Journal of Digital Economy 2 (2023) 244–288

Contents lists available at ScienceDirect

Journal of Digital Economy

journal homepage: www.keaipublishing.com/en/journals/journal-of-digital-economy

Research article

Exploring the current status and future opportunities of blockchain technology adoption and application in supply chain management

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ARTICLE INFO

Keywords:
Blockchain
Supply chain management
Systematic literature review

ABSTRACT

This study comprises a systematic literature review that offers a thorough analysis of the present state-of-the-art knowledge regarding the adoption and application of blockchain technology within the context of supply chain management. Based on an extensive review of 133 articles from highly-regarded journals, we developed a framework where we highlight the integration of the transition from blockchain technology adoption to its application. This transition process is explained by two theories: the Technology Acceptance Model and the Diffusion of Innovation Theory. In the adoption phase, we identified eight internal drivers and seven external drivers, together with comprehensive barriers. Our framework also integrates and examines the blockchain technology application stage, focusing not only on the current development of benefits of blockchain technology implementation but also on the challenges that impede the successful implementation of blockchain technology in supply chain management. The future development prospects are also highlighted which include standardization, platform development, regulation system development, cost reduction, and talent cultivation. These future developments were critical yet were missing in the current academic literature. By providing an in-depth analysis of these challenges, our study can assist supply chain practitioners in making informed decisions about blockchain-enabled supply chain management initiatives.

1. Introduction

Recent technological advancements have led to significant disruptions in supply chain management (SCM), thus driving the exploration of new strategies and business models (Koh et al., 2019). Among those technological advancements, blockchain has emerged as a high promising technology. Initially introduced in the context of Bitcoin, blockchain technology (BCT) operates on a distributed data structure that utilizes peer-to-peer network transactions (Gurtu & Johny, 2019). The interlocking cryptographic hashes link the blocks, and each node in the network possesses a copy (Gurtu & Johny, 2019). The decentralization principle eliminates intermediaries, and smart contracts automate the supply chain. In response to the increased need for traceability, timeliness, and automation in modern SCM operations in the Industry 4.0 era, which emphasizes industrial innovation and disruption (Asokan, et al., 2022), numerous studies have been conducted across various industries since 2018.

In the context of SCM, the adoption of BCT is still in its nascent stages (Alazab et al., 2021). Moreover, academic research on this topic is relatively inadequate and disjointed. There is a growing urgency to conduct a thorough and systematic review of the current

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https://doi.org/10.1016/j.jdec.2024.01.005
Received 8 September 2023; Received in revised form 5 January 2024; Accepted 25 January 2024

literature to identify the primary benefits and opportunities that blockchain technologies can offer to SCM in various industries and business sectors. It is equally important to identify the major obstacles and challenges that come with their adoption and implementation. To provide an up-to-date overview of this cutting-edge technology's impact on SCM, this study employs a systematic literature review (SLR) methodology to address three research questions.

RQ1. What are the primary drivers, enablers, barriers, and challenges to adopting blockchain technologies in supply chain management?

RQ2. What are the key benefits of implementing blockchain technologies in supply chain management?

RQ3. What are the future development prospects for the integration of blockchain technologies in supply chain management?

To address these research questions, this research will conduct a systematic literature review of peer-reviewed articles in journals with a score of 3 or higher on the Academic Journal Guide (AJG) 2024 ranking list. This research can add to the growing body of BCT-SCM literature by providing a timely and holistic review of the state-of-the-art and synthesizing a wide range of high quality academic studies in this field. Through identifying key drivers, enablers, barriers, and benefits of this integration, this research will contribute to the existing literature and provide valuable insights for practitioners seeking to better understand the latest developments in this field. Different from the mainstream literature review research which only focuses on theoretical analysis, this study includes practical cases to exemplify current state of BCT-SCM integration. This study represents an innovative analysis of the blockchain-SCM integration for the period spanning 2008–2023. The results of this analysis will reveal notable gaps in the current literature, highlight managerial implications, and provide a robust agenda for future research.

The paper is organized into seven sections. Section 2 provides an introduction to some basic but important concepts of SCM and blockchain technologies. Section 3 explains the methodology used in the research. Section 4 presents an overview of current research on blockchain-enabled SCM, including a descriptive analysis of selected peer-reviewed journal articles and an assessment of drivers and barriers to applying BCTs in SCM. Section 5 discusses existing research findings regarding the drivers, barriers and the benefits of applying BCTs in SCM. Real life cases are also included to enrich the discussion. Section 6 summarizes the future development prospects of BCT applications in SCM. Finally, Section 7 provides a conclusion, highlights the managerial implications of the research, and identifies the contributions, limitations, and future research.

2. Theoretical background

2.1. Supply chain management

SCM involves the comprehensive and harmonized management of the flow of information, products, processes, and cash, which significantly impacts a business's competitiveness in terms of production cost, speed-to-market, working capital requirements, Return on Investment (ROI), and profitability (Saberi et al., 2019; Seuring and Gold, 2012). However, managing today's globalized supply chains is a challenging task due to the unprecedented uncertainties in the geopolitical, economic, and technological spheres, making supply chain networks highly complex and susceptible to risks, turbulence, and disruptions (Saberi et al., 2019). The adoption of advanced and emerging technologies is increasingly becoming a popular approach to improving SCM performance. Microsoft (2018) describes how BCT can transform the modern supply chain by enhancing transparency, traceability, and efficiency. The World Economic Forum (2018) discusses the potential for blockchain to be used as a building block for a more sustainable future, where supply chains are transparent and traceable. Deloitte (2017) highlights the potential of combining BCT with the Internet of Things (IoT) to create a comprehensive system for supply chain traceability. These sources demonstrate that organizations are recognizing the potential benefits of incorporating advanced and emerging technologies into their SCM practices, and are beginning to experiment with these technologies to improve their supply chain performance. Section 2.2 emphasizes the emergence of BCT as a crucial technology in the Industry 4.0 era.

2.2. Blockchain

As an emerging information technology in industry 4.0, BCT has received widespread attention. BCT has been defined as a decentralized database of interlinked records shared publicly or privately among participating agencies in the network. To put it simply, blockchains are ledgers that record transactions in a trustless environment which are protected by cryptographic techniques (Gurtu and Johny, 2019). The essentials of BCTs include distributed shared ledgers, smart contracts, consensus mechanisms, and cryptography technology (Pournader et al., 2020; Dolgui et al., 2020). Specifically, distributed shared ledger means the distributed storage of data in specific nodes (independent devices) by network members without central control. Smart contracts execute scripts automatically, instead of being managed by third parties. Cryptography technology is based on digital signatures (such as hashing functions) which ensure data integrity and authenticity. The hashing function enables each block to be chained into an immutable sequence. Finally, the consensus mechanism refers to a protocol that supports transactions and verification of different nodes in the distributed network. Table 1 below summarizes the characteristics of the BCT.

Due to these unique attributes, blockchain set itself apart from centrally-managed databases and is prominent in terms of goal achievement (Mangla et al., 2021; Martinez et al., 2019), cost reduction (Büyüközkan et al., 2021; Choi, 2019; Dubey et al., 2020), reduction of opportunistic and opaque behaviour (Cai et al., 2021; Dong et al., 2023; Fan et al., 2022), and environmental friendliness (Cao and Shen, 2022; Liu et al., 2021; Manupati et al., 2020).

Table 1
The main characteristics of BCT.

Characteristics	Explanation
Decentralization	Transaction data in a blockchain network is not verified by a central authority or third party. Instead, each block is verified by the nodes connected to it. Each user on a node has a copy of the same blockchain and can add data to it.
Smart Contract	Smart contracts are self-executing protocols on a blockchain that trigger automatically when certain conditions of the contract are met. By automating transfers and payments of currencies and other assets, smart contracts reduce transaction costs, enhance convenience, and ensure security.
Immutability	Transactions and data on a blockchain can be verified, but they are immutable due to timestamp and permission control limitations.
Security	The immutability of a blockchain ensures that agreed-upon transactions are recorded and cannot be altered, thereby providing security and establishing a clear provenance of assets.
Anonymity	A distributed ledger connects multiple nodes, but all identities remain anonymous.
Transparent/ Visibility	Input data are saved, and the consensus mechanism ensures that any modifications are recorded, making transactions highly transparent and visible.

Sources: Cole et al. (2019); Gurtu and Johny (2019); van Hoek (2019); Wang et al. (2019); Dubey et al. (2020).

2.3. BCT and SCM

BCT can contribute to achieving SCM objectives, such as cost reduction, increased speed, risk management, flexibility, sustainability, dependability, and improved customer relationships. For instance, blockchain-based SCM allows for real-time tracking of products, protecting against counterfeiting and increasing customer confidence (Kshetri, 2018). Karakas et al. (2021) argued that the transparency, visibility, and security attributes of blockchain can help to eliminate unethical behaviour, rebuild trust in commercial supply chains, and create a culture of transparency. Similarly, Lumineau et al. (2021) proposed that BCT can foster a co-governance supply chain that reduces the role of intermediaries and mitigates opportunistic behaviour and transaction costs. Prause and Boevsky (2019) identified smart contracts as the most transformative BCT application for SCM due to their power and flexibility in including business logic under certain conditions, reducing costs and time while increasing transparency and trust. Wang et al. (2019) suggested that blockchain is best applied when a problem involves multiple parties, allowing multiple stakeholders to transact with one another without the need for an intermediary, encouraging participation and incentivizing collaborative behaviours among supply chain members. Recently, the potential of blockchain for circular economy and sustainability has been widely discussed in the literature (e.g., Chaudhuri et al., 2021; Kouhizadeh et al., 2021; Kamble et al., 2021; Biswas et al., 2023). For example, BCT can facilitate the synchronization of information about carbon emissions across supply chain echelons, enhancing the understanding of the impacts of environmental considerations on supply chain operations (Manupati et al., 2020).

2.4. Theories on innovative technology adoption

There are a rich set of theories concerning innovative technology adoption (Queiroz et al., 2020). The technology acceptance model (TAM) is a key model in understanding predictors of human behavior toward potential rejection and acceptance of the technology. The TAM posits that there are two factors that determine whether a computer system would be accepted by its potential users: perceived usefulness and perceived ease of use (Davis et al., 1989). This theory emphasizes on the perceptions of the potential user. In blockchain research, the TAM framework has been widely cited to consider the users' favorableness and unfavourableness toward the new technology and their subsequent behaviour (e.g. Kamble et al., 2019; Yang, 2019). Studies have found that perceived ease of use and perceived usefulness can exert direct and indirect impacts on technology adoption.

Another renowned theory is the innovation diffusion theory (DOI) which seeks to explain why, how, and at what rate new ideas and technologies spread (Rogers, 1962; Moore and Benbasat, 1991). This theory proposes that the acceptance of innovation is influenced by five important factors which include observability, compatibility, complexity, trial ability and relative advantage (Rogers, 2010). In the adopter characteristics step, the innovation adopters were classified into five categories which include innovators, early adopters, late majority, early majority and laggards. The innovation-decision step includes implementation, knowledge, persuasion, confirmation, and decision (Rejali et al., 2023). Different with the TAM framework which focuses on the perceptions of potential users, the DOI framework integrated the innovation decision process, the characteristics of the potential users and the innovation as well.

2.5. The research gap

Despite the numerous benefits of using BCT in supply chain and logistics, it is still in its developing phase (Xu et al., 2023a; Ahmed and MacCarthy, 2023). For most companies, especially small and medium-sized enterprises, blockchain is still a mystery when it comes to its practical use in supply chain activities (Liu et al., 2021). Although research on the application of blockchain in SCM is emerging, it involves multiple disciplines and the literature appears scattered, focusing on various industries and different aspects of SCM (Ahmed and MacCarthy, 2023). The majority of research has been directed towards investigating BCT as a potential solution, but there is a lack of thorough analysis of practical adoption, application, implementation, and performance (Ahmed and MacCarthy, 2023; Xu et al., 2023b). To address this research gap, this study conducted a systematic literature review of relevant studies in high-quality journals. This comprehensive review of the current progress in the field helps to map and assess the existing literature domain. This review is necessary to assist both academics and managers in making sense of the disruptive effects of this topic, especially when the tangible benefits are unclear and its diffusion path remains ambiguous (Tranfield et al., 2003; Pournader et al., 2020).

We aim to design and develop a framework that identifies the key drivers, barriers, and benefits across blockchain-enabled supply chain adoption to the blockchain-enabled supply chain application phase. We apply relevant theories to explain this integration between blockchain technology adoption and its application in SCM. Our study also provides an analysis of the areas of improvement that are crucial for the wider adoption of BCT in SCM. The next section explains the research method used in conducting this review.

3. Research method

As highlighted by Tranfield et al. (2003), a literature review aims to identify the boundaries of knowledge and assess the progress made in the field. To conduct a literature review, Saunders et al. (2017) recommend a three-step process that involves defining pre-defined search keywords, scanning existing literature, and summarizing key findings. Rowley and Slack (2004) suggest a similar approach that includes a mind map structure to supplement the content-based review. This research follows a rigorous six-stage process to review the literature, as outlined by the aforementioned researchers. Fig. 1 below summarizes the stages involved in the systematic literature review, which will be described in detail in the following sections.

3.1. Stage 1: define the purposes and objectives

The first step is to define the research purposes and objectives. In the introduction section, the research questions have been clearly stated. The purpose of this study is to understand the key benefits and opportunities brought by BCT to SCM operations across multiple

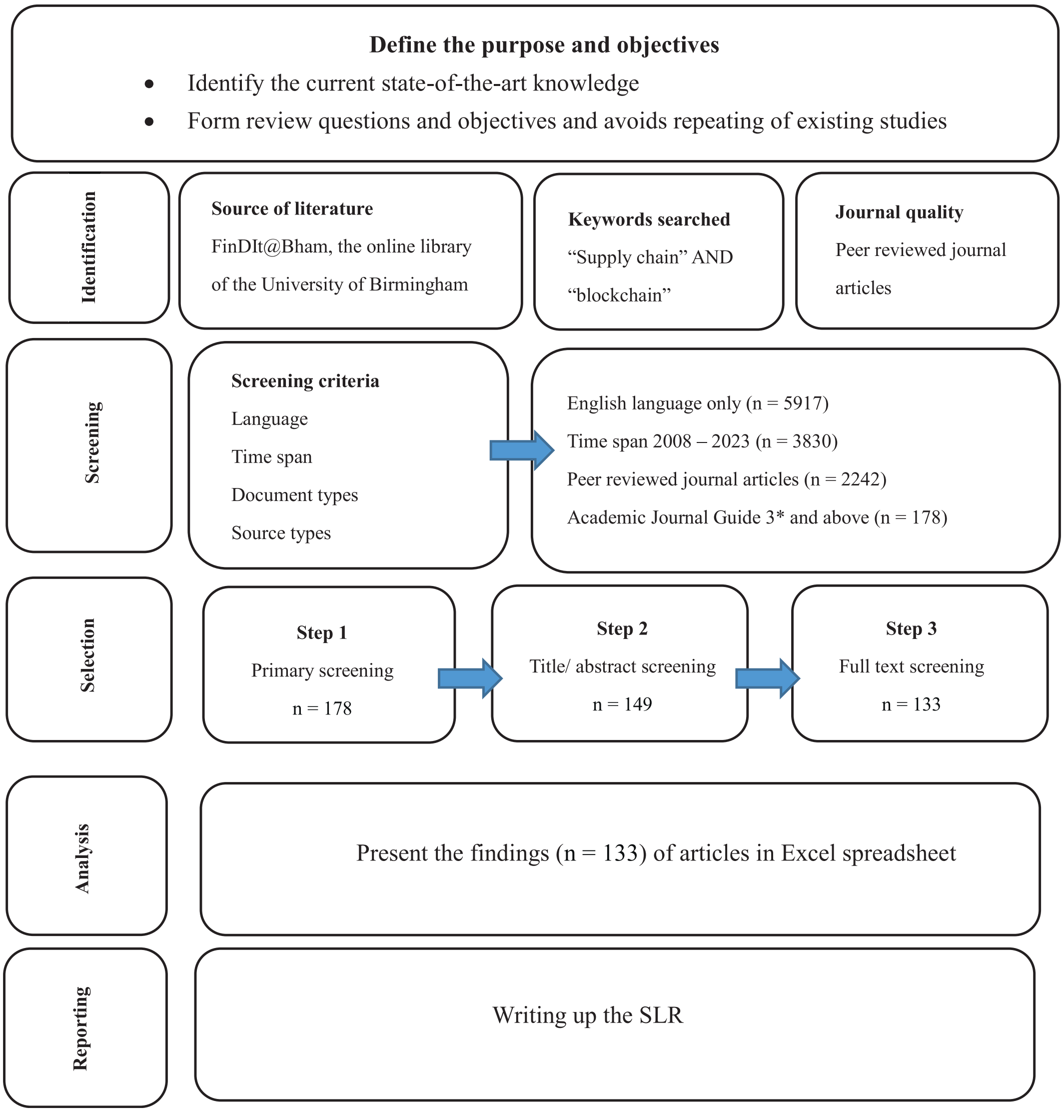

Fig. 1. The process of systematic literature review (Adapted from Ghadafi et al., 2021; Chang and Chen, 2020).

industries and business fields, as well as the key barriers and challenges of such applications. By using the SLR approach, this study aims to eliminate bias and improve the thorough understanding of the latest advancements in BCT in SCM.

Notably, several SLR articles have been published, but the empirical reality is changing rapidly due to the emergence of new business phenomena and applying blockchain in SCM practices. Therefore, to avoid repetition and to ensure up-to-date findings, this SLR will only use peer-reviewed journal articles published between 2008 and 2023. It is also worth considering that the findings reported by prior SLR articles and their fit with established theoretical models may be altered over time (Hanelt et al., 2020).

3.2. Step 2: identify the search terms

Ghadafi et al. (2021) note that the second stage of the SLR involves specifying the literature sources, search keywords, and journal quality to ensure that the selected articles can provide information to answer the defined research questions. For this research, the literature source is FinDIt@Bham, the online library of the University of Birmingham, which incorporates IEEE Xplore, EBSCOhost, Science Direct, SpringerLink, Emerald Insights and Wiley. This electronic database offers convenience and time-saving advantages for retrieving high-quality literature, as opposed to using single databases in turn.

The keywords used to retrieve literature are “supply chain” (OR “supply chain management”) AND “blockchain” (OR blockchain technology), which represent the two key themes of this SLR research. In total, 5917 articles were retrieved with these keywords. To ensure the inclusion of only high-quality and relevant articles, this study uses journals with a score of 3 or above on the AJG 2024 ranking. FinDIt@Bham includes hundreds of journals with varying qualities, and this ranking system helps to filter out journals with lower quality standards.

