Cost-effectiveness	A promising decentralized information technology called blockchain has the potential to improve food SC's by lowering transaction costs and times, boosting efficiency, security, transparency and, and fostering participant confidence	[56]
21	Information control	BCT might be compared with private BCT in the supply chain, where users attempt to identify other actors and so function in a regulated environment by controlling information access. Additionally, knowing how the supply chain network affects business conduct both inside and across organizations is necessary to successfully adopt BCT in the supply chain	[57]
22	Tamper resistance	BT's advantages of decentralization and tamper-resistance give supply networks visibility and verification, which contributes to the development of a supply chain that is more reliable and transparent	[58]
23	Collaboration	Blockchain technology has set the stage for collaboration in achieving supply chains' stability, safety, and flexibility needs. Blockchain has the potential to increase security and flexibility	[59]
24	Disintermediation	With its visibility, toughness, and absence of middlemen, BCT has grown significantly in the supply chain. Due to its advantageous characteristics, such as data security, enhanced visibility, disintermediation, digitalization, and product traceability, SCM is a significant application area for BCT	[19, 26]

Table 7: Continued.

No.	SCM and BCT	Description	Reference
25	Openness of stakeholders	The separation of well-known business partners and the appearance of new players with new roles are challenges supply chain participants face. Understanding and openness to blockchain's evolving responsibilities and functions are necessary for maintaining a working supply chain	[20]
26	Authenticity	BCT offers enormous potential for transferring supply chain operations and business process reengineering from security boost to supply chain authenticity	[21]
27	Flexibility	Key SCM goals including prices, speed, dependability, risk mitigation, sustainability, and flexibility can be achieved with blockchain technology	[22]
28	Performance	According to studies, the deployment of blockchain technology benefits a supply chain (SC) since it enhances integrity, visibility, organizational performance, and the business model	[23]
29	Decisiveness	Supply chain professionals and stakeholders frequently aim to build a more responsive and effective global supply network. Many businesses strive to implement BCT into their business models due to its distinctive properties of immutability, data integrity, attribution, and decisiveness	[24]
30	Cooperation	Higher levels of effectiveness, security, transparency, and visibility are added to OM by implementing blockchain technology in SCM. Additionally, this enhances cooperation among SCM members, directly and favorably influencing the price and effectiveness of SCs. BT might greatly aid the increase in customer trust because commodities can be traced throughout their travel across SC	[25]
31	Expansion	Including SCM, BCT applies to diverse areas, where they are projected to expand by 87% yearly and go from 45 M dollars in 2018 to 3300 M by 2023. For instance, PepsiCo found that the efficiency of its supply chain increased by 28% as a result of its blockchain trial	[60]
32	Capability	Due to supply chain participants' increased capability to track all business transactions and the ability to guarantee ethical and responsible production, blockchain might be beneficial for enhancing manufacturers' brand perception and, as a result, for growing the market	[27]
33	Viability	Blockchain technology offers a promising solution to improve supply chain management by providing an immutable ledger for transparency, traceability, and accountability. Its decentralized nature minimizes single points of failure, increasing resilience and efficiency. Blockchain streamlines transactions, automates manual processes, and improves inventory management. Secure data management facilitates accurate decision-making and collaboration, while smart contracts foster trust. Blockchain also helps mitigate risks associated with counterfeiting and regulatory compliance. It integrates new technologies like the internet of things and artificial intelligence into supply chain processes	[28]
34	Digital ledger system	BT is a decentralized digital ledger that stores transaction records in a sequential chain of blocks using cryptographic links, with the primary goal of ensuring tamper resistance and providing evidence of such tampering	[1]
35	Sustainability	The supply chain, one of many activities that blockchain will likely alter, thus requires special consideration	[29]
36	Product-ability	Management of supply chains should implement blockchain because it makes almost all transactions secure, more visible, accessible, and productive	[30]
37	Popularity	The recently developed distributed ledger technology known as blockchain is becoming increasingly popular, it can be especially used in SCM. Blockchain-based solutions can overcome the drawbacks of centralized traceability solutions. Businesses have already begun integrating blockchain technology into their supply chain operations to increase visibility by tracking and tracing activities	[31]
38	Capacity	Making SCM more effective is crucial due to BCT-specific features, including smart contracts, security, privacy, scalability, and the capacity to address the double-spend issue	[33]
39	Prominence	In supply chain management, blockchain technology has recently garnered prominence as a promising technology. For instance, Maersk tracked its containers worldwide using an IBM blockchain system	[35]
40	Improved transactions management	The governance structures and relationships of supply chain management could all be significantly impacted by blockchain. The buying and supply management (PSM) function is particularly affected by blockchain because international transactions are invisible and open to delays, inaccuracies, and human error	[36]
41	Tracking	The whole supply chain's stages are documented in a blockchain network. To keep track of the particular product in the end-to-end chain, each new transaction in the network is recorded in an immutable block	[37]

Table 8: Presents the description to the RQ2 answers from various studies.