3.3. Stage 3 and stage 4: define the screening criteria and select relevant literature

In the third stage of the SLR, after the preliminary search, inclusion and exclusion criteria are set to extract highly relevant literature. In this study, four screening criteria are used, including language, period, document types, and source types. Specifically, only articles written in English, published between 2008 and 2023, and peer-reviewed journal articles published in AJG 2024 journals with a score of 3 or above are qualified. A total of 178 qualified articles were retrieved after these screening conditions.

In the fourth stage, abstract and full-text examination, the remaining 178 qualified articles were individually assessed for their relevance. The authors browsed the title and abstract, and if necessary, the full text of the articles to ensure that they align with the research questions and objectives. We eliminated papers, such as meta-ethnography, systematic literature review articles, and articles that referred only to either SCM or blockchain. Additionally, we removed articles irrelevant to SCM, such as the Radio Frequency Identification (RFID) application or the application of blockchain in cryptocurrencies. These procedures reduced the number of articles to 149. Finally, we read full articles that could not be determined by the abstract and the title to determine their relevance. Ultimately, a total of 133 articles were selected for extraction and analysis.

3.4. Stage 5 and stage 6: data analysis, synthesis, and reporting

According to Tranfield et al. (2003), this stage involves carrying out a comprehensive and unbiased analysis of identified articles based on research questions and objectives. This stage aims to achieve a cumulative understanding of what is known about the subject through applying analytic techniques which include Meta-analysis or Meta-ethnography (Bryman and Bell, 2011). Meta-analysis synthesizes the findings of multiple quantitative studies and uses various analytical tests to show whether a particular variable has an effect or not (Tranfield et al., 2003). Therefore, a meta-analysis involves pooling the results from various studies to estimate an overall effect by correcting sampling and non-sampling errors that may arise about a particular study (Tranfield et al., 2003). On the other hand, meta-ethnography involves a series of phases as the synthesis progresses and aims to achieve an interpretative synthesis of secondary sources, providing a counterpart to a meta-analysis in quantitative research (Tranfield et al., 2003; Bryman and Bell, 2011). This SLR takes the meta-ethnography approach, where all the articles were read fully and in great detail. Then, the authors put together the various studies by determining the relationships between them regarding the research methods, industries studied, and findings reported by them. After that, the meanings of the studies were interpreted with each other, compared and contrasted, and grouped into different types.

In the final stage, the findings were written and presented to answer the research questions. Following the suggestion of Rowley and Slack (2004), this involves reporting in a way that provides a descriptive map of the findings on the subject. Another important criterion for reporting is readability and accessibility (Bryman and Bell, 2011). This systematic literature review uses an Excel spreadsheet to summarize the selected articles (n = 133). The findings were presented in Microsoft tables as well as line and column charts, which were accessible and understandable to the intended audience.

4. Descriptive analysis of current research on blockchain-enabled SCM

This section presents a descriptive analysis providing an overview of the selected articles. The characteristics analyzed include the year of publication, the journals in which the articles were published, the industry of focus, the research methods used, and the application of theories.

4.1. Year range analysis

Fig. 2 illustrates the distribution of the publication year of the selected articles. The BCT was initially introduced in 2008 and was focused on cryptocurrencies such as Bitcoin. From 2008 to 2018, BCTs moved from their original financial applications to other areas. The discussion of their application in the field of smart contracts in various sectors, including SCM, was first brought up at "The 2018 International Conference on Blockchain." Since then, there has been increasing attention from both academic and business spheres on the application of blockchain technologies in SCM. As shown in Fig. 2, no relevant articles were published before 2017. With the number of articles published increasing steadily from 2017 to 2023, it indicates that blockchain-related studies have become a significant growing research area. Many other SLR papers (e.g., Ying et al., 2022; Asokan et al., 2022) have reported similar trends, arguing that the rapid and explosive growth of blockchain-SCM research began in 2017 and continues to this day.

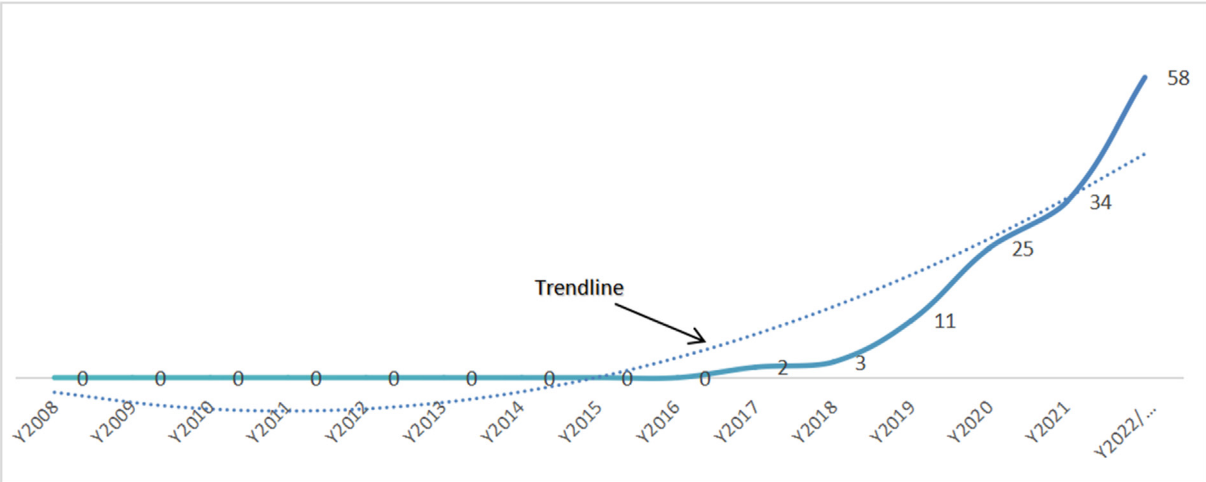

Fig. 2. Year of publication for the period of 2008–2023.

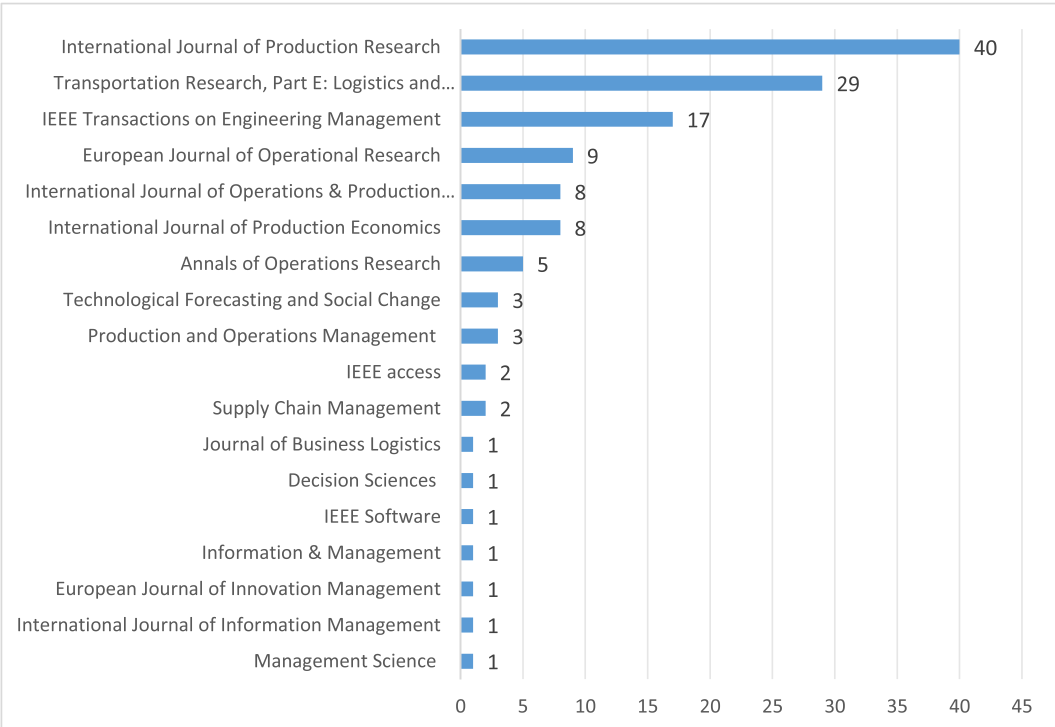

Fig. 3. Number of articles published in each journal 2008–2023.

4.2. Journal analysis

Fig. 3 illustrates the distribution of the selected articles across different journals, revealing an interesting trend. The analysis reveals that three journals, including the International Journal of Production Research, Transportation Research Part E: Logistics and Transportation Review, and IEEE Transactions on Engineering Management, are the most popular journals for publications related to blockchain-SCM, accounting for 71.6 % of the total sample with 40, 29, and 17 articles, respectively. However, it is concerning to note that the data also shows that some highly-regarded journals, specifically 7 out of the 15 journals with a score of 3 or above on the AJG 2024 ranking, only provided one article. Additionally, five journals provided less than 10 articles. This suggests that there may be a lack of maturity in the field and a need for more research to be published in highly-regarded journals to improve the credibility and quality of research in the area of blockchain-SCM.

4.3. Research methods analysis

The research sample employed mixed quantitative and qualitative methods, with modeling being the most commonly used. Qualitative methods, particularly descriptive analysis based on specific cases, have been used to identify and predict the new opportunities that BCTs bring to SCM. Experimental methods, along with numerical calculations, have been utilized to simulate the costs, frequency, and intensity of blockchain-based transactions, which offer insights for managers into the design of blockchain-enabled supply chain transactions. Additionally, several studies (e.g., Baharmand et al., 2021; Chaudhuri et al., 2021; Pattanayak et al., 2023) have employed semi-structured interviews with industry experts to gather information on the research topic, including investment experiences and perspectives, and to develop a better understanding of the research area.

Prior systematic literature review studies (e.g., Ghadafi*et al.*, 2021) have reported that quantitative methods have been underutilized in research on BCT and SCM, given the relative novelty of blockchain and its application in the field. However, the current study found that regression analysis based on secondary data was the least frequently used method. Instead, modeling has been frequently employed to predict supply chain systems with and without blockchain for theory building. For example, Cao and Shen (2022) developed a model to examine the impacts of BCT on less sustainable products' entry to cross-border supply chains, as well as the moderating effects of tariffs and subsidy schemes. The study found that BCT reduced the less sustainable products' entry (LSPE) in cross-border supply chains, and both subsidies and tariffs could enhance the value of BCT adoption to prevent LSPE. Bai and Sarkis (2020) proposed an eight-step blockchain performance measurement model that incorporates various sustainable attributes for evaluating and selecting BCT. Additionally, some studies (e.g., Chu et al., 2022; Dolgui et al., 2020; Guggenberger et al., 2020) focused on technical issues related to blockchains, such as system design, algorithm analysis, and simulation. These model testing studies provide managerial insights for practitioners and offer guidance to policymakers to make informed decisions.

Several studies have utilized mixed or integrated approaches in assessing blockchain adoption in SCM. Qualitative methods are often used to propose a conceptual model, while quantitative methods are employed to test the model. Nonetheless, the existing literature appears to suffer from an insufficiency of comprehensive models or theories that can be used to assess blockchain adoption. As a result, researchers have had to develop comprehensive models by reviewing existing literature and testing their relationships and impacts. For instance, Cai et al. (2021) used qualitative research methods to identify 20 enablers of blockchain adoption and applied the DEMATEL method to test and extract the interdependencies among these enablers and their impacts. The study demonstrated a significant causal relationship between the function of blockchain technology in mitigating transaction costs, consumer interests in tracing data, and the adoption of blockchain technologies in SCM. The use of multiple methods complements each other, providing a clearer illustration and a better understanding of the phenomenon and analyzing the problem from multiple perspectives. These studies are critical in addressing the technical barriers to the application of BCT to SCM. Table 2 below summarizes the methods used by the sample, and a detailed discussion can be found in Table 8.

4.4. Use of theories analysis

Table 3 summarizes only 54 out of 133 articles in the sample designed their research based on one or more theories. This result suggests that the use of theoretical approaches in this field is not yet widespread. This can be understandable given that BCTs are disrupting supply chain practices, and traditional theories may no longer be suitable or relevant.

Among the theories used, the Game Theory was the most commonly applied, followed by the Resource-Based View (RBV) of the organization theory, the Transaction Cost Theory (TCT), the Dynamic Capabilities Theory (DCT), the Agency Theory (AT), and the Technology Acceptance Model (TAM). The classic game theory assumes that the game participants are completely rational and seek to maximize their profits. This makes the game theory a useful lens for studying blockchain-based supply chain research, especially for coordinating the distribution of interests among the supply chain members to ensure that all parties benefit from each other (Zhu et al., 2022a,b).

The RBV suggests that firms can gain or reinforce competitiveness by acquiring rare and valuable resources that are difficult to be accessed or imitate by rivals (Zhu et al., 2022a,b). These resources can be tangible, such as labour and technological assets, or intangible, such as information, brand reputation, and knowledge. From the resource-based theory, it is believed that technological implementation can increase operational efficiency and help firms compete more effectively against rivals (Chan et al., 2020).

The TCT is also useful in examining the cost of technological implementation and the economic gains brought by the new technology. Ideally, blockchain can reduce transaction costs through automation, accurate demand forecasting, and the elimination of intermediaries (Choi, 2019; Cole et al., 2019). By reducing transaction costs, BCT can potentially provide a more efficient and

Table 2
OM and OR methods 2008–2023.

Research methods		No.	Articles
Operations Management	Survey	12	Agi and Jha (2022); Benzidia et al. (2021); Kamble et al. (2021); Kamble et al. (2019); Kucukaltan et al. (2022); Li et al., 2022b; Queiroz et al. (2021); Wong et al. (2020); Wong et al. (2021); Xu et al. (2022); Yang (2019); ManMohan et al. (2023)
	Survey, structural equation modeling	3	Chowdhury et al. (2022); Dubey et al. (2020); De Giovanni (2022)
	Theoretical analysis	3	Du et al. (2020); Mangla et al. (2021); Treiblmaier (2018)
	Literature review	14	Asante et al. (2021); Choi et al. (2019); Cole et al. (2019); Dutta et al. (2022); Hastig and ManMohan (2020); Kouhizadeh et al. (2021); Ramzan et al. (2022); Sahoo et al. (2022); Saberi et al. (2019); Shi et al. (2021); Wang et al. (2022b); Yousefi and Tosarkani (2023); Zhu et al., 2022a,b; Perboli et al. (2018)
	Literature review, correlation test	2	Alzahrani et al. (2022); Nguyen et al. (2022)
	Case study	15	Ali et al. (2021); Ahmed et al. (2022); Cao et al. (2022); Chan et al. (2020); Centorriono et al. (2022); Centobelli et al. (2022); Chaudhuri et al. (2021); Danese et al. (2021); Menon. and Jain (2021); Orji et al. (2020); Rodríguez-Espíndola et al. (2020); Roeck et al. (2020); Lu and Xu (2017); Song et al. (2023); Ahmed and MacCarthy (2023); Gligor et al. (2023); Song et al. (2023)
	Literature review, case study	1	Choi et al. (2020)
	General descriptive analysis	4	Chang et al. (2019); Liu et al., 2021; Quayson et al. (2021); Zhu et al., 2022a,b
	Focus group, survey	2	van Hoek (2019); Wang et al., 2021
	Design science approach	1	Guggenberger et al. (2020)
	Semi-structured interviews	5	Baharmand et al. (2021); Karamchandani et al. (2021); Pattanayak et al. (2023); Tiwari et al. (2023); Wang et al. (2019)
	Interview, interrelationships test	2	Sharma et al. (2022); Balci and Ebru (2021)
Total		64	
Operations Research	Modeling	64	Agrawal et al. (2022); Abdul. and Samir (2020); Arunmozhi et al. (2022); Büyüközkan et al. (2021); Biswas et al. (2023); Bai and Sarkis (2020); Cao and Shen (2022); Chu et al. (2022); Choi (2019); Choi et al., 2020; Choi et al., 2020a,b,c; Cai et al. (2021); Chod et al. (2020); Choi (2020); Dolgui et al. (2020); Dong et al. (2021); Dong et al. (2023); Epiphaniou et al. (2020); Fan et al. (2022); Govindan et al. (2022); Guo et al., 2020; Ji et al. (2022); Kamble et al. (2020); Kanakaris et al. (2021); Liu et al. (2021); Li. (2020); Li et al. (2021); Li et al. (2022a); Liu et al. (2022); Martins et al. (2022); Martinez et al. (2019); Mathivathanan et al. (2021); Manupati et al. (2020); Niu et al. (2022); Niu et al. (2021); Shen et al. (2020); Shen et al. (2021); Tao et al. (2022); Ullah et al. (2022); Wang et al. (2023); Wu et al. (2021); Wu and Yu, 2022; Wang et al. (2022a); Xu et al. (2021); Xu and He (2021); Xu and Choi (2021); Yang et al., 2022; Yu et al. (2022); Yang et al., 2022; Yoon et al. (2020); Yu et al. (2021); Ye et al. (2022); Yang et al., 2022; Zeng et al. (2022); Zhang an Liu (2022); Zhang et al. (2022); Zhang et al., 2023; Zhong et al. (2021); Toyoda et al. (2017); Xu et al. (2023a); Xu et al. (2023b); Joe et al. (2023); Shen et al. (2023)
	Computation experiments	4	Choi and Luo (2019); Rahmanzadeh et al. (2020) Wang et al., 2021; Wang et al., 2023
	Regression analysis	1	Xiong et al. (2021)
Total		69	

cost-effective means of conducting supply chain transactions.

In summary, while not all studies in the sample explicitly utilized a theoretical lens, those that did often drew upon theories such as game theory, resource-based view, and transaction cost theory to gain a clear view of the impact of BCT on SCM.

4.5. Industry of focus analysis

The analysis of industry focus was conducted manually by thoroughly reading the titles, abstracts, and full texts of the articles to determine the industries addressed. Table 4 displays that out of 133 articles, 60 approached the issue in a specific industry. The industries such as agriculture and food, physical distribution and logistics, and retailing (including international trade and e-commerce) were the most extensively studied, while industries such as rental services, wine, music, customer service, or pharmaceuticals received the least attention in the sample.

The pertinence of the agriculture and food sector may be ascribed to the amplified emphasis on food safety by society, primarily prompted by fraudulent practices and alarming incidents related to food safety, as well as the implementation of advanced new technologies in food supply chains (Menon and Jain, 2021). Furthermore, these industries face inauthenticity and inaccuracy issues due to difficulties in controlling the entire supply chain (Ali et al., 2021). Additionally, concerns have been raised that farmers, particularly those in marginal and submarginal households, are among the most vulnerable and disadvantaged groups in society. Addressing their welfare is critical to reducing poverty and inequality (Quayson et al., 2021).