No.	Reason of adoption	Description	Reference
1	Globalization	It is essential to make supply chain procedures more transparent and visible because of growing globalization and the growth of business partnerships into new markets. The characteristics of blockchain technology can be quite significant in these situations. For many businesses, in particular, the capacity to seize opportunities devoid of centralized authority has the potential to be disruptive	[61]
2	Decentralization	The supply chain still has drawbacks like information imbalance and a lack of faith in financing possibilities. With asymmetric encryption, decentralization, nonrepudiation, and the ability to conduct transactions without the oversight of a third party, blockchain technology has gone through several stages of development	[8]
3	Awareness	Using a blockchain platform, for instance, would enable all stakeholders in the supply chain to be informed of all ongoing processes without the need for outside interference	[10]
4	Keeping record	The management of supply chains can promote decentralization of authority and impartiality using BCT. Every action will be recorded in the ledger, and each participant will receive a copy. By making the best use of resources, including money, time, and effort, businesses can be reformed, and benefits can be realized	[12]
5	Delivering transparency	Blockchain technology is a revolutionary breakthrough that can potentially change interorganizational relationships. "By facilitating trust, delivering transparency, and decreasing friction across business ecosystems, blockchain promises to revolutionize sectors." it is an open distributed ledger system that allows all supply chain participants direct access in a peer-to-peer network to exchange immutable records simultaneously	[38]
6	Collaboration	The characteristics of blockchain make it possible for various supply chain participants to coordinate their efforts to accomplish a common objective. For instance, after collaborating with IBM for their blockchain-based maritime container management, the world's largest logistics company, Maersk, was able to save billions of dollars	[39]
7	Process management	Blockchain technology is anticipated to make conducting reliable and efficient measurements of supply chain management process performance easier. Tracking shipments, delivery, and advancement for different supply chain management stakeholders is possible. By cutting out the middlemen, the individual suppliers are able to conduct their own checks	[40]
8	Accessibility	Since controlling information flows have grown challenging, internal and external stakeholders must have complete faith in one another. Blockchains provide a shared, secure data flow record for partner transactions and operations throughout the supply chain network. This ensures data integrity and builds trust in the data, making it accessible to all users	[53]
9	Real-time	By creating trust models amongst all supply parties, safeguarding asset transactions, enabling real-time communication, and enhancing forecasting, blockchain has the potential to offer economic value to address important SC challenges	[18]
10	Efficiency	Supply chain managers should implement BCT to promote cooperation among supply chain participants, resulting in lower costs and greater supply chain efficiency. BCT can improve supply chain transactions' efficiency, transparency, and safety. The capacity of trading partners and other stakeholders to access information is called transparency in the supply chain	[30, 62]
11	Trust	Trust is an essential element of the blockchain consensus mechanism since business interactions between unknown parties in the supply chain must be based on it	[20, 29]
12	Knowledge management	The adoption of BCT can increase the knowledge of supply chain stakeholders. Blockchain has a wide range of uses in the supply chain, including the ability to categorize the participants in any action and analyze the effectiveness of supply chain operations	[24]
13	Information sharing	A supply chain's business partners must communicate and agree on crucial information in accordance with blockchain criteria. Blockchain presents chances to address the issues of trust and information exchange, claims Deloitte. Information sharing between stakeholders is made possible by blockchain	[27]
14	Service provision	BCT assists in integrating services across organizational boundaries and offers a real-time, unchangeable record of informational, monetary, and physical transactions among supply chain participants. Ensuring that there is a single version of the truth throughout the network enables a more coordinated, more effective network of supply chain participants	[1]

Table 8: Continued.

No.	Reason of adoption	Description	Reference
15	Smart contract's enrichment	BC enhances the smart contract's enforceability, transparency, tracking, and privacy for transactions involving two or more participants. In the long term, the SC system will become more energy-efficient, economical, and focused on excellent performance due to the use of BC technology	[33]
16	Data management	Blockchain is a distributed ledger (database) that enables supply chain participants to collaborate and exchange records, including information about products, certificates, localization data, transaction histories, and data from sensors and other connected devices	[35]

blockchain technology, supply chains may provide a transparent, reliable environment that makes it easier to spot fraud and fake goods. The immutability of blockchain records, in conjunction with product verification, supply chain traceability, smart contracts, cooperation, and customer empowerment, dramatically improves transparency and lowers the risk of fraudulent actions throughout the supply chain [45].

4.4. RQ4. What Are the Challenges/Issues in Adopting Blockchain in the Supply Chain? Integrating blockchain technology into supply, SCM faces several challenges (represented in Table 10), including the complexity and high costs associated with implementing blockchain systems, particularly for small and medium-sized enterprises. To fully utilize its potential, thorough planning and strategic consideration are necessary. The lack of awareness among supply chain managers and experts also necessitates comprehensive educational efforts to inform stakeholders about the benefits of blockchain in SCM. Implementation requires coordination and collaboration between multiple stakeholders, overcoming technical limitations, and improving scalability. Regulatory challenges arise from the absence of a global legal framework or specific regulations about blockchain technology. Addressing privacy, data security, compliance, and industrial applications is crucial to ensure regulatory compliance and mitigate legal risks. Understanding industry-specific challenges is essential for adapting blockchain solutions to various supply chain contexts. The slow adoption of blockchain in SCM can be attributed to historical challenges, such as technical unpredictability, scalability issues, and high implementation costs. Studying past challenges and incorporating success stories can help develop more effective strategies for integrating blockchain into SCM operations. BCT is still in the early stages of development; it will take more time to mature. Supply chain management might be overrated because of challenges like more space for data storage, advancements in computer generations, and the consumption of more energy [82].