The logistics industry also received significant attention due to the huge losses in social resources caused by insufficient practices in this industry (Chang and Chen, 2020). Blockchain technologies have the potential to address these issues due to their characteristics, such as decentralization, smart contracts, immutability, anonymity, and visibility (Zhang and Liu, 2022). By restructuring conventional ways of managing product traceability, promoting trust and credibility, and boosting demand, blockchain technologies could potentially

Table 3
Use of theories 2008–2023.

Use of theories	No.	Articles
Game Theory	8	Biswas et al. (2023); Ji et al. (2022); Shen et al. (2021); Tao et al. (2022); Wang et al. (2023); Wu and Yu (2022); Zhang and Liu (2022); Zhang et al. (2022)
The Resource-Based View (RBV) Theory	6	Chan et al. (2020); Karamchandani et al. (2021); Li et al., 2020b; Martinez et al. (2019); van Hoek (2019); Treiblmaier (2018)
Transaction Cost Theory	6	Choi (2019); Cole et al. (2019); Roeck et al. (2020); Saberi et al. (2019); van Hoek (2019); Treiblmaier (2018)
Dynamic Capabilities Theory	4	Ali et al. (2021); Kamble et al. (2021); Li et al., 2020b; Pattanayak et al. (2023)
Agency Theory	4	Cole et al. (2019); Chaudhuri et al. (2021); De Giovanni (2022); Treiblmaier (2018)
The Technology Adoption Model	3	Agi and Jha (2022); Kamble et al. (2019); Yang (2019)
Organizational Information Processing Theory	2	Dubey et al. (2020); Martinez et al. (2019)
Diffusion of Innovation Theory	2	Agi and Jha (2022); Karamchandani et al. (2021)
Hesitant Fuzzy Set and Regret Theory	2	Bai and Sarkis (2020); Rahmanzadeh et al. (2020)
Signaling Theory	2	Chan et al. (2020); Xu et al. (2022)
Mean-Risk Theory	2	Choi et al. (2020); Choi (2020)
Contingency Theory	2	Ahmed et al. (2022); Xiong et al. (2021)
Institutional Theory	1	Chan et al. (2020)
Force Field Theory	1	Kouhizadeh et al. (2021)
Value Co-Creation (VCC) Theory	1	Centorriono et al. (2022)
Supply Chain Ambidexterity Theory	1	Agrawal et al. (2022)
Stakeholder Theory	1	Balci and Ebru (2021)
Mean-Variance (MV) Theory	1	Choi et al. (2019)
Theory of Planned Behaviour (TPB)	1	Kamble et al. (2019)
The Triple Bottom Line Theory	1	Wang et al. (2022b)
Supply Chain Ambidexterity Theory	1	Benzidia et al. (2021)
Innovation Resistance Theory (IRT)	1	Wong et al. (2021)
Network Theory	1	Treiblmaier (2018)
Affordance theory	1	ManMohan et al. (2023)
The expectancy theory	1	Song et al. (2023)
Sensemaking Theory	1	Wang et al., 2019

Table 4
Summary on industry of focus 2008–2023.

Industry of focus	No.	Articles
Agricultural and foods	12	Ali et al. (2021); Cao et al. (2022); Kamble et al. (2020); Kanakaris et al. (2021); Liu et al. (2022); Mangla et al. (2021); Menon and Jain (2021); Quayson et al. (2021); Sharma et al. (2022); Wu et al. (2021); Ye et al. (2022); Perboli et al. (2018)
Physical distribution and logistics	10	Choi et al. (2019); Chang et al. (2019); Guggenberger et al. (2020); Orji et al. (2020); Tiwari et al. (2023); Tao et al. (2022); Yang et al., 2022; Zhang and Liu (2022); Zhang et al., 2023; Zhong et al. (2021)
Retailing/international trade/e-commerce	8	Cao and Shen (2022); Chu et al. (2022); Li et al. (2021); Shen et al. (2020); Xu and He (2021); Xu and Choi (2021); Yoon et al. (2020); Zhang et al. (2022)
Fashion/luxury industry	5	Choi and Luo (2019); Choi (2019); Chan et al. (2020); Choi (2020); Guo et al., 2020
Finance	5	Du et al. (2020); Kucukaltan et al. (2022); Liu et al. (2021); Yang et al., (2022); Song et al., 2023
Maritime	4	Balci and Ebru (2021); Liu et al. (2021); Nguyen et al. (2022); Yang (2019)
Manufacturing	4	Ji et al. (2022); Karamchandani et al. (2021); Wang et al., 2021; Yang et al., 2022
Healthcare	3	Alzahrani et al. (2022); Govindan et al. (2022); Ramzan et al. (2022)
Consumer goods/personal care	2	Shen et al. (2021); Wang et al. (2022b)
Automotive	2	Arunmozhi et al. (2022); Kamble et al. (2020)
Rental service industry	1	Choi et al. (2020)
Wine	1	Danese et al. (2021)
Music	1	Centorriono et al. (2022)
Customer service industry	1	Ullah et al. (2022)
Pharmaceuticals	1	Hastig and ManMohan (2020).

revolutionize the logistics industry.

After conducting an analysis, it was found that the agriculture and food, physical distribution and logistics, and retailing industries have been extensively studied in the literature. These industries encounter various challenges that can potentially be addressed by blockchain technologies. Therefore, there is potential for blockchain to revolutionize SCM practices not only in these industries but also in others.

4.6. An overview of research area

Among existing research discussing the application of blockchain in supply chain management, some are purely theoretical analysis while others step forward to discuss the specific practical application of blokchain technologies in the field of supply chain management

Table 5
An overview of research area.

Areas	Articles	No. (%)
Theoretical	Agi and Jha (2022); ManMohan et al. (2023); Joe et al. (2023); Xu et al. (2023a); Xu et al. (2023b); Wang et al. (2023); Agrawal et al., 2022; Abdul and Samir (2020); Ahmed et al. (2022); Alzahrani et al., 2022; Asante et al., 2021; Arunmozhi et al., 2022; Benzidia et al., 2021; Büyüközkan et al. (2021); Biswas et al. (2023); Bai and Sarkis (2020); Baharmand et al., 2021; Balci and Ebru (2021); Choi and Luo (2019); Cao and Shen (2022); Choi et al., 2019; Choi et al., 2020; Cole et al., 2019; Chang et al. (2019); Chaudhuri et al. (2021); Chod et al., 2020; Choi (2020); Dutta et al., 2022; Centorriono et al., 2022; Cai et al. (2021); Dolgui et al., 2020; Fan et al., 2022; Govindan et al., 2022; Guo et al., 2020; Li et al. (2020); Liu et al., 2022b; De Giovanni (2022); Du et al. (2020); Guggenberger et al. (2020); Hastig and ManMohan (2020); Kouhizadeh et al., 2021; Kamble et al. (2019); Kucukaltan et al., 2022; Liu et al. (2021); Li et al. (2021); Martins et al., 2022; Martinez et al., 2019; Mathivathanan et al., 2021; Manupati et al., 2020; Niu et al. (2022); Niu et al. (2021); Orji et al., 2020; Quayson et al., 2021; Queiroz et al., 2021; Rahmanzadeh et al. (2020); Ramzan et al., 2022; Sahoo et al., 2022; Sharma et al., 2022; Shen et al., 2020; Saberi et al., 2019; Shen et al. (2021); Shi et al., 2021; Tao et al., 2022; Ullah et al., 2022; van Hoek (2019); Wang et al. (2023); Wu et al., 2021; Wu and Yu (2022); Wang et al. (2022a); Wang et al. (2022b); Wong et al. (2020); Wang et al., 2021; Wang et al. (2019); Wong et al. (2021); Xu et al. (2021); Xiong et al. (2021); Xu et al. (2022); Xu and He (2021); Xu and Choi (2021); Yang et al., 2022; Yu et al., 2022; Yang et al., 2022; Yoon et al., 2020; Yu et al., 2021; Yousefi and Tosarkani (2023); Ye et al. (2022); L. Yang et al., 2022; Zeng et al., 2022; Zhang and Liu (2022); Zhu et al. (2022); Zhang et al. (2022); Zhu et al., 2022; Zhang et al., 2023; Zhong et al., 2021; Toyoda et al. (2017); Lu and Xu (2017); Treiblmaier (2018); Perboli et al., 2018	98 (73.7 %)
Application	Song et al. (2023); Ali et al. (2021); Choi et al., 2020; Centobelli et al., 2022; Chowdhury et al., 2022; Danese et al. (2021); Kamble et al., 2021; Kanakaris et al., 2021; Karamchandani et al., 2021; Mangla et al., 2021; Menon & Jain (2021); Rodríguez-Espíndola, et al., 2020; Tiwari et al., 2023; Yang (2019);	14 (10.5 %)
Efficiency evaluation	Gligor, et al., 2023; Shen et al. (2023); Cao et al. (2022); Chu et al. (2022); Choi, 2019; Chan et al. (2020); Choi et al., 2020; Dubey et al., 2020; Dong et al. (2021); Dong et al. (2023); Epiphaniou et al. (2020); Ji et al. (2022); Kamble et al., 2020; Liu et al., 2021; Li et al. (2021a); Liu et al. (2022); Roeck et al. (2020); Wang et al. (2021);	18 (13.5 %)
Optimization	Ahmed & MacCarth, 2023; Nguyen et al., 2022; Pattanayak et al., 2023;	3 (2.3 %)

as well as their performance. Table 5 below summarizes the research area that each article belongs to. The statistical result shows that the majority of current research (98 out of 133) have been directed towards investigating BCT as a potential solution, and there is a lack of thorough analysis of practical application, implementation, and performance evaluation of the new technology. This result further confirmed the research gap identified in some earlier studies (i.e. Ahmed and MacCarthy, 2023; Xu et al., 2023b).

5. A framework of integrating BCT into SCM

Beyond the descriptive analysis results, we summarized the detailed in-depth content analysis in Fig. 4. Along with the fast development of technology, we have found that the current literature focus has transformed largely from its adoption to its application in real-life supply chain operations. This witness is underpinned by the theories of the Technology Acceptance Model and Diffusion of Innovation Theory. Transitioning from the blockchain-enabled supply chain adoption to the application phase, these two theories provide organizations with a comprehensive understanding of the adoption and use of BCT in SCM. This understanding can help organizations develop effective strategies to promote its adoption and ensure its successful implementation within the supply chain ecosystem.

The Technology Acceptance Model (TAM) is the most relevant theory that underpins the adoption of BCT in SCM (Kshetri, 2018). Developed by Davis et al. (1989), TAM is a widely-used theory that explains the factors influencing users' acceptance and use of new technologies, including blockchain. In the context of SCM, TAM helps organizations understand the key factors that influence users' acceptance and use of BCT, such as perceived usefulness, ease of use, social influence, and trust. Moreover, the Diffusion of Innovation Theory (DOI), developed by Rogers (2003), can provide useful insights into the adoption of BCT in SCM. This theory helps organizations understand the process of how new technologies, like blockchain, are adopted and diffused among supply chain stakeholders. It explains the factors that influence the adoption of new technology, such as the perceived advantages of using blockchain in SCM, the ease of use and complexity of the technology, and the role of social networks and opinion leaders in promoting its adoption.

5.1. Drivers

The adoption of BCT in the realm of SCM has been the focus of significant research efforts, with numerous studies exploring the drivers and barriers to its adoption. Table 6 provides a summary of the main drivers and enablers identified in the literature review. These factors have been grouped into internal and external drivers, with the most commonly mentioned motivations being an increased need for transparency, traceability, accountability, and security, as well as a growing demand for coordination and collaboration, customer pressure, leadership commitment, and cost control. (Baharmand et al., 2021; van Hoek, 2019; Biswas et al., 2023; Bai and Sarkis, 2020; Choi et al., 2019; Cao et al., 2022; Cole et al., 2019; Liu et al., 2021; Nguyen et al., 2022). In essence, the integration of BCT into SCM is primarily influenced by customer and market factors, indicating the centrality of these elements in the decision-making process. These findings are consistent with several systematic literature reviews that have summarized the drivers for blockchain implementation in SCM (e.g., Hanelt et al., 2020).

External drivers of blockchain adoption in the supply chain include competitive pressure to demonstrate competencies to customers, investors, or stakeholders (Orji et al., 2020). In the global market, companies are constantly seeking ways to improve their competitive

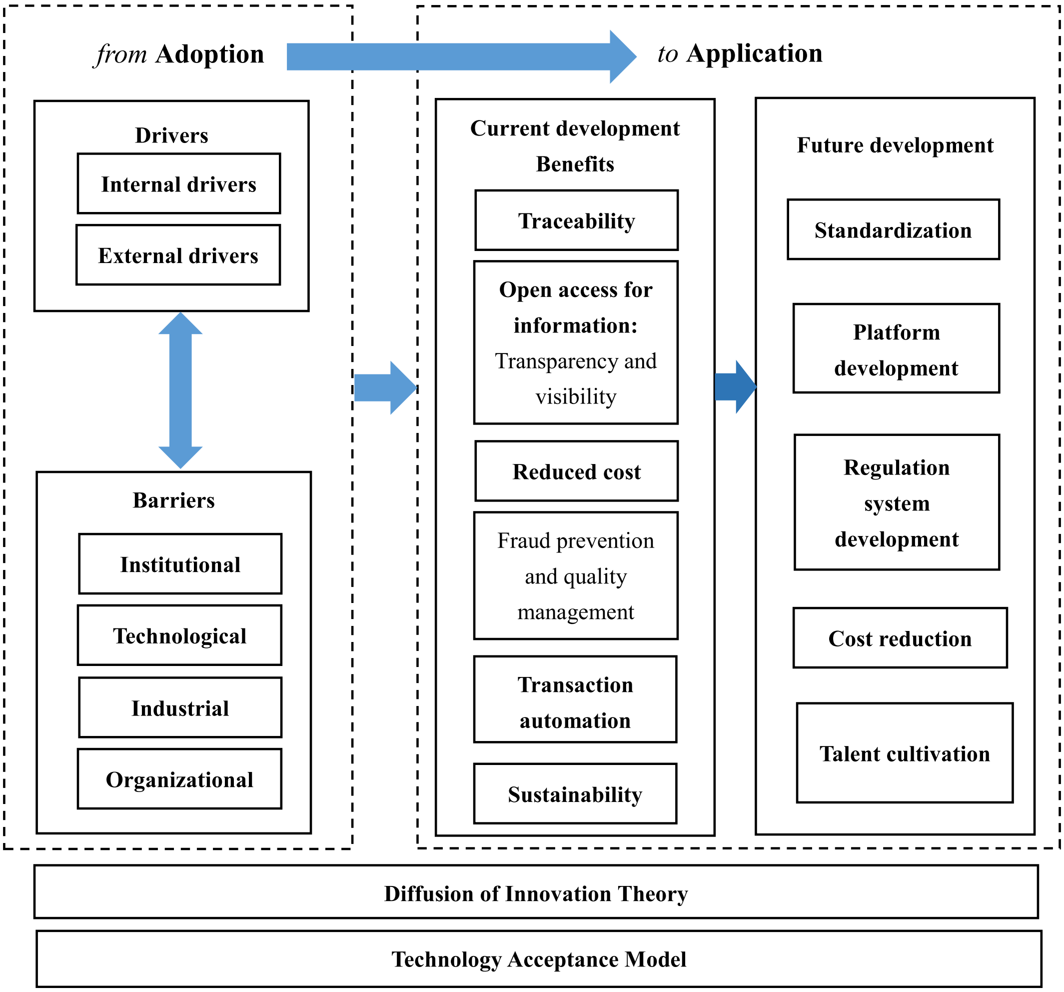

Fig. 4. A framework for the adoption and application of blockchain in SCM.

advantage, leading them to explore the promising benefits of blockchain for improving supply chain performance, such as reduced settlement lead time and transaction costs, automated transactions, secured databases, and traceability of resources. Top management commitment has been identified as a significant driver of emerging technology implementation, such as blockchain, due to the heavy capital and labour investment required (van Hoek, 2019; Kamble et al., 2020). While top management determines the adoption of blockchain, middle management is critical for its implementation. However, it is worth noting that much of the current research on this topic remains conceptual, and the benefits of BCT for SCM require further evidence from real-world projects.

The growing focus on sustainability is driving the adoption of blockchain in SCM. SCM practices are increasingly expected to be sustainable and meet specific criteria. The triple-bottom-line theory emphasizes the importance of balancing the social, environmental, and economic dimensions when managing the supply chain. From a sustainability perspective, blockchain's unique characteristics, such as traceability and information transparency, can help reduce the entry of less sustainable products into supply chains and minimize pollutant emissions (Manupati et al., 2020; Cao and Shen, 2022). Therefore, an important application of blockchain is to track the potential environmental and social impacts of supply chain activities that may cause safety, health, and pollution problems (Saberi et al., 2019). By leveraging blockchain's ability to provide a secure and transparent record of supply chain activities, it is possible to identify and address potential issues before they become significant problems. In summary, adopting and applying blockchain in SCM is driven by the need for sustainability considerations and the importance of balancing the social, environmental, and economic dimensions. Blockchain's unique features, such as traceability and transparency, can help reduce the entry of less sustainable products into supply chains and minimize pollutant emissions, making it a valuable tool for achieving sustainable SCM.

5.2. Barriers to applying blockchain in supply chains

Although blockchain holds immense potential to refine businesses and revolutionize logistics, researchers (e.g., Kamble et al., 2020; Saberi et al., 2019; van Hoek, 2019) have highlighted barriers and obstacles that hinder the application of this new technology in SCM.

Table 6
Drivers of blockchain adoption in supply chains 2008–2023.

Drivers	Articles
Internal drivers:	
1. The need for asset management and tracking	Agi and Jha (2022); Ali et al. (2021); Arunmozhi et al. (2022); Büyüközkan et al. (2021); Biswas et al. (2023); Ji et al. (2022); Kamble et al. (2020); Kanakaris et al. (2021); Liu et al. (2022); Liu et al., 2022b; Mangla et al.,2021; Martinez et al. (2019); Quayson et al. (2021); van Hoek (2019); Zeng et al. (2022), Zhang et al. (2022)
2. The need to improve quality control	Cao et al. (2022); Chu et al. (2022); Choi (2019); Cai et al. (2021); Dong et al. (2023); Fan et al. (2022); Niu et al. (2021); Shen et al. (2021); van Hoek (2019); Wang et al. (2023)
3. The need for demand forecast and inventory management	Chan et al. (2020); Dubey et al. (2020); Du et al. (2020); Menon and Jain (2021); Mathivathanan et al. (2021); Ullah et al. (2022); van Hoek (2019); Ye et al. (2022)
4. The need to increase automation	Chang et al. (2019); Liu et al. (2021); Mangla et al.,2021; Martins et al.,2022; van Hoek (2019); Wang et al., 2021; Wang et al. (2023)
5. The need to control and reduce cost	Abdul and Samir (2020); Asante et al. (2021); Centorriono et al. (2022); Dutta et al. (2022); Kucukaltan et al. (2022); Rodríguez-Espíndola et al. (2020); Wang et al. (2019)
6 The need to improve operational efficiency, including shopping and receiving	Centobelli et al. (2022); Mathivathanan et al. (2021); Rahmanzadeh et al. (2020); van Hoek (2019); Zhu et al., 2022a,b; van Hoek (2019); Xiong et al. (2021)
7. Security requirements	78, 81, van Hoek (2019);, 105
8. Leadership commitment	Kamble et al. (2020); Saberi et al. (2019)
External drivers:	
1. Sustainability concerns	Ali et al. (2021); Biswas et al. (2023); Bai and Sarkis (2020); Choi and Luo (2019); Cao and Shen (2022); Chaudhuri et al. (2021); Guo et al. (2020); Kouhizadeh et al. (2021); Kamble et al. (2021); Li et al. (2020); Li et al. (2022a); Manupati et al. (2020); Quayson et al. (2021); Saberi et al. (2019), Wang et al. (2022b); Yousefi and Tosarkani, 2023; Zeng et al. (2022); Ahmed and MacCarthy (2023)
2. Information sharing needed among SC partners	Asante et al. (2021); Choi and Luo (2019); Chu et al. (2022); Chan et al. (2020); Dolgui et al. (2020); Dutta et al. (2022); van Hoek (2019); Ye et al. (2022); Zeng et al. (2022), Zhang et al. (2022); Zhang et al. (2023)
3. Cooperation and collaboration needed among SC partners	Chu et al. (2022); Choi et al. (2019); Hastig and ManMohan (2020); Niu et al. (2022); Rahmanzadeh et al. (2020); Wang et al. (2019); Zeng et al. (2022); Zhang and Liu (2022)
4. Technological progress	Agrawal et al. (2022); Alzahrani et al. (2022); Asante et al. (2021); Biswas et al. (2023); Dong et al. (2021); van Hoek (2019); Zhang and Liu (2022)
5. Pressure from customers to improve efficiency	van Hoek (2019); W. Yang et al., 2022; Zeng et al. (2022)
6. Competitive pressure	van Hoek (2019); Zeng et al. (2022); Zhang et al. (2023)
7. Pressure from customers for transparent information	van Hoek (2019); Zeng et al. (2022); Ahmed and MacCarthy (2023)

Despite the promising potential, blockchain is still in its nascent stages of evolution, particularly in the field of SCM. Fig. 5 below summarizes the main barriers that prevent organizations from applying blockchain in their management of supply chains. Based on the

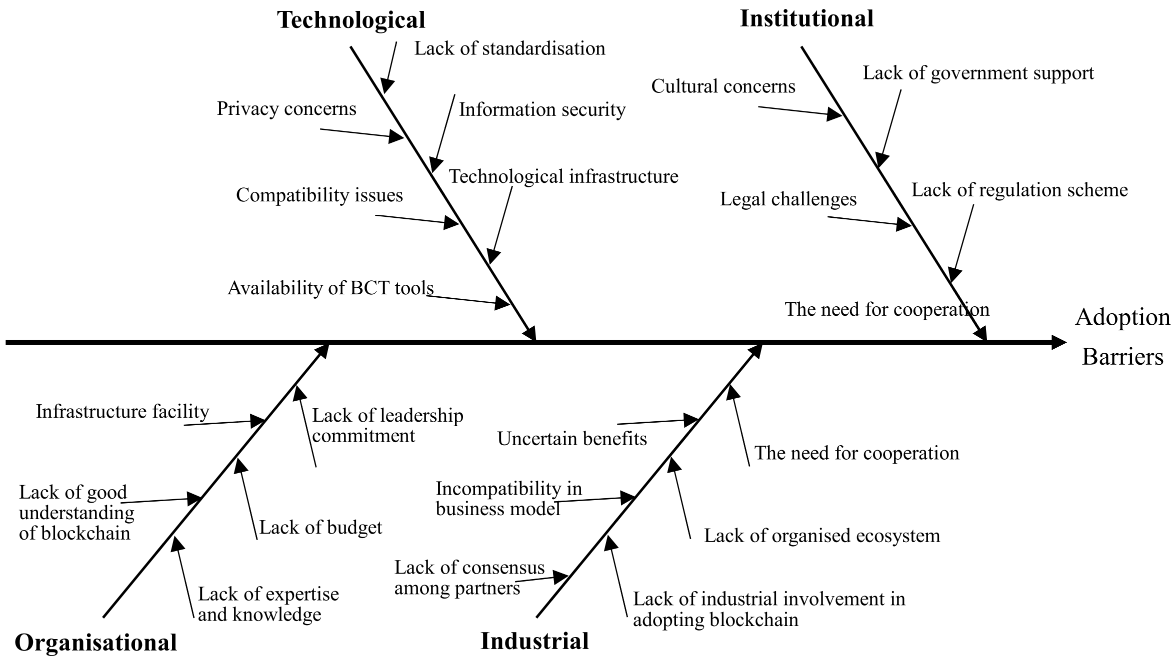

Fig. 5. Barriers to blockchain applications in supply chains.

collected literature sample, we classify these barriers into four main categories, namely institutional barriers, technological barriers, industrial barriers, and organizational barriers. For each category, key attributes are clearly defined.

Institutional barriers: Researchers have pointed out that there is a lack of a unified legal system and efficient regulatory scheme to supervise the application of this new technology. Additionally, there is a lack of government incentives or support to promote the application of BCT in business organizations (Orji et al., 2020). Therefore, researchers recommend that government policies should be enacted to support and protect firms during the adoption period of innovative technologies, and financial incentives should be provided to private firms to subsidize the high costs of blockchain investments. Furthermore, Quayson et al. (2021) have emphasized that the application of blockchain technologies is also influenced by socio-cultural factors. For instance, in the agricultural industry, smallholder farmers in emerging economies may not understand blockchain, and it could be more challenging for them to achieve sustainability objectives. The level of education, poverty, and age may also affect blockchain usage. These factors present specific socio-cultural dynamics of blockchain technologies in emerging countries compared to developed countries (Quayson et al., 2021). Currently, the cultural impacts of blockchain adoption have been under-researched, with only one article mentioning it.

Technological barriers: There were many criticisms of BCT in the sample, which was unexpected. As the application of blockchain is still in its nascent stages, there is still a lack of standardization regarding blockchain implementation in commercial organizations, and a lack of technological infrastructure to popularize the technology at a national scale (Baharmand et al., 2021). The sample frequently mentioned privacy concerns since blockchain is still immature in terms of data security (Baharmand et al., 2021; Chaudhuri et al., 2021; De Giovanni, 2022; Du et al., 2020; Liu et al., 2021; Liu et al., 2022; Mathivathanan et al., 2021; Wong et al., 2021; Zhang et al., 2022). Zhang et al. (2022) even found that consumers' privacy concerns had a direct impact on retailers' prices and profits when adopting BCT, as it reduced consumers' valuations of products and their intention to buy. Compatibility is also a significant concern. According to the DOI theory, compatibility which refers to the degree of an innovation's consistency with the organization's experiences and values, influence adoption intentions (Rogers, 2010). The technology is relatively new, making it difficult to integrate into organizations' current business systems (Baharmand et al., 2021). In addition, the immutability feature of the technology prevents data tampering, but it also allows for the possibility of incorrect data (Balci and Ebru, 2021). Furthermore, in a highly dynamic business context, smart contracts may be cumbersome because they cannot adapt and negotiate. Therefore, interdisciplinary or collaborative development is needed to make blockchain technologies fully compatible with supply chain practices and to ensure their long-term positive impacts.

Industrial barriers: “Engagement issues” are important (Baharmand et al., 2021). Supply chain collaboration is critical to the operation of blockchain-based supply chains, which involves defining problems, developing shared goals, making joint decisions, and assigning roles and responsibilities to execute supply chain operations (Baharmand et al., 2021). However, supply chain partners are often reluctant to provide timely feedback when implementing new technology, and consensus can be challenging to reach among all partners with different business models (Hastig and ManMohan, 2020; Nguyen et al., 2022). Additionally, incompatibility issues among partners can arise, and the uncertain benefits of blockchain technologies to SCM can discourage many practitioners (Mathivathanan et al., 2021; Alzahrani et al., 2022).

Organizational barriers: Orji et al. (2020) highlighted the barriers due to the lack of resources, such as a technological basis and human resources, to efficiently implement blockchain technologies. For example, Wang et al. (2021) identified some intra-organizational barriers, such as a lack of knowledge and expertise on blockchain and a lack of tools for blockchain implementation. As noted by the DOI theory, complexity of the innovation is also an adoption barrier (Saberi et al., 2019). Organizational readiness, which manifested as lack of technical expertise and lack of tools to address the complexity of blockchain, make it difficult for business organizations to

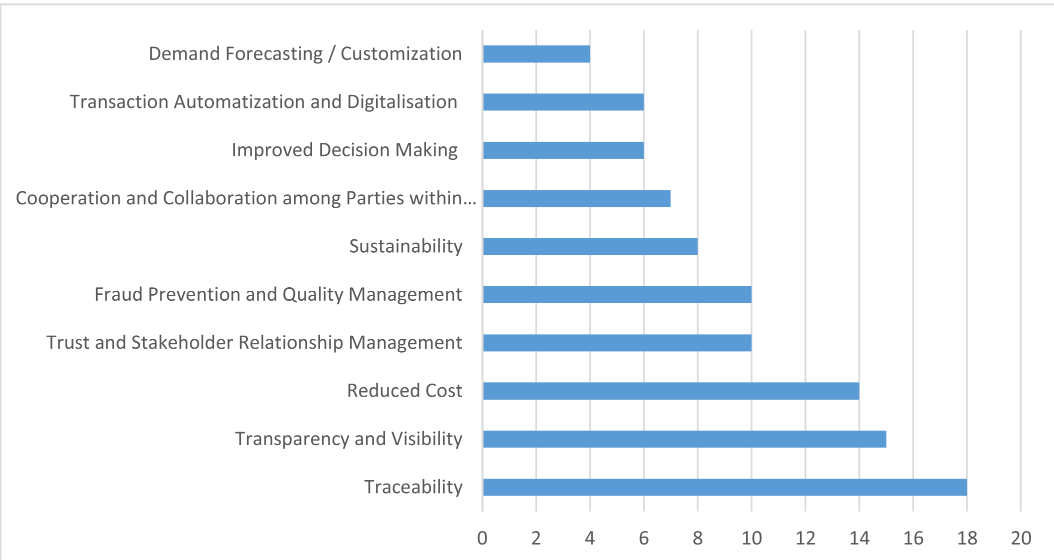

Fig. 6. Benefits brought by BCT to supply chains.

embrace the new technology. Moreover, Ali et al. (2021) noted that a limited understanding of BCT among managers in the food supply chain limited the application of BCT in practice. Similarly, Hastig and ManMohan (2020) mentioned that a lack of good understanding among top leaders and managers regarding the benefits of blockchain was a key barrier to blockchain adoption in private firms. Queiroz et al. (2021) also argued that leadership support is an essential enabler for blockchain adoption. Investing in blockchain can be challenging if leaders are less receptive to advanced technologies or hold a sceptical attitude about the benefits brought by new technologies. Additionally, the cost is a significant concern when making blockchain-related decisions, as the initial cost of blockchain implementation, including purchasing the technology, pilot and implementation costs, and training and technology maintenance costs, can be high and unaffordable for many companies (Zhang and Liu, 2022; Choi et al., 2020; Choi et al., 2020a,b,c; Chaudhuri et al., 2021; Dong et al., 2023). Cao et al. (2022)'s case study research shows that the operational costs of blockchain could outweigh the benefits created by the blockchain-enabled platform.

5.3. Benefits of applying BCT in SCM

Over the past five years, a plethora of experimental endeavours have been initiated in both pragmatic and scholarly domains to explore the implementation of BCT in SCM across various industries (Ying et al., 2022). This research paper aims to systematically summarize the benefits that BCT bring to SCM. As illustrated in Fig. 6, the top three benefits reported by the sample are "Traceability and Visibility," "Transparency," and "Reduced Cost," followed by "Trust and Stakeholder Relationship Management," "Fraud Prevention and Quality Management," and "Sustainability." A detailed explanation of each benefit is provided in Table 7.

It is worth noting that our research findings regarding the prioritized benefits are slightly different from those of previous systematic literature reviews. For instance, Chang and Chen (2020) identified and ranked "Traceability," "Stakeholder Involvement and Collaboration," and "Supply Chain Integration and Digitalization" as the three most important benefits reported by the sample, while "Cost" was among the least important.

In the global market, SCM plays a critical role in reducing operational costs for companies (Yadav and Singh, 2020). Manufacturers and retailers aim to supply products at the lowest possible cost, making cost control a key consideration in the field of SCM. Therefore, it is reasonable to see that "Reduced Cost" is one of the most considered benefits in our sample. Blockchain technologies are expected to reduce transaction costs and increase profits in the end. A comprehensive examination of each advantageous aspect will be expounded upon in the ensuing sections.

5.3.1. Traceability

Traceability is a critical feature of BCT that enables the precise tracking of inventory locations and the record of product custody (Agi and Jha, 2022). This aspect primarily addresses the what, when, and where questions regarding inventory transfers in supply chains. The distributed ledger and consensus mechanism of BCT allow suppliers, manufacturers, distributors, and other supply chain parties to record information (Choi, 2019). Blockchain comprises decentralized, open-source ledgers used for data recording. In blockchain-based supply chains, all involved parties must fulfil a smart contract condition before product exchange to validate the transaction, and the blockchain ledger is updated with transaction information (including nature, quantity, quality, location, and ownership information) when all parties have complied with their duties and processes (Pattanayak et al., 2023). As a result, customers can view the continuous chain of transactions from raw materials to the final sale and check the origin, certification, destination, date, and other relevant information within the blockchain-based system.

The traceability feature of BCT is extensively discussed in the supply chain field and is a hot topic in the selected articles. Traceability allows internal and external stakeholders to manage and respond to risks in a highly documented and responsive manner. For example, Kanakaris et al. (2021) mentioned that BCTs improve supply chain resilience by eliminating system and geographic boundaries and allowing the integration of heterogeneous traceability-related data across the entire supply chain. Ji et al. (2022) added that the introduction of BCT satisfies consumers' preferences for product traceability and authenticity. This benefit is particularly valuable in specific industries such as the agriculture and food industry (Ali et al., 2021; Cao et al., 2022; Kamble et al., 2020; Wu et al., 2021).

5.3.2. Open access for information: transparency and visibility

Transparency in the supply chain is crucial for all parties involved, including end-customers, as it ensures the accessibility and availability of relevant information (Bai and Sarkis, 2020). With the emergence of Industry 4.0, achieving transparency has become a technological challenge. However, by integrating blockchain with advanced sensing technologies and IoT, supply chain activities can be monitored in real-time, ensuring better transparency. Blockchain's distributed ledger also plays a significant role in achieving transparency in the supply chain. It creates a decentralized and immutable record of transaction information and digitizes physical assets, thereby increasing transparency. Additionally, smart contracts enable better real-time monitoring of product flow (Wu and Yu, 2022). In today's trustless business environment, BCT is highly valued for the benefits it offers.

Our literature review reveals that blockchain-based SCM studies have primarily focused on its potential to enhance transparency and visibility by providing accurate and open access to information. Choi et al. (2020a,b,c) noted that blockchain creates a publicly available, permanent data record that can be used for verification and checking. Improved transparency and visibility offer many benefits, including consistent information sharing, reduced information asymmetry among supply chain participants (Rodríguez-Espíndola et al., 2020; Liu et al., 2022b; Tao et al., 2022), and agile information exchange, which facilitates agile movement of goods and services (Karamchandani et al., 2021). Additionally, blockchain-based supply chain systems provide rich information, such as product origin and nutritional value, giving buyers more assurance that their products are sourced from qualified suppliers and made by ethical manufacturers, thus promoting corporate social responsibility (CSR) (Chan et al., 2020).

Table 7
Key benefits of BCT to SCM.