Although there are many advantages to using blockchain technology for supply chain management, a number of problems still need to be resolved before it can be widely used. The following are some major obstacles: Scalability issues are a common problem for blockchain networks, particularly open ones. The blockchain network may get slower and less productive as the number of participants and transactions rises. For supply chains with lots of transactions and many stakeholders, this presents a problem. This problem is being addressed via scalability techniques, including sidechains, off-chain processing, and layer-two protocols. Many distinct organizations often participate in supply chains utilizing various technologies and methods. Integrating blockchain technology with older systems and achieving interoperability between different blockchain platforms can be challenging. To overcome this obstacle, standardization initiatives and the creation of cross-chain communication protocols are in progress [12]. Implementing blockchain technology is necessary to invest in infrastructure, such as network, storage, and computer resources. Especially for small and medium-sized businesses, the expenses involved in setting up and maintaining blockchain networks might deter adoption. Sustainability also requires addressing the energy usage of various blockchain networks, such as proof-of-work-based systems. Effective collaboration amongst supply chain actors requires establishing blockchain governance models, including decision-making procedures, consensus mechanisms, and dispute resolution procedures.

Additionally, it might be challenging to comply with current standards because the regulatory environment surrounding blockchain technology and cryptocurrencies is constantly changing. For blockchain use in supply chains, providing the necessary legal and regulatory frameworks is crucial. Although blockchain offers immutability and transparency, it can present data security and privacy issues. Participants in the supply chain could be reluctant to divulge private or confidential data on a public blockchain. These issues can be addressed using privacy-enhancing technology like private or permissioned blockchains and zero-knowledge proofs. Stakeholders who are inexperienced with or uncertain of the benefits of blockchain technology may be resistant to its adoption. For blockchain adoption in supply chain management to be effective, getting over change aversion and promoting cooperation among industry actors is essential. The solution to this problem may be found through fostering trust, showcasing effective use cases, and involving stakeholders at the earliest stage [50].

Table 9: Presents the description to the RQ3 answers from various studies.

No.	Transparency	Description	Reference
1	Security	Chained blocks made up of multiple transactions are found on a public, distributed ledger called a blockchain. To ensure security, these blocks are universally and publicly validated (i.e., they are only comprised of valid and correct transactions). The blocks are disseminated and synchronized among nodes through a peer-to-peer, distributed, and decentralized structure	[63]
2	Legitimacy	Whether or not the supply chain and commerce industries engage in blockchain technology to detect fake goods is debatable. Businesses like Everledger and Provenance leverage BC technologies to increase trust through transparency by producing permanent records on a ledger that show the products' or assets' origin and enable anybody to check the products' legitimacy and spot fakes. This alone is of enormous significance since asset tracking becomes challenging and expensive when supply chains and logistics span continents and include various diverse parties, some of whom may be malicious owing to their own objectives	[64]
3	Tracking	The primary technological remedy for the issue of supply chain management is thought to be blockchain. Blockchain technology can track every connection in the supply chain and increase the chain's overall security	[7]
4	Counterfeiting	Since the early 1990s, there has been a massive spike in counterfeiting in the wine industry; today, fake wine represents close to 5% of the global market. It results in a proposal for the creation of BCT to record important information about the actors in the area using techniques for industry research and cryptography	[9]
5	Decentralization	The management of supply chains can promote decentralization of authority and fairness using BCT. Every action will be recorded in the ledger, and each participant will receive a copy. By making the best use of resources, including money, time, and effort, businesses can be reformed, and benefits can be realized. The company's system will be out of sync with the rest of the ecosystem if there is any fraud	[12]
6	Data encryption	Blockchain integration into supply chain could offer numerous solutions to the serious problems the present systems face. Blockchain characteristics like immutability, decentralization, and data encryption help address supply chain systems' security and integrity issues	[65]
7	Enhanced payment system	The keystone of blockchain technology is a distributed and irreversible digital record that enables participants to conduct business openly and honestly without the need for a central authority or intermediary. Its use in payment system applications like bitcoin has garnered the greatest attention so far. SCM, which may increase accountability and trust in interorganizational business collaboration, is one of the industry sectors where this revolutionary technology is predicted to deliver considerable economic value	[13]
8	Traceability	The blockchain's clear traceability can stop product fraud and supply chain product counterfeiting	[17]
9	Smart contracts	After the Internet, blockchain is viewed as the next technological breakthrough. Blockchain can manage traditional supply chains with many layers of stakeholders and answer issues about fraud and transparency. Blockchain technology's distributed ledger and smart contracts features are beneficial for reengineering corporate processes, and this has continued to attract more research interest from supply chain management academics	[66]

Table 9: Continued.