Key benefits	No.	Key Points	Articles
Traceability	19	● Blockchain is expected to ensure transparency and real-time information sharing (Ali et al., 2021) ● The introduction of blockchain technology satisfies consumers' preferences for product traceability and product authenticity (Ji et al., 2022) ● Blockchain improves the traceability of agricultural products (Kamble et al., 2020) ● BCT improves supply chain resilience by eliminating system and geographic boundaries and allowing the integration of heterogeneous traceability-related data across the entire supply chain (Kanakaris et al., 2021). ● Blockchain increases profits when consumers are more concerned about the safety of buying imported fresh food because the traceability of blockchain increases customer's perceived safety of imported fresh food (Liu et al., 2022) ● Blockchain can trace the delivery process for smallholder farmers (Pattanayak et al., 2023). ● BCT provides an immutable traceable digital record of transactions that supports information sharing in the globally dispersed supply networks which address the issue of data traceability (Ahmed and MacCarthy, 2023).	Agi and Jha (2022); Ali et al. (2021); Arunmozhi et al. (2022); Büyüközkan et al. (2021); Biswas et al. (2023); Ji et al. (2022); Kamble et al. (2020); Kanakaris et al. (2021); Liu et al. (2022); Liu et al., 2022b; Mangla et al. (2021); Martinez et al. (2019); Quayson et al. (2021); Wang et al., 2021; Wu et al. (2021); Xiong et al. (2021); Yang et al., 2022; Lu and Xu (2017); Ahmed and MacCarthy (2023)
Transparency and Visibility/ Accurate and Open Access for Information	16	● Blockchain can facilitate information dissemination more transparently (Choi et al., 2020a,b,c). ● The blockchain helps create a permanent data record which is publicly available and can be used for checking and verification (Choi et al., 2020a,b,c). ● The increased supply chain transparency and ethical behaviours (such as ethical sourcing) enabled by blockchain technologies can improve the level of CSR (Chan et al., 2020). ● Agile information availability on blockchain will facilitate agile information exchange and thereby agile movement of goods and services (Karamchandani et al., 2021). ● Consistent information among participants (Rodríguez-Espíndola, et al., 2020) ● Blockchain reduces information asymmetry between suppliers and customers (Liu et al., 2022b; Tao et al., 2022) ● End-to-end visibility (Liu et al., 2022b; Martinez et al., 2019) ● Blockchain attributes help solve information asymmetry problems and enhance financing performance through supporting transparency, traceability and verification of transmissions (Song et al., 2023)	Bai and Sarkis (2020); Chan et al. (2020); Dubey et al. (2020); Karamchandani et al. (2021); Li et al.,2020; Liu et al. (2021); Li et al., 2020b; Mangla et al. (2021); Quayson et al. (2021); Rodríguez-Espíndola et al. (2020); Sharma et al. (2022); Tao et al. (2022); Wang et al. (2019); Yu et al. (2022); Zhu et al., 2022a,b; Song et al. (2023)
Reduced Cost	14	● A significant causal relationship between the role of blockchain to reduce transaction costs, consumer interests in tracing data and the adoption of BCTs in SCM has been found (Agi and Jha, 2022) ● The use of smart contracts reduces computational costs and transaction costs (Abdul and Samir, 2020) ● BCTs and AI provide reliable predictive analytics results from the mainstream machine learning algorithms which help to control cost and energy consumption (Arunmozhi et al., 2022)	Agi and Jha (2022); Abdul and Samir (2020); Büyüközkan et al. (2021); Choi (2019); Dubey et al. (2020); Dong et al. (2021); Rodríguez-Espíndola et al. (2020); Rahmanzadeh et al. (2020); Saberi et al. (2019); Wang et al. (2023); Wu and Yu (2022); Yu et al. (2022); Zeng et al., 2022; Zhang and Liu (2022)

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Key benefits	No.	Key Points	Articles
		● Blockchain reduces the diamond authentication and certification (BDAC) cost (Choi, 2019) ● Systems with blockchain technology reduce the wholesale price, retail price, and discount of funds (Dong et al., 2021) ● Blockchain chain contributes to efficient budget control (Rodríguez-Espíndola et al., 2020) ● Blockchains support disintermediation where fewer tiers help to reduce transaction costs and time as well as business waste in the supply chain (Zhang and Liu, 2022).	
Trust and Stakeholder Relationship Management	10	● Blockchain contributes to buyer-supplier relationships (Hastig and ManMohan, 2020) ● A logic-based approach to trust building (Abdul and Samir, 2020) ● Evidence supports that blockchain could enhance both commitment and swift trust (Baharmand et al., 2021) ● Storing transaction records as well as other data and information in a decentralized and distributed ledger promotes trust amongst supply chain partners (Centobelli, et al., 2022) ● Blockchain technologies support educating and engaging with customers and building local relationships with them (Chaudhuri et al., 2021) ● Blockchain ensures better acceptance among consumers when purchasing refurbished goods, and among firms when using recycled materials (De Giovanni, 2022). ● BCT-enabled supply chain financial platform solves the problem of nontrust among the participants in the financial supply chain (Du et al., 2020). ● Blockchain technology improves trust between core enterprises (CEs), SMEs, and commercial banks of a supply chain and also facilitates CEs and banks to provide guarantees for SMEs	Abdul and Samir (2020); Benzidia et al. (2021); Chu et al. (2022); Centobelli et al. (2022); Chaudhuri et al. (2021); De Giovanni (2022); Du et al. (2020); Liu et al. (2021); Wang et al. (2019); Xu et al. (2022)
Fraud Prevention and Quality Management	10	● The blockchain creates more value in a business environment with lower credibility (Cao et al., 2022). ● Blockchain-enabled systems tend to avoid cheating because it reduces platforms' motivation to cheat (Chu et al., 2022) ● Blockchain reduces illegal counterfeiting by providing information about the origin of a product (Choi, 2019) ● Blockchain helps to address the moral hazard problem in SCM (Cai et al., 2021) ● Adopting blockchain has the potential to prevent greenwashing (Dong et al., 2023) ● Blockchain technology plays an important role in monitoring product quality and responding to product safety problems with a powerful information traceability function (Fan et al., 2022). ● E-retailers benefit from blockchain as quality verification (Niu et al., 2021) ● Blockchain adoption induces low-quality mask sellers to enhance their quality level (Shen et al., 2021). ● Selling through a PBT retailer can effectively combat copycats, though under certain conditions (Shen et al., 2023)	Cao et al. (2022); Chu et al. (2022); Choi (2019); Cai et al. (2021); Dong et al. (2023); Fan et al. (2022); Niu et al. (2021); Shen et al. (2021); Wu et al. (2021); Toyoda et al. (2017); Shen et al. (2023)
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Table 7 (*continued*)

Key benefits	No.	Key Points	Articles
Sustainability/Reduce Negative Impacts on the Environment and the Society		● Blockchain technology helps to reduce less sustainable products' entry into cross-border supply chains (Cao and Shen, 2022). ● The blockchain-based approach minimizes operational expenses incurred by emissions (Manupati et al., 2020). ● Blockchain, along with IoT and big data, automate data collection and recording and also prevents data manipulation which enhances traceability to achieve social sustainability in the supply chain (Quayson et al., 2021). ● A blockchain-enabled SCM provides better assurance of human rights and fair work practices (Saberi, et al., 2019).	Arunmozhi et al. (2022); Biswas et al. (2023); Cao and Shen (2022); Liu et al. (2021); Manupati et al. (2020); Quayson et al. (2021); Saberi et al. (2019); Wang et al. (2022b)
Cooperation and Collaboration among Parties within the SC	7	● Blockchain enhances inter-organizational cooperation in value creation in the music industry (Centorriono et al., 2022). ● BCT increases an organization's capability to proactively engage with downstream and upstream parties of the supply chain and to create visibility and traceability in supply chain operations (Dubey et al., 2020). ● Blockchain improves SC integration with the fragmented sector and reduces the silo effect (Wang et al., 2021). ● Collaborative maintenance is guaranteed by blockchain (Wang et al., 2021). ● Blockchain facilitates coordination between the manufacturer and the retailer (Xu et al., 2021) and between the manufacturer and the platform (Xu et al., 2023a). ● BCT provides opportunities for collaboration in the maritime shipping SC (Yang, 2019).	Centorriono et al. (2022); Dubey et al. (2020); Wang et al., 2021; Wang et al., 2021; Xu et al. (2021); Xu et al. (2022); Yang (2019); Xu et al. (2023a)
Improved Decision Making	6	● The blockchain-based platform has a significant impact on the supply chain entities' optimal decisions (Cao et al., 2022). ● Blockchain technology enables a real-time tracking system that allows automatic and timely updates of status data which supports effective business decision-making (Centobelli et al., 2022). ● BCT supports multi-objective decision-making in smart contract design (Dolgui, et al., 2020) ● BCT, namely distributed ledger technology, aids decision-makers and thereby limits the assumption of bounded rationality (Roeck et., 2020). ● Accurate information sharing supports effective product deletion decision-making across various stages of SCM processes (Zhu et al., 2022a,b).	Cao et al. (2022); Centobelli et al. (2022); Dolgui et al. (2020); Roeck et al. (2020); Zhu et al., 2022a,b; Zhong et al. (2021)
Transaction Automatization and Digitalization	6	● Transparency and accountability enabled by blockchain helps to automate business process reengineering in tracking supply chain processes (Chang et al., 2019) ● The blockchain supports the digital transformation of the marine supply chain and establishes a stable and shared network for data management, monitoring and minimizing risks (Liu et al., 2021). ● Decentralized recording of transactions (Mangla et al., 2021) ● Smart contracts automate operational activities like payment, and delivery confirmation (Martins et al., 2022)	Chang et al. (2019); Liu et al. (2021); Mangla et al. (2021); Martins et al. (2022); Wang et al., 2021; Wang et al. (2023)
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Table 7 (*continued*)

Key benefits	No.	Key Points	Articles
Demand Forecasting/ Customization		● Blockchain technology supports demand forecasting and customized pricing scheme which enhance the profitability of the platform (Choi et al., 2020a,b,c). ● Blockchain improves the efficient of inventory transactions and reduces costly operational distortions (Chod et al., 2020) ● Blockchain can improve profitability by improving mass customization and delivery reliability (Karamchandani et al., 2021) ● Blockchain helps to forecast different product demands based on mass consumer information and share the information with suppliers (Wu and Yu, 2022) ● Blockchain made exporters make proactive decisions regarding logistics and prepared backup plans more effectively and efficiently react to demand realization (Yoon et al., 2020).	Choi et al. (2020); Chod et al. (2020); Wu and Yu (2022); Yoon et al. (2020)

5.3.3. *Reduced cost*

In a complex supply chain, recording and transmitting information can be costly and require human intervention. Fortunately, blockchain technologies offer an easy solution to these problems. Among the articles we reviewed, several demonstrated a direct relationship between adopting blockchain technologies and reducing costs. For instance, Agi and Jha (2022) found a significant causal relationship between blockchain's ability to reduce transaction costs, consumers' interest in tracking data, and the adoption of BCTs in SCM. Abdul and Samir (2020) reported that the use of smart contracts reduces computational and transaction costs. Arunmozhi et al. (2022) found that BCTs and AI provide reliable predictive analytics results from mainstream machine learning algorithms, which help to control costs and energy consumption. Choi (2019) demonstrated that blockchain reduces diamond authentication and certification costs, while other studies have shown that it reduces wholesale and retail prices, discounts, and the need for intermediaries, resulting in more efficient budget control and reduced transaction costs and waste in the supply chain. Additionally, robust control of production and energy consumption supports sustainable economic development (Arunmozhi et al., 2022).

However, it is not always beneficial to adopt BCT in all industries or situations. There are circumstances where blockchain may have negative impacts. For example, Zhang et al. (2022) found that consumer privacy concerns about blockchain reduce both retailers' prices and profits, as such concerns lower consumer perceived value of products, thereby reducing demand. As a result, retailers may only apply blockchain when consumers' concerns about privacy issues are low. Another issue frequently mentioned in the literature is the cost of initial blockchain implementation. Investing in new software and hardware can be costly for organizations and supply chain partners, making the large-scale application of blockchain a challenge. In a similar vein, Joe et al. (2023) also argued that blockchain was not always financially beneficial because investment in blockchain might exceed the financial incomes it brought to the business.

5.3.4. *Fraud prevention and quality management*

BCT has proven to be a valuable tool in enhancing supply chain efficiency and preventing fraud by creating a robust audit trail with greater visibility. The tracking capabilities of blockchain provide a complete audit trail of transaction data at every point in the supply chain, including authenticity verification through digital signatures or other encrypted measures, which can provide indisputable proof of product authenticity and quality. This benefit is particularly valuable in industries such as e-commerce and luxury goods, which are plagued by counterfeit products that not only harm consumers but also erode brand integrity. As Cao et al. (2022) suggest, BCT creates greater value in a business environment with lower credibility. By providing information on the origin and flow of products, blockchain reduces the occurrence of illegal counterfeiting and helps prevent cheating by reducing platforms' motivation to cheat, as noted by Chu et al. (2022). For example, e-retailers benefit from BCT by using it to verify product quality, as evidenced by Niu et al.'s (2021) research.

The traceability function of blockchain plays a critical role in monitoring product quality and responding to product safety issues, according to Fan et al. (2022). While Niu et al.'s (2021) research showed that blockchain increased retailers' wholesaling profits by improving customer confidence and quality verification, tariffs can negatively impact international traders' profits and reduce their incentive to participate in the blockchain. In addition to e-commerce, the problem of counterfeiting is also prevalent in the luxury goods industry. Many luxury brands are fighting against non-deceptive counterfeiting in emerging markets. Choi (2019) examined the efficiency of BCT in the diamond industry, particularly for authentication and certification. The study found that a blockchain is a critical tool for diamond authentication and certification, but the blockchain-based platform incurs significant costs due to activities such as digital thumb-printing, certification, and authentication, which can reduce the benefits of all parties involved in the supply chain. These results suggest that BCT is a double-edged sword that brings both benefits and costs to its users.

5.3.5. *Transaction automatization*

Supply chain digitization has numerous advantages, including the elimination of cumbersome administrative practices and the

Table 8
A detailed summary of the research methods used by the sample.

Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
International journal of production research	Agrawal et al. (2022)	**Method**: Modeling **Purpose**: to explore the role of a blockchain-based collaborative framework on resource sharing using smart contracts.	This study proposes a demonstrator framework which ensures quality and data authenticity in SC. After testing the model, this study verified that smart contracts incorporate customized rules that promote collaboration among actors in the SC.	International Journal of Production Economics	Agi and Jha (2022)	**The survey method** based on the DEMATEL method is used **Data collection method**: e-mail survey to 52 experts and 37 useful responses collected **Data analysis**: Excel	This study identified 20 enablers of blockchain adoption in SC with “the relative advantage of the technology” and “the external pressure” being the two most prominent ones. There are significant relationship between blockchain adoption and reduce transaction cost, the consumer interest in traceability data and the establishment of a regulatory framework.
International journal of production research	Abdul and Samir (2020)	**Method:** Modeling based on data collected from EVM **Purpose**: to test the link between blockchain transaction and computational costs	This study found gas has the potential to increase transaction costs based on platform usage. This study provides help manufacturers and supply chain practitioners to understand the use of smart contracts and costs involved per transaction.	Technological Forecasting & Social Change	Ali et al. (2021)	**Method**: 5 in-depth case studies. From the halal food industry of Malaysia. The cases remained anonymous. **Data collection**: online interview **Data analysis**: Within-case and cross-case analyses	This study reveals a practical framework for overcoming the challenges faced by the halal food supply chain regarding blockchain implementation.
Transportation research, Part E: Logistics and transportation review	Arunmozhi et al. (2022)	**Method:** Modeling, Margin Indicator (MI) is developed to obtain reliable predictive analytics based on machine learning algorithms. **Purpose**: to investigate the relationship between AI and Blockchain-based Smart Contracts with sustainable supply chain operations.	The model test observed a reduction in energy wastage and hidden financial transactions by 12.48 % and 11.58 %, suggesting that blockchain-based smart contracts are expected to improve product traceability, transaction transparency, and sustainable economic growth for the AV supply chains.	International journal of operations & production management	Ahmed et al., 2022	**Method**: case study **Data collection**: This study investigates 50 use cases of blockchain applications in SCM which covers six industries. **Data analysis:** textual and correlation analysis	This study develops a framework which captures ten principal motivations of blockchain adoption, three blockchain application areas, and five clusters of contingency factors that influence the blockchain application in different industrial sectors.
International Journal of Production Economics	Büyüközkan et al., 2021	**Method:** The GDM approach is employed to overcome the biases of decision making, while IIFRs deal with different or complementary focus centers in qualitative data.	A Blockchain-based digital supply chain is expected to deliver continuing financial benefit, the ability to support, and efficient use of time. Automation, effective coordination, and conformity are identified as	IEEE transactions on engineering management	Alzahrani et al., 2022	**Method**: An integrated approach used Qua-find influencing factors through review; quan-test and evaluate their interdependencies and impact on adoption **Data collection**: LR and expert interview	This study develops a scoring model to evaluate healthcare organization's readiness to adopt blockchain for electronic health records system management. 17 factors that influence healthcare organizations'

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
			highly critical design requirements.			**Data analysis:** textual and correlation analysis	readiness for blockchain adoption was identified which were grouped into financial, social, technical, organizational, and regulations and legal categories.
European Journal of Operational Research	Biswas et al. (2023)	**Method:** modeling in a SC involving one manufacturer and one retailer. **Description**: This study proposes a supply chain that includes one upstream firm and one downstream firm to capture the trade-offs between traceability and sustainability for blockchain adoption.	The adoption of blockchain leads to an increase in prices and decrease of distrust. **Two** factors determine whether to pursue this technology or not: low consumer sensitivity to price and high sensitivity to quality. Moreover, high levels of distrust pushes firms to avoid the implementation of blockchain	IEEE transactions on engineering management	Asante et al. (2021)	**Method**: literature review **Data analysis:** textual analysis of 111 articles	This study clustered these articles using standard descriptors linked to trustworthiness, which include immutability, transparency, traceability, and integrity.
International journal of production research	Bai and Sarkis (2020)	**Method**: modeling technologies **Description**: proposed a linear programming model for the evaluation and selection of blockchain	This study does not discuss the pros or cons of blockchain technologies, but proposed a model to support evaluation of blockchain and decision making	Technological Forecasting and Social Change	Benzidia et al., 2021	**Method**: Survey, empirically validates the model with data collected from 379 French manufacturing companies. **Data analysis:**	The study found a positive effect between internal integration and blockchain technology as well as relational social capital factors in buyer–supplier relationships. The findings highlight the critical role of relational and technological capital in buyer–supplier relationships which act as a catalyst for exploiting internal capabilities to achieve the innovation objectives.
Transportation research, Part E: Logistics and transportation review	Choi and Luo (2019)	Technology-based experiment to explore how **data quality problems** affect on **sustainable fashion supply chain operation**s.	This study found poor data quality reduced supply chain profit and social welfare. Moreover, this study also found necessary and sufficient condition under which blockchain is efficient to improve social welfare.	International Journal of Operations & Production Management	Baharmand et al., 2021	**Method**: semi-structured interviews to experts and focus group discussion **Description**: The focus group invited 21 participants which six scholars and 15 practitioners who are interested in the research field. Data for the case study were collected from 10 semi-structured interviews involving senior-level managers and technical experts.	Main drivers include accountability, traceability, trust, visibility, collaboration, cross-sector partnership, time efficiency, and reducing administrative work, etc. Main barriers include engagement issues, lack of technical skills and training, lack of resources, privacy concerns, regulatory problems, pilot scalability

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
							issues and governance challenges.
Transportation research, Part E: Logistics and transportation review	Cao and Shen (2022)	**Method**: modeling to test the effects of adopting blockchain technology on deterring LSPE	This study classifies the effectiveness of blockchain-enabled entry deterrence into three regions on the basis of the values of blockchain adoption cost. Moreover, government intervention interplays with blockchain adoption in combating LSPE.	Transportation research, Part E: Logistics and transportation review	Balci and Ebru (2021)	**Method**: Interview + interrelationships test, the **purpose** is to investigate the structural relationship between blockchain adoption barriers in containerized international trade	The most impactful among the eight barriers are lack of support from influential stakeholders, lack of understanding regarding blockchain, and lack of government regulations. Moreover, the high salient stakeholders among 11 legitimate stakeholders are container lines, ports, beneficial cargo owners, freight forwarders/third party logistics, and customs authorities.
Transportation research, Part E: Logistics and transportation review	Chu et al. (2022)	**Method**: modeling with numerical experiments which include an updated operation process to ensure reliable information inputs, a consortium blockchain network to avoid data tampering, and an intelligent algorithm embedded in a smart contract to automatically detect cheats.	This study demonstrates that an intelligent algorithm is embedded in a smart contract to automatically and periodically detect collusive behaviour between the platform and downstream retailers.	Transportation research, Part E: Logistics and transportation review	Cao et al. (2022)	**Method**: case study which considers a two-level supply chain featuring a typical cooperative and a buyer and establish stylized game models with and without the blockchain-based platform **Purpose**: This study analyzes how the adoption of a blockchain-based platform can affect the decisions of agricultural supply chains and also explores the way that the platform address the challenges.	The involvement of the blockchain-based platform can lead to increased production quantity and total surplus of the supply chain. Moreover, it also encourages more sustainability/green investment to produce greener products.
Transportation research, Part E: Logistics and transportation review	Choi (2019)	**Method**: modeling to test the values and applicability of BTS platform for diamond authentication and certification.	The sales channel via the BTS platform can help generate more benefit to the manufacturer and the consumers under certain circumstance.	Transportation research, Part E: Logistics and transportation review	Choi et al. (2019)	**Method:** systematic literature review Meta-analysis **Description**: This study examines air logistics related operations management from four areas	This study exemplified how the mean–variance (MV) approach can be applied to explore global supply chain operations risk with air logistics in the blockchain technology era.
International Journal of Production Economics	Choi et al., 2020	**Method**: modeling **Description**: The basic model is a two-platform (TPF) scenario to mimic the case in the market which include two groups of sellers who offer the same type of product to the	This study found that the blockchain technology will lead to an increase of the optimal product information disclosure level, an increase of consumer surplus, and the likelihood of having the full product information	Transportation research, Part E: Logistics and transportation review	Choi et al., 2020	**Method**: literature review + case study **Description**: The LR include39 articles from the SCM journal list,4 the UK's ABS journal list (levels 4 and 4*), the USA's UTD journal list,5 and the Australian ABDC A* journals	The blockchain technology facilitates the implementation of mean-variance risk analysis for global supply chain operations. This study also highlights several promising areas for further studies.

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
		market by directly selling the product to the platforms.	disclosure scenario is also higher.				
European journal of operational research	Choi et al. (2020)	**Method**: modeling **Description**: The model considers a platform which offers an on-demand service such as quick food delivery.	This study found that if the customers are more risk averse, the optimal service price will drop. The blockchain technology is a valuable technological tool to identify the risk attitudes of customers.	Transportation research, Part E: Logistics and transportation review	Chan et al. (2020)	**Method**: mixed method **Description**: The approach includes case study, semi-structured interviews, and analytical modeling.	Nike has the highest CSR commitment level, followed by H&M and LV. Blockchain technology can help to improve the low level of CSR commitment.
Decision Sciences	Cai et al., 2021	**Method**: modeling **Description**: the model considers a supply chain selling a newsvendor product with a manufacturer and a retailer and including moral hazard problem in the model.	This study found that Blockchain technology can help to address the moral hazard problem occurred in the supply chain.	European Journal of Innovation Management	Centorriono et al., 2022	A qualitative-based approach based on a case study is adopted; **Bitsong** is selected as the case.	This study found that blockchain adoption in the music industry can singularly shape the business model, representing a powerful tool to enhance inter-organizational cooperation in value creation. It effectively deals with operational and business issues, besides financial transactions, profoundly impacting both the creation and distribution of value within the supply chain.
Management Science	Chod et al. (2020)	**Method**: modeling **Purpose**: This study examines how the transaction verifiability enabled by blockchain can be used by firms to transmit information about their inherent quality.	This study found that blockchain improves the efficient of inventory transactions and reduce costly operational distortions. An important benefit of blockchain is that it opens a window of transparency into a firm's supply chain. Blockchain technology furnishes the ability to secure favorable financing terms at lower signaling costs.	Information & Management	Centobelli et al. (2022)	**Method**: A single in-depth case study is adopted and data is collected through face-to-face with company managers for the SCM, OM, and IM departments. The second stage of data collection include an active remote dyadic (back-and-forth) interactions and a validation workshop with managers.	Blockchain improves trust, traceability, and transparency. The use of a circular blockchain technology affects the current development trust process amongst partners. Moreover, blockchain technology enables an almost unique and real-time tracking system that allows timely and automatic updates of status data in order to make efficient and effective business decisions. Transparency is also achieved through an inherent tampering-proof mechanism characterizing blockchain technology.
Annals of Operations Research	Choi (2020)	**Method**: analytical modeling **Purpose**:Modeling under the	Blockchain-supported supply chain incurs a lower	Supply chain management: an	Cole et al., 2019	**Method**: A systematic review of blockchain technology	Digital ledger technologies offer great opportunities for

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
		standard newsvendor problem setting with a single manufacturer and a single retailer employing a revenue sharing contract both with and without blockchain	level of operational risk than the traditional supply chain. Thus, blockchain technology is a mean-risk dominating policy which brings a higher expected profit and a lower risk for the supply chain and its members.	international Journal		regarding its implications for OSCM.	OSCM, including enhancing product safety and security; improving quality management; reducing illegal counterfeiting; improving sustainable supply chain management. Future research agenda is also proposed.
International journal of production research	Dolgui et al. (2020)	**Method**: modeling **Description**: The model and the experimental environment constitute an event-driven dynamic approach to task and service composition when designing the smart contract.	This study reveals that BCT allows for balancing the trade-off between SC lead-time and contract costs supporting multi-objective decision-making in smart contract design.	Technological Forecasting and Social Change	Chang et al. (2019)	**Method**: descriptive analysis **Description**: This study illustrates design of an integrated process which provide an achievable use case of the disintermediation of business processes via a conceptual, shared information ledger.	Blockchain technology not only facilitates the sharing of tracking information but also promotes a network for multilateral collaboration among supply chain members. This demonstrates the benefits of traceability and collaboration of the blockchain.
International Journal of Production Economics	Dong et al. (2021)	**Method**: modeling **Description**: The model and the experimental situation with and without blockchain	The core company should not establish her own originated channel when her main business is to sell high-cost products or when the marginal cost of blockchain implementation is sufficiently large. Moreover, the impacts of the blockchain technology depend on the production cost.	Annals of Operations Research	Chaudhuri et al. (2021)	**Method**: multiple case study (iFinca and Plastic Bank) and data is collected through interview **Description**: the researcher conducted 12 interviews	This study found developing user-friendly applications, developing secure digital payment systems, providing support for suppliers and farmers and adapting to local conditions as the key outcome-based mechanisms.
Transportation research. Part E, Logistics and transportation review	Dong et al. (2023)	**Method**: modeling **Description**: the model considers a manufacturer sells products through an e-commerce platform and there are two types of consumers in the market, namely the prosocial consumers that prefer green logistics and non-prosocial consumers.	This study show that adopting blockchain has the potential to prevent greenwashing because it increases the transparency of supply chains, but the cost of blockchain adoption is too large which motivate logistic firms to take risk.	Annals of Operations Research	Chowdhury et al. (2022)	**Method:** survey + structural equation modeling **Description:** a model was proposed through literature review and was tested with survey data collected from responses from 116 operations managers in the UK (during COVID-19 pandemic) through SEM.	With regard to the benefits of blockchain, involvement in resilient organizational practices and user-friendly implementation of the technology will have a significant and positive influence on the intention to adopt BCT for risk management in the OSCM context. Moreover, a decision framework is proposed for BCT adoption.
IEEE transactions on engineering management	Epiphaniou et al. (2020)	**Method**: modeling utilizing a novel search and retrieve algorithm leveraging metadata	This study Just constructed and implemented a simulation platform for IoD.	International journal of	Dubey et al. (2020)	**Method:** survey (structure equation modeling) **Description:** the researcher	This study demonstrated that the distributed ledger technology further reduces

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
		attributes **Purpose**: This study extracts key concepts from three existing large scale networks, namely the air traffic control network, the cellular network, and the Internet, and also explores their connections to the novel architecture for drone traffic management.		production research		contacted 1713 respondents via e-mail and received 256 useable responses.	transaction cost, improves visibility across the supply chain and further enhances coordination among the partners.
Annals of Operations Research	Fan et al., 2022	**Method**: modeling Description: this research studied the optimal pricing strategies of the supply chain considering the traceability awareness of consumers in two scenarios.	Results show that it is conditional for the implication of blockchain technology on supply chain which related closely to the traceability awareness of consumers, the production costs of the supplier and manufacturer, and the cost of using the blockchain technology. Under a certain condition, the revenue sharing contract can realize a Pareto improvement for the supply chain that adopts the blockchain technology.	Transportation research, Part E: Logistics and transportation review	Dutta et al. (2022)	**Method:** SLR **Description**: This study reviewed 178 research articles in the field of blockchain implementation in supply chains.	This study concludes that various supply chain functions that can be enhanced through blockchain.
International journal of production research	Govindan et al. (2022)	**Mixed method**: modeling using a structural approach based on the weighted influence non-linear gauge system plus a case study.	This study found that financial issues, security issues, lack of expertise and knowledge, and uncertain government policies are the most important barriers to BT adoption in the healthcare industry.	International journal of operations & production management	De Giovanni (2022)	**Method**: survey (structure equation modeling) **Description**: This study collected primary data by designing and administering a questionnaire survey which were sent to firms selected through Bureau van Dijk Electronic Publishing. A total of 157 useable observations, excluding those removed as invalid. Multigroup analysis is used to test the data.	Results of this study demonstrate that the blockchain facilitates a more efficient circular economy system. Specifically, blockchain ensures better acceptance among consumers when purchasing refurbished goods, and among firms when using recycled materials. However, the implementation of blockchain technology does not have any positive impact on a firm's business performance.
IEEE transactions on engineering management	Guo et al., 2020	**Method**: modeling based on Game-theoretic approach. This study presents analysis of a fashion supply chain consisting of a fashion retailer and an	The application of the blockchain technology influences the information disclosure games over the environmental efforts in the	International journal of operations & production management	Danese et al. (2021)	A multiple-case study of five Italian wine companies, Data collection took place between October 2018 and May 2019.	The key driver to consider in the design of BC systems is that the desired level of upstream/downstream counterfeiting protection that

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
		upstream manufacturer with and without BCT	fashion industry. At the same time, the value of blockchain to the fashion SC is closely related to the consumer's willingness to pay for the fashion retailer's blockchain advertisement level.			Semi-structured interviews were chosen as the primary data	a brand owner intends to guarantee to customers through BC. In other words, BC systems can be designed to effectively prevent counterfeiting.
International Journal of Production Economics	Ji et al. (2022)	Method: modeling consisting of two manufacturers (M1 and M2) and a retailer (R)	The introduction of blockchain technology can satisfy some consumers' preferences for product authenticity and product traceability	IEEE transactions on engineering management	Du et al. (2020)	**Theoretical analysis**: This study builds a new type of supply chain financial platform that uses blockchain technology to manage the whole process.	BCT enabled supply chain financial platform solves the problem of non-trust among the participants in the supply chain, improves the efficiency of the capital flow and information flow, reduces costs, and provides better financial services to the relevant parties in the supply chain.
International Journal of Information Management	Kamble et al., 2020	**Modeling** using combined ISM and DEMATEL methodology	Blockchain improves the traceability of the agricultural products which provide evidence to support our classified benefit of traceability	IEEE transactions on engineering management	Guggenberger et al., 2020	**Design science research approach:** designing a software prototype based on Hyperledger Fabric using the design science research approach. **Purpose**: this article aims at analyzing how and to what extent blockchain can facilitate information sharing for vendor managed inventory	This study proposed a decentralized information hub model and also described how companies utilize decentralized technologies.
International journal of production research	Kanakaris et al. (2021)	**Modeling** with a distributed trustless and secure architecture for FSC traceability	BCT offers significant benefits in terms of supply chain resilience by (a) eliminating both system boundaries and geographic limitations and (b) allowing the integration of heterogeneous traceability-related data across the entire supply chain.	Production and Operations Management	Hastig and ManMohan (2020)	**Method**: SLR to 75 articles	The business requirements for traceability systems are curbing illegal practices; improving sustainability performance; increasing operational efficiency; enhancing supply chain coordination; and sensing market trends. Critical success factors for BCT implementation are companies' capabilities; collaboration; technology maturity; supply chain practices; leadership; and governance of the traceability efforts.

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
International journal of production research	Liu et al., 2021	**Modeling** which construct a three-tier supply chain consisting of an upstream manufacturer, a tier-1 distributor, and a tier-2 retailer.	Blockchain technology improves trust between core enterprises (CEs), SMEs, and commercial banks of a supply chain and also facilitates CEs and banks to provide guarantee for SMEs	International Journal of Production Economics	Kouhizadeh et al., 2021	**LR with a Meta-analysis method** using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) tool.	The key barriers of BCT application include lack of industry involvement, lack of management commitment and support information disclosure policy between supply chain partners.
International journal of production research	Li et al. (2020)	**Modeling** which construct a 5-tier SC platform incorporating IoT, LSTM, Analytic Hierarchy Process (AHP) and blockchain.	Blockchain technology is adopted to enable open and decentralized data storage and sharing, provide fair and automatic trading of data.	Annals of Operations Research	Kamble et al. (2021)	Survey - The companies were first selected from the Automotive Components Manufacturers Association of India (ACMA) and The Society of Indian Automotive Manufacturers (SIAM) database. The online questionnaire was designed and distributed using a Google-drive link to 525 managers from 305 companies.	BT can integrate, builds and reconfigure, both the internal and external competencies to address the challenges posed by the rapidly changing environment. Moreover, Stakeholders' integration in the SC matter. The more stakeholders and partners in the SC an organization can integrate in its sustainability strategy, the more it may benefit from BT technology to enhance its partnership and SC integrity.
IEEE transactions on engineering management	Li et al., 2021	**Method:** Modeling **Purpose**: this study investigate the choice strategy of authentication technology for luxury e-commerce platform(s) in the monopoly and duopoly markets	The choice of authentication technology for platform(s) depends on the cost difference between manual technology authentication and blockchain technology authentication. High cost difference facilitates blockchain adoption. Meanwhile, in the monopoly and duopoly markets, adopting blockchain technology is likely to improve consumer surplus and social welfare.	International journal of production research	Kamble et al. (2019)	**Method:**Survey to 181 supply chain practitioners in India. Data analysis: SPSS	Supply chain practitioners perceive BT adoption free of efforts and would help them to derive maximum benefits for improving the supply chain effectiveness. Moreover, the perceived ease of use influences the perceived usefulness.
Transportation research, Part E: Logistics and transportation review	Li et al., 2021a	**Modeling** based on two cases with and without BCT	Blockchain implementation enhances the green investment level and increases the retailer's profit only if the blockchain-driven green sensitivity level increment is significant. However, blockchain adoption may weaken the	International journal of production research	Karamchandani, et al. (2021)	**Method:** interview + confirmatory factor analysis (CFA) and structural equation modeling (SEM) on the proposed model.	Blockchain adoption can assist supply chains to be data-driven, responsive, resilient, cost-efficient, sustainable and adaptable to the swift structural changes that can happen in physical and cyberspace of global supply chain networks.

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
			positive impact of fairness on the supply chain performance.				
Transportation research, Part E: Logistics and transportation review	Liu et al. (2022)	**Modeling** which consider a supply chain consisting of an imported fresh food manufacturer, a retailer, and a blockchain platform.	Blockchain increases profits when consumers are more concerned about the safety of buying imported fresh food because the traceability of blockchain increases customer's perceived safety of imported fresh food	International journal of production research	Kucukaltan et al. (2022)	Survey based on LR and web-based big data (which include clickstream data regarding the source of website traffic, navigation paths, and the behaviour of visitors during their website visits)	The interest in blockchain technology neither focused on finance nor data privacy as emphasized in the literature but mainly on the benefits of increasing digitalization and efficiency in supply chains.
IEEE transactions on engineering management	Martins et al. (2022)	**Modeling** which relies on a smart contract framework	Smart contracts make it possible to automate many operational activities, such as payment escrows/release upon delivery confirmation, increasing the efficiency along the supply chain.	International journal of production research	Liu et al., 2021	**Method:** general discussion based on literature review	The authors construct a new operation management mode of the maritime supply chain and propose an integrated BMSCS suitable for global economic development which utilizes the characteristic decentralization, openness, independence, and security of blockchain technology.
International journal of operations & production management	Martinez et al. (2019)	**Method:** programing + multiple scenarios simulation	Blockchain reduces the number of operations, reduces the average time of orders in the system, reduces workload, shows traceability of orders and improves visibility to various supply chain participants.	Transportation research, Part E: Logistics and transportation review	Liu et al., 2022b	**Survey** using data collected from Chinese firms.	Blockchain brings many benefits which include end-to-end visibility, process transparency and information symmetry.
International journal of production research	Mathivathanan et al. (2021)	**Method:** Total Interpretive Structural Modeling (TISM) and Cross-Impact Matrix Multiplication Applied to Classification (MICMAC)	The main barriers include: data privacy/security concerns, regulatory uncertainty, technological infeasibility, complexity in set up/use, uncertain benefits, dependence on blockchain operators, lack of cooperation among supply chain partners	Transportation research, Part E: Logistics and transportation review	Mangla et al. (2021)	This study integrated the system theory and system dynamics modeling approaches. Moreover, an agricultural development cooperative founded to support dairy farmers has been examined in order to understand the societal impacts of Blockchain technology.	blockchain technology can be incorporated into the existing system so that transparent and end-to-end accurate tracking of the supply chain is made possible, while creating decentralized recording of transactions. Moreover, the critical traceability points of a milk supply chain are evaluated with the blockchain adoption. This will help achieve the sustainable development goals (SDGs) of providing safe food, promoting good health and