No.	Transparency	Description	Reference
10	Immutability	Current SCM systems still have issues like product meddling, insufficient tracking, delays, and lack of information sharing. A cutting-edge development in decentralized information technologies known as blockchain can currently address the existing challenges due to its essential qualities, including decentralization, transparency, and immutability	[67]
11	Verifiability	Supply chains that are already complex and interconnected can benefit from advanced information exchange and verifiability to reduce wasteful transactions and fraud. Each participant in the supply chain, including producers, suppliers, and retailers, has a separate ledger for these transactions and a copy of the "truth" in each ledger. By offering a shared, tamper-evident ledger that is accessible by all supply chain participants, blockchain eliminates information leakages and fraud	[19]
12	Accountability	Transparency, product tracing, and accountability are just a few of the concerns that traditional supply chains are dealing with. Blockchain technology is viewed in this context as one of the most promising IT advancements that will significantly improve supply chain transactions	[68]
13	Ethereal assets management system	Blockchain's immutable nature may improve SC performance and make it more difficult to commit fraud in the halal SC, which deals with ethereal assets that cannot be physically assessed	[23]
14	Preventing product fraud	BCT technology may significantly cut expenses and increase efficiency by preventing product fraud and fakes across SCs	[25]
15	Error-free system	Lack of transparency, poor traceability, smuggling, document and/or product fraud, extensive paperwork, high rates of human mistakes, and follow-up on financial transactions are the most frequent issues with SCM. With the help of blockchain technology, many of these issues can be resolved	[26]
16	Authenticity	BCT is a cutting-edge technical strategy supported by industry 4.0 that offers all agrifood value chain stakeholders flaw tolerance, authenticity, trust, transparency, and full traceability of the recorded transaction records	[28]
17	Real-time access	BCT assists in integrating services across organizational boundaries and offers a real-time, unchangeable record of informational, financial, and tangible transactions across supply chain participants. Gusting a single version of the truth throughout the network enables a more coordinated, more effective network of supply chain participants	[1]
18	Lucidity	Blockchain technology has the potential to operate as a single source of truth and enable transparency for the whole network of supply chain actors. Through tracking and tracing, blockchain technology helps supply networks promote transparency	[31]
19	Validity	Finding the root of the issue becomes challenging in SCM when substandard and counterfeit goods start to appear. Since blockchain technology can guarantee the validity and traceability of information during transmission and the security of transactions in a hostile environment, it is ideally suited for addressing these supply chain concerns. These traits have a significant effect on SCM	[32]

Table 9: Continued.

No.	Transparency	Description	Reference
20	Provision of accurate and up-to-date information	Due to issues with information flaws, logistics, and capital flaws, as well as a general lack of confidence among supply chain transaction participants, supply chain management suffers from issues that increase opportunity costs. Introducing blockchain technology presents a chance to enhance the ecosystem of the supply chain	[69]
21	Anonymity	There are a number of significant issues with the conventional supply chain management system, including product tampering, delays, and fraud. Additionally, it lacks data management, effective participant authentication, and data integrity. The blockchain mechanism's key attributes, including decentralization, transparency, a trustless environment, anonymity, and immutability, make it capable of resolving the aforementioned problems	[37]

Table 10: Presents the description of the RQ4 answers from various studies.

No.	Challenges	Description	Reference
1	Not for everyone	Blockchain is a sophisticated technology that may not be appropriate in all situations even though it has a significant potential to transform how businesses generate value. Most of the time, business managers and domain specialists are unaware of what blockchain can offer and how it can be used to advance corporate objectives and requirements. It is crucial to comprehend why and how blockchain technology should be utilized without adding excessive effort or forcing system alteration. This calls for a distinct and comprehensive understanding of how business and information technology are related	[11]
2	Complexity	The adoption process for blockchain technology is significantly more complicated than that for organizational technology adoptions that are internally oriented since it permits authorized transactions across a network of supply chain players	[38]
3	Distrust	Blockchain technology is gaining traction in the supply chain, but its implementation faces challenges such as adoption costs, scalability issues, privacy and security concerns, and distrust. Similar to other disruptive technologies, BCT is struggling in SME supply chain networks, particularly in organizational, technological, behavioral, and policy aspects. These challenges require further investigation due to their impact on practice and study	[39, 73]
4	Privacy	Despite having many benefits, there are a lot of application obstacles for blockchain in certain industries that require rapid attention. Due to scalability and privacy concerns, the lack of a global legal framework somewhat inhibits the use of blockchain technology. Adopting new technology is always considered a crucial choice for commercial organizations. These factors warrant careful consideration while deciding whether to accept new technologies. Therefore, it is critical to pinpoint the obstacles preventing the widespread implementation of blockchain technology across various businesses	[40]
5	Awareness	As blockchain technology develops, more people are becoming aware of its challenges and the challenges of integrating it with existing supply chain systems. Some organizations have started looking into blockchain after analyzing its potential applications for their industry. They are still cautious as they compare the difficulties in using this technology with potential advantages	[14]
6	Fear of data breach	Implementing blockchain for reverse logistics presents several difficulties, including concern over disclosing confidential information to rivals, large upfront costs, a lack of stakeholder confidence, and an absence of experienced human resources	[70]
7	Cooperation	Though the obstacles to blockchain adoption are well known, little is known about how businesses might get beyond them and benefit from the technology. Building and implementing blockchain applications across a user network, which requires cooperation between businesses, is a specific hurdle in adopting them	[16]
8	Technological challenges	Although the number of use cases for blockchain has grown over time, supply chain networks still face several challenges in adopting and using blockchain. These challenges are similar to any potentially disruptive system or technology. Blockchain is still in its infancy and faces several challenges from behavioral, organizational, technological, and policy perspectives	[71]
9	Information leakages	Information may be leaked as the business uses digital technologies and distinct geographical peoples	[19]
10	Require experts	With its decentralized note and storage methods, smart contracts, asymmetric cryptography, and consensus algorithms, blockchain technology offers a revolutionary opportunity to revolutionize business processes and elevate supply chain operations, transforming how businesses operate and enhancing security across various industries. Although the technology is effective, it requires experts to achieve organizational goals	[21]
11	Electricity consumption	The literature describes the widespread use of blockchain technology in supply chains, including high energy consumption, scalability issues, lack of regulations and laws, interoperability issues, lack of blockchain knowledge within organizations, and the complex global supply chain environment. Several barriers to adoption are highlighted. These issues must be addressed to ensure a successful implementation	[22]
12	High adoption cost	Blockchain does not come for free. Its complexity and high adoption costs hinder the application of this technology in businesses	[36, 72]

Table 10: Continued.