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
							better well-being for everyone.
International journal of production research	Manupati, et al. (2020)	**Modeling**: This study formulated as a Mixed Integer Non-Linear Programming (MINLP) model	This study shows that the distributed ledger-based blockchain approach minimizes both total cost and carbon emissions.	IEEE transactions on engineering management	Menon & Jain (2021)	**Method**: Case study **Data analysis**: thematic analysis **Purpose**: This article examines the question: How blockchain technology facilitates transparency in agri-food supply chains?	Primary attributes of blockchain, namely traceability, immutability, auditability, and provenance, promote transparency in supply chains.
Transportation research, Part E: Logistics and transportation review	Niu et al., 2022	Method: modeling Description: This study considered a two-stage supply chain comprised of a component supplier and a manufacturer, the supplier sells new components to the manufacturer to produce regular products while the manufacturer collects reused components to produce remanufactured products.	The manufacturer prefers blockchain doption while the supplier prefers blockchain adoption if (1) the consumers are not very risk averse; (2) the consumers' risk-aversion degree is moderate but customers' quality uncertainty of the remanufactured product is small.	Transportation research, Part E: Logistics and transportation review	Nguyen et al., 2022	**Mixed method:** The qualitative phase established a risk network supported by a comprehensive knowledge base. The quantitative phase provides risk insights and foresight based on multi-event risk scenarios. A set of probabilistic indexes for risk network analysis is proposed to analyze complex risk situations.	The empirical study found increased complexity of risk situation with a rise in IOR and uncertainty level, which has been projected for highly digitalized systems in maritime logistics but not yet confirmed. Besides, although most MESs in container shipping BISs are predicted to be unlikely to occur, their uncertainty is high with low data availability and potential accumulated consequence.
Transportation research, Part E: Logistics and transportation review	Niu et al. (2021)	**Method**: modeling **Description**: This study considered a MNF consisting of a manufacturing division and a retail division.	E-tailers benefit from blockchain as results of quality verification	Transportation research, Part E: Logistics and transportation review	Orji et al., 2020	**Method:** multiple case study based on the analytic network process (ANP)	This study identified that 'availability of specific blockchain tools', 'infrastructural facility', and 'government policy and support' were the three topmost ranked significant factors that influence the adoption of blockchains in the freight logistics industry.
International journal of production research	Rahmanzadeh et al. (2020)	**Method**: computation Experiment	The company can achieve favorable designs by spending approximately 1 % of the supply chain total cost. Additionally, benefiting the registering mechanism can decrease the cost of using non-original designs more than 41 %.	IEEE transactions on engineering management	Pattanayak et al. (2023)	This study employs semi-structured interviews interwoven with thematic analysis to identify the capabilities deployable by BCT at each stage of disruption.	BCT can enhance the ability to sense, the ability to seize, and the ability to maintain.
Transportation research, Part E: Logistics and	Shen et al., 2020	Modeling: SC platforms with and without BCT	This study found that horizontal integration was more effective in improving the supply chain's total profit	IEEE transactions on engineering management	Quayson et al., 2021	General discussions based on past literatures	This article identifies some blockchain technologies in emerging economies and that the promise of using

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
transportation review			with the use of blockchain. A win-win-win outcome can be achieved for the platform, the supplier, and consumers in a supply chain.				technology to improve smallholders' vulnerability in the cocoa supply chain remains underexploited in Africa and other emerging economies.
International journal of production research	Shen et al. (2021)	**Method**: Modeling which consider two types of masks in terms of quality levels	Both quality inspection and blockchain adoption can induce low-quality mask sellers to enhance the quality level.	International journal of production research	Queiroz et al. (2021)	Method: Survey (structure equation modeling) and data were collected via social networking sites Data analysis: SPSS	Trusting blockchain entails the availability of and confidence in the information that is shared between the members of the supply chain. Moreover, managers need to deploy efforts to ensure consensus for blockchain adoption and use, while effectively guaranteeing trust in transactions.
International journal of production research	Tao et al., 2022	**Method**: Modeling which define pi and qi as the selling prices and quality levels of a product without and with blockchain technology	Blockchain reduces information asymmetry between suppliers and customers	International journal of production research	Rodríguez-Espíndola et al. (2020)	Method: Case study with thirteen agencies were included for the case, and these were Municipality, DICONSA, DIF, IMSS, ISSET, PC, SMEXICO, STABASCO, SCT, SEDENA, SEGOB, SEMAR and SSP. Purpose: to analyze the prospective role of EDTs in disasters.	The analysis shows the potential of the framework to reduce congestion in the supply chain, enhance simultaneous collaboration of different stakeholders, decrease lead times, increase transparency, traceability and accountability of material and financial resources, and allow victims to get involved in the fulfilment of their own needs.
International journal of production research	Ullah et al. (2022)	**Method**: Modeling which considers a supply chain where two competitive manufacturers sell products directly to consumers by retail price.	This study found that managers were encouraged to outsource more often with blockchain because if they are giving consumers a long time to engage with the service system, there should be a transparent environment.	International journal of production research	Roeck et al., 2020	Case study and data is collected through semi-structured interview	BCT, namely DLT, aids decision-makers and thereby limits the assumption of bounded rationality
European journal of operational research	Wang et al. (2023)	Method: construct a **model** with a three-echelon supply chain consisting of a supplier, a manufacturer, and a newsvendor-like retailer.	Blockchain adoption can save trade credit management cost and share repayment risk. Blockchain adoption improves equilibrium order quantity and supply chain efficiency.	IEEE transactions on engineering management	Ramzan et al. (2022)	Method: literature review	This study present a detailed introduction, history, technical information, and types of blockchain technology, motivations behind this technology and top healthcare projects

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
							completed using this technology
European journal of operational research	Wu et al., 2021	**Method**: Modeling which considers a supply chain with and without blockchain implementation	The use of this technology cannot only provide verifiable traceability information for consumers, but also help firms monitor product quality. Adopting blockchain technology is not always the optimal decision for the FPSC, which is related to the consumers' acceptance degree for the product without blockchain technology.	IEEE transactions on engineering management	Sahoo et al. (2022)	Method: PRISMA-Based literature review Description: This article provides a summary of 308 scientific work published since 2016 which extracted from the SCOPUS database.	This study identified five identified knowledge clusters: 1) blockchain for food SC transparency, 2) distributed ledger for sustainable SCs, 3) traceability systems using smart contracts, 4) internet of things for logistics, and 5) the emergence of Ethereum and hyperledger in SCs.
International journal of production research	Wu and Yu (2022)	**Method**: This study adopts the game theory model to solve the key question: What is the best blockchain strategy for each supply chain member?	The platform can forecast different product demands by analyzing mass consumer information and share this information with suppliers via a blockchain. It also helps to reduce transaction cost.	IEEE transactions on engineering management	Sharma et al., 2022	**INTERVIEW + TESTING:** The study used the Interpretive Structural Modeling—Decision Making Trial and Evaluation Laboratory in identifying the factors and ranking them based on their extent of influence.	The authors proposed that most stakeholders are not ready yet for a paradigm shift toward BCT-ready food SC because of the social-economic and procedural implications that are still not well understood among most stakeholders. BCT protocols may also face serious scalability obstacles since transaction processing rates are restricted by latency issues, block size and interval, system instability with increased branching, and issues in network.
International journal of production research	Wang et al. (2022a)	**Method**: construct a model which consider a circular supply chain consisting of one supplier and one retailer.	The presence of a strong retailer dramatically reduces suppliers' incentive to invest in blockchain. However, when the cost of blockchain is relatively small, or consumers' sensitivity to blockchain or product recycling benefits is rather large, the supplier is still likely to invest more in a retailer-led supply chain.	International journal of production research	Saberi et al. (2019)	**Method**: literature review	This study found that a blockchain-based supply chain provides better assurance of human rights and fair work practices. Blockchains can result in supply chain disintermediation where fewer tiers result in transaction costs and time reduction, reducing business waste in the supply chain. It also identified four categories

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
							of blockchain technology adoption barriers.
International journal of production research	Wang et al., 2021	Computation experiments using Q learning-based optimization approach	The collaborative maintenance is guaranteed by blockchain technology. However, intra-organizational barriers such as lack of knowledge and expertise; and lack of tools for BC technology implementation.	International journal of production research	Shi et al., 2021	**Method:** literature review with the set of 239 papers	Blockchain technology now plays a revolutionary role in on-demand service platform operations. This study reviewed latest articles covering blockchain and supply chain management.
International journal of production research	Xu et al. (2021)	**Method**: modeling consider a stylized supply chain that is composed of a manufacturer and a retailer.	Blockchain adoption suffers coordination problem of the manufacturer and the retailer. Blockchain technology can help the products become greener.	Transportation research, Part E: Logistics and transportation review	Tiwari et al. (2023)	**Method:** interview with four innovation/project managers of well-established logistics companies	This study presents a framework for a BCT system applied to a supply chain with 3 P L.
International Journal of Operations & Production Management	Xiong et al. (2021)	**Method**: regression analysis **Description**: The authors conduct an event study to quantify the financial effects of COVID-19 and also compares firms with and without blockchain implementation. The authors also perform a regression analysis to examine how the role of BESCs in mitigating COVID-19's negative impact varies across firms with different levels of supply chain leanness and complexity.	The mitigating role of blockchain-enabled supply chains is more pronounced for firms with lean and complex supply chains, highlighting the importance of adopting blockchain to reduce the risks of supply chain disruptions. Firms can use blockchain to better monitor and trace the inventories and other resources available in their lean supply chains, enabling faster identification of and response to the disruptions in these supply chains.	International Journal of Operations & Production Management	van Hoek (2019)	Method: initial exploration using a focus group and a survey and further exploration using a multiple case study method	Many drivers summarized which include internal drivers (such as leadership commitment), external drivers (such as improved response to customer inquiries)
International journal of production research	Xu and He (2021)	**Method:** modeling considers a blockchain technology-supported retail platform that sells a product to consumers at price	The adoption of blockchain technology can improve consumers' willingness to pay because blockchain technology can provide the full details of every diamond, including carat, colour, clarity and cut, which consumers can then use in realizing their private valuations of these products.	International journal of production research	Wang et al., 2021	**Method:** This research adopts a qualitative, participative research approach and is particularly informed by design science research methodology. Data was collected from a range of sources, for instance focus groups, working seminars, interviews, co-creation workshops and weekly project meetings.	This study found that the visibility of title/ownership transfer between supply chain actors and near real-time tracking of resources (e.g. financial and material) along the supply chain. It offers a secured record of critical data and transactions that bridges information gaps and supports whole lifecycle asset management. Blockchain

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
							reduces the silo effect and enforces and improves supply chain integration within the fragmented sector.
Transportation research. Part E, Logistics and transportation review	Xu and Choi (2021)	**Method:** modeling considers supply chain systems with and without blockchain	blockchain technology can generate more consumer surplus if the cross-channel effect is low. However, whether blockchain technology can bring more profits for the manufacturer's offline channel depends on the cross-channel effect. In other words, blockchain not always guarantee profits.	International journal of production research	Wang et al. (2022b)	Through literature review, this research develops a system architecture of blockchain-based multi-tier sustainable supply chain management in the PPE industry.	Blockchain technology can enable identification and coordination for sustainable standards compliance in PPE multi-tier supply chains.
Transportation research, Part E: Logistics and transportation review	Yang et al., 2022	**Method:** model Considers a two-tier supply chain consisting of a brand manufacturer and an independent remanufacturer.	The brand advantage has key effects on the manufacturer's mode selection except for the remanufacturer, but blockchain influences both of their selections.	International journal of production research	Wong et al. (2020)	**Survey** (structure equation modeling) Data gathered from 157 firms is analyzed using SPSS version 2	Facilitating Condition, Technology Readiness, Technology Affinity have a positive influence on intention to use blockchain for SCM and regulatory support moderates the effect of Facilitating Condition.
Transportation research, Part E: Logistics and transportation review	Yu et al., 2022	**Method:**model Consider a two-echelon supply chain consisting of a retailer and a supplier over a planning horizon of periods with discount factor.	Blockchain's operational value to the retailer stems from the roles of smart credit: delayed wholesale payment and low financing interest benefit the retailer by reducing inventory costs. As the demand information becomes transparent, the supplier can use this information to reduce the uncertainties in downstream orders, update the manufacturing decisions, and reduce the inventory cost.	International journal of production economics	Wang et al. (2019)	**Method**: expert interview	Blockchain contributes to improvement in supply chain visibility and operational improvements, secure information sharing and the building of trust.
International journal of production research	Yang et al., 2022	**Method:** modeling consider a firm that produces and sells a product to its customers.	The traceability enabled by the blockchain technology can resolve the logistics firm's moral hazard and encourage the producer to	IEEE transactions on engineering management	Wong et al. (2021)	**Method**: survey Data collected from 178 responses from manufacturing firms were analyzed using artificial neural network (ANN)	Functional risk barrier has the highest level of importance toward blockchain resistance, followed by usage barrier, security and privacy barrier, information barrier.

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
			improve the production quality.				
International journal of production research	Yoon et al. (2020)	**Method:** modeling consider a firm that produces and exports a single product to a foreign market **Purpose**: this study seek to answer the questions of when and how Blockchain improves an exporting firm's profits in international trade.	The reduced lead time and decreased ocean transport cost under Blockchain enable the exporting firm to increase shipment via the ocean. Blockchain makes the firm more proactive while preparing a backup plan to more effectively and efficiently react to demand realization. Blockchain has two potential advantages on profit, including (i) save storage cost at ports/ terminals and (ii) increase revenue using ocean shipment postponement with the shortened lead time and corresponding potential reduction in demand volatility.	International Journal of Operations & Production Management	Xu et al. (2022)	**Method**: survey to 110 Chinese firms	Trust increases along with an increasing congruence between blockchain and norm or solidarity, but in a diminishing rate.
International journal of production research	Yu et al., 2021	**Method:** modeling includes four kinds of players: a platform, a bank, multiple transportation service providers, and a capital-constrained customer.	Blockchain technology helps firms use self-guarantee in traditional SCF.	Transportation research, Part E: Logistics and transportation review	Yang (2019)	**Method:** survey **Description:** questionnaire to 508 respondents	Blockchain assists maritime shipping in achieving effectiveness, efficiency and competitiveness through technological and managerial innovation. Blockchain improves opportunities for collaboration in the maritime shipping supply chain. Blockchain also greatly enhances cross-border trade security and safety.
IEEE transactions on engineering management	Ye et al. (2022)	**Method:** modeling with SC systems adopts blockchain in different stages	Early adopter can always snatch more benefit from the adoption of the BT than the follower.	IEEE transactions on engineering management	Yousefi and Tosarkani (2023)	**Method:** literature review **Description**: a system-analysis-based approach to investigate the impact of BT adoption on the improvement of SSC performance.	Blockchain can significantly affect various dimensions of SSC networks' performance.
International journal of production research	Yang et al. (2022)	**Method:** modeling **Description**: this study used a designed ant colony algorithm to optimize the blockchain	Blockchain-based system is proposed to achieve overall optimal in terms of security, cost, and efficiency.	International journal of production research	Zhu et al. (2022)	**Method**: general discussion based on existing literature	Accurate information sharing mechanisms and their new information governance influences can provide the required inputs for effective

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
		application in the financial institution-based SCF system					product deletion decision making across various stages of supply chain management processes.
International journal of production research	Zeng et al., 2022	**Method:** modeling	BCT minimize the total cost incurred in production and transportation.	Transportation research, Part E: Logistics and transportation review	Zhu et al., 2022	**Method:** literature review	This study compares and contrasts various theories related to the adoption of blockchain in supply chain management
International journal of production research	Zhang and Liu (2022)	**Method:** modeling quality decisions in a serial logistics service chain with and without the adoption of blockchain technology	BCT can realize the Pareto optimality on delivery quality and profit of the entire system. Moreover, adopting blockchain improves service chain efficiency by eliminating moral hazard.	IEEE software	Lu and Xu (2017)	**Method**: case study **The case**: OriginChain	Blockchain helps to provide a transparent, tamper-proof metadata infrastructure to trace the origin of products across complex SCs.
European journal of operational research	Zhang et al. (2022)	**Method:** modeling which establish a retailer competition model including an initial retailer and an entrant retailer both of whom can decide whether to apply the blockchain technology.	Consumer privacy concerns decline both retailers' prices and profits when adopting blockchain technology because consumer privacy concerns lower consumers' valuations of products, thereby reducing demand. Therefore, this study provides evidence counter the mainstream opinion.	Supply chain management: an international journal	Treiblmaier (2018)	This paper builds on previous theories that are frequently used in SCM research	This paper introduces a framework for middle-range theorizing together with several research questions.
Transportation research, Part E: Logistics and transportation review	Zhang et al., 2023	**Method:** modeling which considered a cold supply chain consisting of a manufacturer, a retailer, and a 3 P L, where the manufacturer is a fresh product firm and the retailer is a large retail platform.	Blockchain adoption would lead to a preservation service level increase if the 3 P L charges a low transportation fee, but a preservation service level decrease if the 3 P L charges a high one. Second, the blockchain adoption may induce the manufacturer to increase its wholesale price, which does not cause the retailer to cut the order quantity but instead sets a lager one.	IEEE access	Perboli et al., 2018	**Method**: literature review	This study presented the results of a use case in the fresh food delivery, showing the critical aspects of implementing a Blockchain solution. The authors highlight that a correct implementation of the Blockchain technology in the SC must start from an analysis of the needs and the objectives of the different actors involved, with the aim to create a business model capable of highlighting the returns.
Transportation research, Part E:	Zhong et al., 2021	**Method:** modeling	Blockchain can effectively isolate the huge impact of	International Journal of	Ahmed & MacCarth,2023	**Method**: Multiple case study	This study found that blockchain provides an

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Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
Logistics and transportation review			the low freight rate on the container shipping market through real time decision making	Production Economics			immutable digital trace to support supply chain traceability (SCT). This study also provideda framework to specify the scope of an effective blockchain-enabled SCT solution.
IEEE Access	Toyoda et al. (2017)	**Method:** modeling with two parties. The first one belongs to the supply chain, that is, an administrator, such as manufacturers, distributors, and retailers. The second group belongs to the post supply chain parties, that is, second hand shops and consumers.	Blockchain makes the efforts of counterfeiters to clone genuine tags redundant since they cannot prove the possession of products on this system. This result supports the benefits of "Fraud prevention"	Journal of Business Logistics	Gligor et al. (2023)	**Method**: Single case study	This study explains the way that BCT enhances SC transparency
European Journal of Operational Research	Joe et al., 2023	**Method**: modeling	The genuine manufacturer can strategically balance between increasing the quality of its product and adopting blockchain to prevent deceptive counterfeits. However, the availability of blockchain may also lead manufacturers to ignore improving the quality of their products and alternatively invest in blockchain to combat counterfeiting which then leads to lower quality products.	Production and Operations Management	ManMohan et al. (2023)	**Method**: survey to 400 S C managers	The characteristics of the technology do not inform user expectations at the early stages of adoption.
Production and Operations Management	Shen et al., 2023	**Method**: modeling	Permissioned Blockchain Technology helps to combat copycats in the supply chain	International Journal of Operations and Production Management	Song et al., 2023	**Method**: Multiple case study	The success of blockchain-enabled supply chain finance (BSCF) depends on the profiles of BSCF expectancy, instrumentality and valence. Blockchain attributes help solve information asymmetry problems and enhance financing performance.
European Journal of Operational Research	Xu et al. (2023a)	**Method**: modeling	The cross-channel effect and blockchain have significant impacts on the optimal decisions and coordination results.	/	/	/	/

(*continued on next page*)

Table 8 (*continued*)

Operations research/Management science stream				Operations management stream			
Journal	Authors	Method description	key findings and relationship with research questions	Journal	Authors	Method description	Key findings and relationship with research questions
European Journal of Operational Research	Xu et al. (2023b)	**Method**: modeling	The optimal production quantities and optimal collection rates with and without blockchain in the marketplace and reselling modes increase with the allocated cap and platform-enabled power.	/	/	/	/
European Journal of Operational Research	Wang et al., 2023	**Method**: modeling	This study found that blockchain can restrict the misused amount of green loans and improve the environmental performance, but decrease the consumer surplus.	/	/	/	/

creation of a fully integrated ecosystem with improved efficiency and accuracy. The integration of BCT, alongside artificial intelligence and the internet of things, has been recognized as the backbone for supply chain digitization, allowing for automated transactions and reduced transaction time and administrative costs by replacing paperwork with automated data storage processes (Wang et al., 2021). This benefit is made possible through the use of smart contracts and the tokenization of assets.