No.	Challenges	Description	Reference
13	Cultural barriers	Industry 4.0 technologies complicate global supply chain connections, posing challenges like inefficient transactions, supplier performance, fraud, language barriers, and international laws. Regulations also pose problems. Lack of commitment from suppliers can hinder effective supply chain management. More visible, transparent, and verifiable information is needed to reduce inefficient transactions and business risks. Addressing these issues requires a comprehensive approach to supply chain management	[34]

5. Conclusion

Our study incorporated a systematic literature review on blockchain technology integration in supply chain management. Based on the analysis, limitations to conventional supply chain management were identified, and some of key features related to blockchain adoption in supply chain were explained. Firstly, blockchain adoption can transform traditional supply chains into smart supply chains because of its decentralized nature, interconnecting all the components involved in distribution systems. Secondly, key members involved in the supply chain will agree to adopt blockchain because of its nature, making the system safer and more resistant, transparent, and well structured. It will benefit the whole supply chain network because of a common, nonaltered ledger. Thirdly, because of its transparency, the threats of fraud and counterfeiting in the whole supply chain are eliminated. Finally, although BCT seems to be fruitful, there are challenges and hurdles that can hinder its adoption. That seems to be because of its high adoption cost, complexity for managers to understand, and organizational technological and policy-oriented adoption. Specifically, we wanted to explore the benefits and drawbacks of adoption with the goal of providing professionals and academics with a foundation for their future work on improving innovation and its relevance.

Data Availability

The authors used all secondary data from different libraries and cited them in the paper. All required data details are included in the paper.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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References

[1] M. S. Sangari and A. Mashatan, "A data-driven, comparative review of the academic literature and news media on blockchain-enabled supply chain management: Trends, gaps, and research needs," *Computers in Industry*, vol. 143, Article ID 103769, 2022.

[2] P. K. Wan, L. Huang, and H. Holtskog, "Blockchain-enabled information sharing within a supply chain: A systematic literature review," *IEEE Access*, vol. 8, pp. 49645–49656, 2020.

[3] D. Shakhbulatov, J. Medina, Z. Dong, and R. Rojas-Cessa, "How blockchain enhances supply chain management: A survey," *IEEE Open Journal of the Computer Society*, vol. 1, pp. 230–249, 2020.

[4] K. Gupta, L. Goel, M. Gupta, and N. Bansal, "Enhancing supply chain management using blockchain technology," in *Proceedings of the 2022 2nd International Conference on Intelligent Technologies (CONIT)*, pp. 1–5, IEEE, Hubli, India, June 2022.

[5] S. Keele, "Guidelines for performing systematic literature reviews in software engineering," Technical report, vol. 5, Keele University, Keele, UK, 2007.

[6] B. Kitchenham and P. Brereton, "A systematic review of systematic review process research in software engineering," *Information and Software Technology*, vol. 55, no. 12, pp. 2049–2075, 2013.

[7] R. Tan and H. Zhai, "Application research of blockchain technology in logistics supply chain," in *Proceedings of the Retracted on September 15, 2021 the Sixth International Conference on Information Management and Technology*, pp. 1–4, Jakarta, Indonesia, August 2021.

[8] X. Yu, "Blockchain-based supply chain financial services using smart contract," in *Proceedings of the 2021 4th International Conference on Blockchain Technology and Applications*, pp. 63–69, Xi'an, China, December 2021.

[9] J. Lenge, K. Musumbu, G. Wanuku, and P. Sungu, "Blockchain technology as A guarantee of transparency in the supply chain of commercial enterprises," in *Proceedings of the 2022 3rd Asia Service Sciences and Software Engineering Conference*, pp. 1–7, Macau, Macao, February 2022.

[10] Md M. Rashid, S.-H. Lee, P. Choi, and Ki-R. Kwon, "A blockchain-based approach in healthcare supply chain using smart contracts and decentralized storage systems," in *Proceedings of the 2022 ACM Conference on Information Technology for Social Good*, pp. 300–307, Limassol, Cyprus, September 2022.

[11] S. Jiang and T. Bakkejord Ræder, "Experience on using ArchiMate models for modelling blockchain-enhanced value chains," in *Proceedings of the 26th International Conference on Evaluation and Assessment in Software Engineering*, pp. 375–382, Gothenburg, Sweden, June 2022.

[12] S. Pathak, "Blockchain-Enabled supply chain management system," *Blockchain for Business: How it Works and Creates Value*, pp. 179–200, Wiley, Hoboken, NY, USA, 2021.

[13] A. Kumar, R. Liu, and Z. Shan, "Is blockchain a silver bullet for supply chain management? Technical challenges and

research opportunities," *Decision Sciences*, vol. 51, no. 1, pp. 8–37, 2020.

[14] C. Bai and J. Sarkis, "A supply chain transparency and sustainability technology appraisal model for blockchain technology," *International Journal of Production Research*, vol. 58, no. 7, pp. 2142–2162, 2020.

[15] A. Karamchandani, S. K. Srivastava, S. Kumar, and A. Srivastava, "Analysing perceived role of blockchain technology in SCM context for the manufacturing industry," *International Journal of Production Research*, vol. 59, no. 11, pp. 3398–3429, 2021.

[16] S. Naef, S. M. Wagner, and C. Saur, "Blockchain and network governance: Learning from applications in the supply chain sector," *Production Planning and Control*, vol. 35, no. 9, pp. 932–946, 2024.

[17] L. Trautmann, T. Hübner, and R. Lasch, "Blockchain concept to combat drug counterfeiting by increasing supply chain visibility," *International Journal of Logistics Research and Applications*, vol. 27, no. 6, pp. 959–985, 2024.

[18] B. Alawi, M. M. S. Al Mubarak, and A. Hamdan, "Blockchain evaluation framework for supply chain management: A decision-making approach," *Supply Chain Forum: International Journal*, vol. 23, no. 3, pp. 212–226, 2022.

[19] İ. Gölcük, "An interval type-2 fuzzy axiomatic design method: A case study for evaluating blockchain deployment projects in supply chain," *Information Sciences*, vol. 602, pp. 159–183, 2022.

[20] S. Tönnissen and F. Teuteberg, "Analysing the impact of blockchain-technology for operations and supply chain management: An explanatory model drawn from multiple case studies," *International Journal of Information Management*, vol. 52, Article ID 101953, 2020.

[21] D. Prajapati, S. K. Jauhar, A. Gunasekaran, S. S. Kamble, and S. Pratap, "Blockchain and IoT embedded sustainable virtual closed-loop supply chain in E-commerce towards the circular economy," *Computers and Industrial Engineering*, vol. 172, Article ID 108530, 2022.

[22] M. Kopyto, S. Lechler, H. A. von der Gracht, and E. Hartmann, "Potentials of blockchain technology in supply chain management: Long-term judgments of an international expert panel," *Technological Forecasting and Social Change*, vol. 161, Article ID 120330, 2020.

[23] M. H. Ali, L. Chung, A. Kumar, S. Zailani, and K. H. Tan, "A sustainable Blockchain framework for the halal food supply chain: Lessons from Malaysia," *Technological Forecasting and Social Change*, vol. 170, Article ID 120870, 2021.

[24] T. Paul, S. Mondal, N. Islam, and S. Rakshit, "The impact of blockchain technology on the tea supply chain and its sustainable performance," *Technological Forecasting and Social Change*, vol. 173, Article ID 121163, 2021.

[25] J. Zhang, X. Zhang, W. Liu, M. Ji, and A. R. Mishra, "Critical success factors of blockchain technology to implement the sustainable supply chain using an extended decision-making approach," *Technological Forecasting and Social Change*, vol. 182, Article ID 121881, 2022.

[26] A. Budak and V. Çoban, "Evaluation of the impact of blockchain technology on supply chain using cognitive maps," *Expert Systems with Applications*, vol. 184, Article ID 115455, 2021.

[27] B. Niu, J. Dong, and Y. Liu, "Incentive alignment for blockchain adoption in medicine supply chains," *Transportation Research Part E: Logistics and Transportation Review*, vol. 152, Article ID 102276, 2021.

[28] G. Zhao, S. Liu, C. Lopez et al., "Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions," *Computers in Industry*, vol. 109, pp. 83–99, 2019.

[29] N. Kshetri, "1 Blockchain's roles in meeting key supply chain management objectives," *International Journal of Information Management*, vol. 39, pp. 80–89, 2018.

[30] M. M. Queiroz and S. Fosso Wamba, "Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA," *International Journal of Information Management*, vol. 46, pp. 70–82, 2019.

[31] J. Sunny, N. Undralla, and V. Madhusudanan Pillai, "Supply chain transparency through blockchain-based traceability: An overview with demonstration," *Computers and Industrial Engineering*, vol. 150, Article ID 106895, 2020.

[32] M. K. Lim, Y. Li, C. Wang, and M.-L. Tseng, "A literature review of blockchain technology applications in supply chains: A comprehensive analysis of themes, methodologies and industries," *Computers & Industrial Engineering*, vol. 154, Article ID 107133, 2021.

[33] S. Yadav and S. P. Singh, "Blockchain critical success factors for sustainable supply chain," *Resources, Conservation and Recycling*, vol. 152, Article ID 104505, 2020.

[34] P. De Giovanni, "Blockchain and smart contracts in supply chain management: A game theoretic model," *International Journal of Production Economics*, vol. 228, Article ID 107855, 2020.

[35] M. A. N. Agi and A. K. Jha, "Blockchain technology in the supply chain: An integrated theoretical perspective of organizational adoption," *International Journal of Production Economics*, vol. 247, Article ID 108458, 2022.

[36] C. G. Schmidt and S. M. Wagner, "Blockchain and supply chain relations: A transaction cost theory perspective," *Journal of Purchasing and Supply Management*, vol. 25, no. 4, Article ID 100552, 2019.

[37] S. K. Dwivedi, R. Amin, and S. Vollala, "Blockchain based secured information sharing protocol in supply chain management system with key distribution mechanism," *Journal of Information Security and Applications*, vol. 54, Article ID 102554, 2020.

[38] E. C. Falcone, Z. R. Steelman, and J. A. Aloysius, "Understanding managers' reactions to blockchain technologies in the supply chain: The reliable and unbiased software agent," *Journal of Business Logistics*, vol. 42, no. 1, pp. 25–45, 2021.

[39] G. Nayak and A. S. Dhaigude, "A conceptual model of sustainable supply chain management in small and medium enterprises using blockchain technology," *Cogent Economics & Finance*, vol. 7, no. 1, Article ID 1667184, 2019.

[40] K. Karuppiah, B. Sankaranarayanan, and S. M. Ali, "A decision-aid model for evaluating challenges to blockchain adoption in supply chains," *International Journal of Logistics Research and Applications*, vol. 26, no. 3, pp. 257–278, 2023.

[41] F. S. A. Pour, U. Tatar, and A. Gheorghe, "Agent-based model of sand supply governance employing blockchain technology," in *Proceedings of the Annual Simulation Symposium*, pp. 1–11, Baltimore, MD, USA, April 2018.

[42] S. Mann, V. Potdar, R. S. Gajavilli, and A. Chandan, "Blockchain technology for supply chain traceability, transparency and data provenance," in *Proceedings of the 2018 International Conference on Blockchain Technology and Application*, pp. 22–26, Xi'an China, December 2018.

[43] W. Xie, B. Wang, Z. Ye, W. Wu, J. You, and Z. Qi, "Simulation-based blockchain design to secure biopharmaceutical supply chain," in *Proceedings of the 2019*

Winter Simulation Conference (WSC), pp. 797–808, IEEE, National Harbor, MD, USA, December 2019.

[44] R. Zhao, J. Bal, and X. Ma, "Creating lean and agile supply chains with blockchain," in *Proceedings of the 2021 3rd International Conference on Blockchain Technology*, pp. 135–146, Shanghai, China, March 2021.

[45] Ya-J. Cai, T.-M. Choi, and J. Zhang, "Platform supported supply chain operations in the blockchain era: Supply contracting and moral hazards," *Decision Sciences*, vol. 52, no. 4, pp. 866–892, 2021.

[46] Z. Li, H. Guo, A. V. Barenji, W. M. Wang, Y. Guan, and G. Q. Huang, "A sustainable production capability evaluation mechanism based on blockchain, LSTM, analytic hierarchy process for supply chain network," *International Journal of Production Research*, vol. 58, no. 24, pp. 7399–7419, 2020.

[47] L. Yuyan and W. Lan, "The role of blockchain technology on supply chain finance," in *Proceedings of the 3rd International Conference on Data Science and Information Technology*, pp. 153–158, Xiamen, China, July 2020.

[48] E. Gökalp, M. O. Gökalp, and S. Çoban, "Blockchain-based supply chain management: Understanding the determinants of adoption in the context of organizations," *Information Systems Management*, vol. 39, no. 2, pp. 100–121, 2022.

[49] Y. Chang, E. Iakovou, and W. Shi, "Blockchain in global supply chains and cross border trade: A critical synthesis of the state-of-the-art, challenges and opportunities," *International Journal of Production Research*, vol. 58, no. 7, pp. 2082–2099, 2020.

[50] A. Kumar, K. Abhishek, M. Rukunuddin Ghalib et al., "Securing logistics system and supply chain using Blockchain," *Applied Stochastic Models in Business and Industry*, vol. 37, no. 3, pp. 413–428, 2021.

[51] P. R. de Carvalho, J. Naoum-Sawaya, S. Elhedhli, and S. Elhedhli, "Blockchain-enabled supply chains: An application in fresh-cut flowers," *Applied Mathematical Modelling*, vol. 110, pp. 841–858, 2022.

[52] J. Aslam, A. Saleem, N. T. Khan, and Y. B. Kim, "Factors influencing blockchain adoption in supply chain management practices: A study based on the oil industry," *Journal of Innovation & Knowledge*, vol. 6, no. 2, pp. 124–134, 2021.

[53] D. Mathivathanan, K. Mathiyazhagan, N. P. Rana, S. Khorana, and Y. K. Dwivedi, "Barriers to the adoption of blockchain technology in business supply chains: A total interpretive structural modelling (TISM) approach," *International Journal of Production Research*, vol. 59, no. 11, pp. 3338–3359, 2021.

[54] S. Karakas, A. Z. Acar, and B. Kucukaltan, "Blockchain adoption in logistics and supply chain: A literature review and research agenda," *International Journal of Production Research*, pp. 1–24, 2021.

[55] M. Pournader, Y. Shi, S. Seuring, and S. C. L. Koh, "Blockchain applications in supply chains, transport and logistics: A systematic review of the literature," *International Journal of Production Research*, vol. 58, no. 7, pp. 2063–2081, 2020.

[56] K. Li, J.-Y. Lee, and A. Gharehgozli, "Blockchain in food supply chains: A literature review and synthesis analysis of platforms, benefits and challenges," *International Journal of Production Research*, vol. 61, no. 11, pp. 3527–3546, 2023.

[57] S. Elhidaoui, K. Benhida, S. El Fezazi, S. Kota, and A. Lamalem, "Critical success factors of blockchain adoption in green supply chain management: Contribution through an interpretive structural model," *Production and Manufacturing Research*, vol. 10, no. 1, pp. 1–23, 2022.

[58] X.-Y. Wu, Z.-P. Fan, and G. Li, "Strategic analysis for adopting blockchain technology under supply chain competition," *International Journal of Logistics Research and Applications*, vol. 26, no. 10, pp. 1384–1407, 2023.

[59] W. Viriyasitavat, Z. Bi, and D. Hoonsopon, "Blockchain technologies for interoperation of business processes in smart supply chains," *Journal of Industrial Information Integration*, vol. 26, Article ID 100326, 2022.

[60] S. Köhler and M. Pizzol, "Technology assessment of blockchain-based technologies in the food supply chain," *Journal of Cleaner Production*, vol. 269, Article ID 122193, 2020.

[61] T. Gürpinar, G. Guadiana, P. A. Ioannidis, N. Straub, and M. Henke, "The current state of blockchain applications in supply chain management," in *Proceedings of the 2021 3rd International Conference on Blockchain Technology*, pp. 168–175, Shanghai, China, March 2021.

[62] T. Paul, N. Islam, S. Mondal, and S. Rakshit, "RFID-integrated blockchain-driven circular supply chain management: a system architecture for B2B tea industry," *Industrial Marketing Management*, vol. 101, pp. 238–257, 2022.

[63] N. Alzahrani and N. Bulusu, "Block-supply chain: A new anti-counterfeiting supply chain using NFC and blockchain," in *Proceedings of the 1st Workshop on Cryptocurrencies and Blockchains for Distributed Systems*, pp. 30–35, Munich, Germany, June 2018.

[64] S. Terzi, A. Zacharaki, A. Nizamis et al., "Transforming the supply-chain management and industry logistics with blockchain smart contracts," in *Proceedings of the 23rd Pan-Hellenic Conference on Informatics*, pp. 9–14, Nicosia, Cyprus, November 2019.

[65] N. Malik, K. Alkhatib, Y. Sun, E. Knight, and Y. Jararweh, "A comprehensive review of blockchain applications in industrial internet of things and supply chain systems," *Applied Stochastic Models in Business and Industry*, vol. 37, no. 3, pp. 391–412, 2021.

[66] K. F. Oguntegbe, N. Di Paola, and R. Vona, "Behavioural antecedents to blockchain implementation in agrifood supply chain management: A thematic analysis," *Technology in Society*, vol. 68, Article ID 101927, 2022.

[67] M. Hader, D. Tchoffa, A. E. Mhamedi, P. Ghodous, A. Dolgui, and A. Abouabdellah, "Applying integrated Blockchain and big data technologies to improve supply chain traceability and information sharing in the textile sector," *Journal of Industrial Information Integration*, vol. 28, Article ID 100345, 2022.

[68] S. S. Kamble, A. Gunasekaran, V. Kumar, A. Belhadi, and C. Foropon, "A machine learning based approach for predicting blockchain adoption in supply Chain," *Technological Forecasting and Social Change*, vol. 163, Article ID 120465, 2021.

[69] Y. Wu and Y. Zhang, "An integrated framework for blockchain-enabled supply chain trust management towards smart manufacturing," *Advanced Engineering Informatics*, vol. 51, Article ID 101522, 2022.

[70] A. Panghal, S. Manoram, R. S. Mor, and P. Vern, "Adoption challenges of blockchain technology for reverse logistics in the food processing industry," *Supply Chain Forum: International Journal*, vol. 24, no. 1, pp. 7–16, 2023.

[71] S. Saberi, M. Kouhizadeh, J. Sarkis, and L. Shen, "Blockchain technology and its relationships to sustainable supply chain management," *International Journal of Production Research*, vol. 57, no. 7, pp. 2117–2135, 2019.

[72] L. Yang, J. Zhang, and X. Shi, "Can blockchain help food supply chains with platform operations during the COVID-19 outbreak?" *Electronic Commerce Research and Applications*, vol. 49, Article ID 101093, 2021.

[73] M. Irannezhad, S. Shokouhyar, S. Ahmadi, and E. I. Papageorgiou, "An integrated FCM-FBWM approach to assess and manage the readiness for blockchain incorporation in the supply chain," *Applied Soft Computing*, vol. 112, Article ID 107832, 2021.

[74] R. Z. Rasi, U. S. B. Rakiman, R. Z. R. M. Radzi, N. R. Masrom, and V. P. K. Sundram, "A literature review on blockchain technology: Risk in supply chain management," *IEEE Engineering Management Review*, vol. 50, no. 1, pp. 186–200, 2022.

[75] A. Chang, N. El-Rayes, and J. Shi, "Blockchain technology for supply chain management: A comprehensive review," *FinTech*, vol. 1, no. 2, pp. 191–205, 2022.

[76] F. Casino, T. K. Dasaklis, and C. Patsakis, "A systematic literature review of blockchain-based applications: current status, classification and open issues," *Telematics and Informatics*, vol. 36, pp. 55–81, 2019.

[77] M. M. Queiroz, R. Telles, and S. H. Bonilla, "Blockchain and supply chain management integration: A systematic review of the literature," *Supply Chain Management: International Journal*, vol. 25, no. 2, pp. 241–254, 2019.

[78] S. Warren, S. Deshmukh, S. Whitehouse et al., *Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits*, World Economic Forum, Cologny, Switzerland, 2019.

[79] J.-H. Lee and M. Pilkington, "How the blockchain revolution will reshape the consumer electronics industry [future directions]," *IEEE Consumer Electronics Magazine*, vol. 6, no. 3, pp. 19–23, 2017.

[80] S. Kamble, A. Gunasekaran, and H. Arha, "Understanding the Blockchain technology adoption in supply chains-Indian context," *International Journal of Production Research*, vol. 57, no. 7, pp. 2009–2033, 2019.

[81] M. C. Jayaprasanna, V. A. Soundharya, M. Suhana, and S. Sujatha, "A block chain based management system for detecting counterfeit product in supply chain," in *Proceedings of the 2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)*, pp. 253–257, IEEE, Tirunelveli, India, February 2021.

[82] A. R. Kazmi, M. Afzal, H. Abbas, S. Tahir, and A. Rauf, "Is blockchain overrated?" in *Proceedings of the 2021 IEEE 19th International Conference on Embedded and Ubiquitous Computing (EUC)*, pp. 187–192, IEEE, Shenyang, China, October 2021.