Smart contracts specify the rules of bidding, listings, token exchanges, reputation status, and other activities. These contracts enable activities such as order fulfilment, shipping, and payment to be executed automatically by the machine itself if the terms of the contract are met (Chang et al., 2020). Special clauses are used to trigger automatic events that lead to the automated fulfilment of customer needs. As a result, smart contracts have garnered considerable attention as one of the most promising features of blockchain, allowing for the automation of ownership transfers and payments.

The benefits of transaction automatization and digitization have been highlighted in several articles in our sample. For instance, Chang et al. (2019) mentioned that transparency and accountability enabled by blockchain helped automate business process re-engineering in tracking supply chain processes. Mangla et al. (2021) noted that the decentralized recording of transactions reduced food fraud. Martins et al. (2022) mentioned that blockchain facilitated the execution of business logic, and process flows, and improved supply chain efficiency. The automation provided by blockchain leads to significant reductions in time and transaction costs, contributing to economic sustainability (Chang et al., 2020). Wang et al. (2023) underscored the need for firms to adjust their capabilities and positioning to take advantage of the latest and dynamically emerging opportunities. In the context of BCT, data-oriented supply chain systems make firms reactive to market feedback automatically. Collectively, these findings suggest that blockchain technologies enable virtual, automated, and data-driven business processes as well as the development and production of smart and customized products (Hanelt et al., 2020).

5.3.6. *Sustainability*

Blockchain has shown significant potential in addressing environmental and social issues, which can pose significant concerns for health, safety, and human rights (Saberi et al., 2019). The manufacturing industry, for instance, has leveraged blockchain's integration with SCM to achieve sustainability. According to Manupati et al. (2020), blockchain-based approaches have reduced operational expenses associated with waste, over-production, and emissions. Additionally, blockchain has facilitated the tracking of products' carbon footprints, allowing customers to make more informed decisions when purchasing goods with lower carbon emissions and taxes, leading firms to renew their supply chains to meet these demands. Xu et al. (2023b) examined the role of BCT in remanufacturing businesses and found that BCT can track and record information on each part of the product, providing more information for the manufacturer which thus enhance reproduction decisions, improve productivity and reduce carbon emission. Biswas et al. (2023) proposed a game theory model between a manufacturer and a retailer that found blockchain to be effective in minimizing environmental damage. However, the implementation of blockchain can also consume high levels of energy, contributing to emissions and exacerbating global warming issues. Therefore, firms should carefully weigh the benefits against the costs before adopting blockchain (Cao and Shen, 2022).

Blockchain also contributes to social sustainability by providing better assurance of fair work practices and human rights in global supply chains. By combining blockchain with IoT and big data, data collection and recording can be automated, preventing data manipulation and improving traceability to achieve social sustainability (Quayson et al., 2021). Saberi et al. (2019) demonstrated that blockchain-based transparency and traceability in supply chains provide better assurance of human rights and fair work practices. Smart contracts can be programmed to track and control regulatory policies, ensuring that products are supplied and manufactured from ethical sources. Furthermore, since the information is stored in blockchain-based systems, any attempts to modify the data require the approval and authorization of designated parties. Therefore, blockchain can also serve as an effective approach to prevent corruption (Wang et al., 2022b). Wang et al. (2023) highlighted that BCT could restrict the misuse of green loans and improve the environmental performance.

5.3.7. *Other benefits*

There are several additional benefits discussed in the current literature, which will be explained below.

Improved demand forecasting and customization. Yoon et al. (2020) argue that BCT can assist exporters in making proactive decisions regarding logistics and efficiently reacting to demand realizations by preparing backup plans. With a more accurate estimation of demand, suppliers can reduce inventory and uncertainties in downstream orders, as well as adjust their manufacturing plans accordingly (Yu et al., 2022). Additionally, Choi et al. (2020a,b,c) demonstrate through their model testing research that BCT can identify risk-seeking, risk-averse, and risk-neutral customers more accurately, which can help on-demand service platforms set optimal service prices using customized pricing schemes. Similarly, Karamchandani et al. (2021) note that BCT improves profits through mass customization and reliable delivery.

The impacts of blockchain technologies on organizational performance depend on various factors, such as industrial types and customers' attitudes toward the technology. For instance, Ji et al. (2022) found that the impacts of BCT on profits vary in terms of industry and customers' psychological readiness to embrace the technology. Therefore, firms should consider these factors when implementing BCT to ensure that it brings positive outcomes to their businesses.

Trust and stakeholder relationship management. Trust plays a critical role in the supply chain, and traditionally, intermediaries such as legal entities or industrial associations have been relied upon as brokers of trust to coordinate transactions. However, in the context of cross-border trade, verifying the identity of issuers of certificates of origin presents a challenge, resulting in the asymmetric trust problem (Chang and Chen, 2020).

Blockchain provides a logical approach to building trust by using cryptography, distributed ledgers, underlying code, and consensus (Abdul and Samir, 2020). This technology addresses the trust problem by recording transactional data that cannot be altered or edited, thus efficiently solving the asymmetric trust problem in international trade. The transparency of information disclosure, reduced business expenses, responsibility attribution, and enhanced information exchange through blockchain technologies make the supply chain a trustless system (Centobelli et al., 2022).

Implementation of blockchain-based supply chain systems builds trust not only in individual partners but also in the BCT itself. This positive effect motivates both the trustee and the trustor (Centobelli et al., 2022). Those benefits have been studied in various industries, including the circular economy (Centobelli et al., 2022), financial sector (Du et al., 2020; Wang et al., 2019), second-luxury sector (Choi, 2019), and food industry (Liu et al., 2022). Furthermore, good buyer-supplier and brand-customer relationships foster internal integration and innovation, contributing to social sustainability.

Cooperation and collaboration among parties within the SC. In today's highly turbulent and digitalized business environment, customer preferences are constantly changing, and interconnected generative technologies have led to a vast number of interdependent parties shaping competitive and cooperative relationships (Wong et al., 2020). The supply chain represents the coordinated configuration of interdependent partners who collaborate to create value (Hanelt et al., 2020). BCT improves stakeholder involvement and collaboration among the parties involved in the supply chain, enhancing an organization's capability to engage proactively with both downstream and upstream stakeholders while simultaneously ensuring visibility and traceability created across the entire supply chain (Dubey et al., 2020). For example, Xu et al. (2023a)'s model consisting of a manufacturer and an online platform showed that adopting blockchain promotes the coordination of the manufacturer and the platform and improved their decision making.

Research in the music industry by Centorriono et al. (2022) reports that blockchain enhances inter-organizational cooperation in value creation. In the Bitsong case, stakeholders include not only artists and producers but also consumers, fans, investors, and regulators. BCT helps build an innovative supply chain system, where fans can use Fan Tokens to obtain digital collectables that enable artists to tokenize their music and establish a trustworthy relationship leading to the success of musical products and projects. At the micro-level, blockchain-based platforms enable artists, fans, and consumers to co-create value and handle the latest trends in the music industry, providing economic benefits to all stakeholders for their collective behaviour.

Similar findings have been reported by Yang (2019) in the maritime shipping supply chain, where blockchain technologies provide opportunities for collaboration in the industry. Wang et al. (2021) argue that collaborative production and maintenance of failed machines in manufacturing factories are guaranteed by blockchain, which greatly improves production efficiency and customer satisfaction. Therefore, blockchain technologies have immense potential in enhancing the cooperation of interdependent parties in supply chains, resulting in the creation of value and economic benefits for all stakeholders involved.

5.4. Practical evidence of BCT adoption in SCM

The DOI theory proposes that one of the main drivers for adopting innovation is its relative advantage over existing innovations (Rogers, 2010). Blockchain technology has the relative advantage over existing SCM system in terms of traceability, transparency, operation cost, authenticity, automatization, and sustainability. Due to these relative advantages, blockchain has been applied in the business field across the whole value chain from product design, to manufacturing, logistics, and even after-sale customer service processes. Meanwhile, the TAM theory notes that technology acceptance is dependent on the perceived fulfillment of users' problems and the attainment of their goals (Zhu and Kouhizadeh, 2019). Blockchain technology applied in SC systems help to improve accuracy, reduce time and cost, enhance transparency and efficiency, etc. All these benefits help SC managers to fulfill their roles, therein make blockchain acceptable and preferential in many industries.

Walmart Canada applied blockchain to solve payment disputes with its 70 third-party freight carriers which delivered over 500,000 shipments annually (Vitasek et al., 2022). The blockchain system continuously gathers information automatically at every step from the tender offer to the proof of delivery and the approval of payment. The information is synchronized in real-time and is open for access to the parties involved in the SC. The system solved the problem of vast data discrepancies in the invoice and payment process for freight carriers which brought reconciliation efforts and serious payment delays. Walmart's case highlighted the unprecedented level of trust its SC visibility has created between Walmart Canada and its carriers, which not only reduced reconciliation cost, but also eliminated disputes and improves efficiency. Supplier relations were improved. However, it has drawbacks. It allows unlimited viewing of information without asking for permission which may reduce the industrial-level and organizational-level security requirements (Vitasek et al., 2022). Similar concerns have been proposed in our samples (e.g. Zhang et al., 2022; Baharmand et al., 2021).

In addition, blockchain has been applied by digital retailers to improve visibility on the supply side to fight against counterfeit products and food fraud (Xu et al., 2023a). A typical example is Alibaba which has utilized BCT in its cross-border supply chains to record product information and track sources for food, through which product information would be automatically delivered to customers (Zhao, 2018). The new pilot program started in 2018 which used the blockchain-based Food Trust Framework to track international shipments to China from Australian healthcare supply firm Blackmores and New Zealand dairy product maker Fonterra (Zhao, 2018). The blockchain network recorded detailed information about country of origin, shipping port and method, arrival port and customs report details (Zhao, 2018). Meanwhile, blockchain also help the retailer and manufacturer learn more about buyer's behaviour so as to reduce demand volatility.

In the home application market, blockchain technologies have been applied to facilitate cooperation between the platform and manufacturers to pursue the 'customer-to-manufacturer (C2M)' business mode. For example, Tmall. Com worked with Gree and Midea to promote the design and manufacturer of dish-washing machines and air-energy water heters based on functional data and after-sales tracking data collected from BCT. The blockchain technology can record the functional status of each part of the products and help the manufacturer identify the vulnerable parts as evidences for product design. The practical evidence of Tmall, Gree and Midea supports many empirical findings, such as Karamchandani et al. (2021), Yu et al. (2022); Choi et al., 2020a,b,c, which expect that blockchain contributed to improved customization, demand forecasting, and reliable delivery.

Recent studies have found that blockchain and remanufacturing are also a perfect match (Xu et al., 2023b). Volve Cars had cooperated with Circulor, a blockchain company, to deploy the industry's first blockchain traceability system to track the cobalt used in their electric car batteries. Cobalt is expensive due to its great scarcity. BCT helps to realize 100 % traceability and recycle of cobalt usage which not only saves the product cost of Volve Cars, but also reduce environmental impacts through recycling (Xu et al., 2023b). Meanwhile, the BCT system can record the functional status and CO2 emission level of each part of the product, providing accurate information for Volve to make remanufacturing decisions. Volve's case demonstrated that BCT do enhance productivity and improve sustainability by providing more reliable and verifiable information for the manufacturer, thus supporting findings of many theoretical studies (i.e., Manupati et al., 2020; Biswas et al., 2023; Saberi et al., 2019; Bai and Sarkis, 2020; Wu and Yu, 2022; Choi et al., 2020a,b,c).

6. Future development prospect of BCT in SCM

A review of the literature shows that there are still many challenges that hinder the wide application of BCT in the SCM of different industries. This research has identified five areas (see Fig. 4) for future improvements that are also key opportunities for BCT in the domain of SCM: standardization, platform development, regulation system development, cost reduction, and talent cultivation.

First, *standardization* is a critical component of the successful implementation of blockchain-based supply chain systems (Anjum et al., 2017). By enabling accurate and seamless communication between partners, standardization can help overcome compatibility issues and ensure the effective management of supply chains. Supply chain systems involve a complex network of downstream, upstream, and parallel operations with different partners, each with its unique business models. The compatibility issues that arise from this complexity can create "engagement barriers" between partners (Anjum et al., 2017). Standardization is critical to overcoming these barriers and ensuring smooth communication and coordination across the entire supply chain. A blockchain-based system can provide a secure, transparent, and tamper-proof way of tracking goods as they move through the supply chain. However, for such a system to work effectively, all participants must be able to communicate information accurately and quickly without technological barriers. To achieve this goal, standardization of technical specifications for blockchain-based supply chain systems is essential. This will allow for seamless integration between different systems and partners, regardless of their business models.

Second, blockchain currently lacks a good operation management *platforms*. Technology service providers such as IBM and SAP have developed some blockchain platforms like Ethereum and Hyperledger, but these platforms have certain limitations in terms of hacking, latency, and smooth data transfer between a firm's existing IT systems and the blockchain (Wang et al., 2019). Developing a common platform for BCT will be a key opportunity for blockchain to be widely applied in SCM. This will help to address issues raised by differing levels of digital readiness, industry-specific technical practices, and cultural barriers. Yang (2019) highlighted that a common platform was critical to facilitate its implication in the field of the supply chain.

Third, there is an urgent need to perfect the *regulation system*. At present, governments and companies are still in a state of uncertainty regarding how blockchain technologies can be applied, their future market potential, and the regulatory mechanisms that supervise the operations of digital SCs. Pattanayak et al. (2023) believed that the pain point of BCT would no longer be the technology itself but the lack of an accompanying set of regulations. Many researchers (e.g., Xu et al., 2022; Alzahrani et al., 2022; Govindan et al., 2022) have highlighted that regulatory uncertainty is one of the main concerns for supply chain practitioners because the distributed nature of the technology and its irreversible functions bring risks for businesses. For example, when one of the supply chain partners leaks key information or data is stolen, many legal obligations are faced by the participants. Therefore, developing a sound governance system (i.e., laws or agreements) is a central component in need of further improvement.

Fourth, *cost reduction*. The initial purchase cost as well as the cost for staff recruiting and training, skills upgrading, and legal and administrative costs associated with blockchain adoption could be high and unaffordable to firms with financial constraints, making this technology challenging to adopt (Li et al., 2021; Niu et al., 2021). As the technology acceptance model posits, the end users' perceived potential of the technology to fulfill the business goals directly impact on their behavioral intentions (Rejali et al., 2023). If firms were unable to transfer the increased costs to the end customers, by setting higher prices or getting government subsidies, the cost of the technology might reduce expected returns on investment and reduced intention for managers to adopt the technology, known as the linkage between a firm's financial constraints and the level of technology adopted (Ullah et al., 2022). For SMEs with limited resources, the return on investment in technology adoption is critical for their success. The high cost associated with blockchain adoption makes it prohibitive for many firms. Reducing costs is an important premise to realize the widespread implementation of blockchain technologies. More efforts are required to make blockchain a simple, safe, effective, and low-cost technology.

Finally, *talent cultivation*. Experts with the right set of professional knowledge and experience are crucial for successful blockchain implementation. However, one primary barrier to blockchain adoption in the industry is the lack of technical expertise (Lohmer and Lasch, 2020; Wang et al., 2021). Currently, there is an uneven distribution of knowledge accumulation between big and small enterprises. Large companies may establish blockchain departments by either investing in existing staff or hiring experts, but smaller firms may struggle to do so (Lohmer and Lasch, 2020). Moreover, skilled workers, particularly developers, are scarce in the labour market (Karakas et al., 2021). This shortage of skilled specialists can be a significant obstacle to the widespread adoption of BCT. To promote blockchain adoption, more efforts are needed in talent cultivation and competence building.

7. Conclusions

7.1. Contribution of this research

This research conducted a systematic literature review of 133 studies from 2008 to 2023, those studies represent the most-recent state-of-the-art knowledge regarding the adoption as well as the application of BCT in the context of SCM. This is in response to the argument that the adoption of BCT in SCM is still in its nascent stages (Alazab et al., 2021), which demands a comprehensive understanding of it for both researchers and practitioners. Hence, first of all, this research contributes to the SCM subject area by providing a comprehensive overview of the latest academic research on blockchain's adoption and application in SCM.

The research results contribute to the knowledge of BCT in SCM through the development of the “from adoption to application” framework where we highlighted the current ongoing transition from BCT adoption to its application. This framework is founded on two theories: the Technology Acceptance Model and the Diffusion of Innovation Theory. Following these two theories, this framework covers not only the drivers and barriers but also the benefits and future development trends derived from the literature review results. These bring academic researchers in this area deeper insights and develop a better understanding of the trends in this emerging field. Scholars new to this field will also find this study to be a comprehensive review of blockchain research relevant to SCM.

In the BCT adoption phase, we identified eight internal drivers and seven external drivers, together with a comprehensive list of barriers. Similar to the recent review of Karakas et al. (2021), which investigated the BCT adoption's enablers, barriers and risks. However, Karakas et al. (2021) did not examine and review the benefits and BCT implementation benefits and obstacles in the application phase. The latest reviews of Wang et al. (2019); Pournader et al. (2020); Asante et al. (2021); Dasaklis et al. (2021); Dutta et al. (2022) analyzed technical implementation aspects of blockchain-enabled supply chains, including data and network security, visibility, traceability, immutability, transparency and integrity. Nevertheless, these recent aforementioned reviews did not consider and integrate the BCT adoption phase with its implementation phase. Our framework contributes to the integration and examination of both the BCT adoption and its transition to its BCT application stage.

In the BCT application phase, we noted Chang and Chen (2020); Chowdhury et al. (2022); Ying et al. (2022) conducted their reviews only on the applications and implementation of BCT in SCM. By looking into each reviewed study alone, we could not gather a comprehensive overview of all relevant implementation issues. Our study focuses on not only the current development of benefits of blockchain technology implementation analyzed in these aforementioned review studies, but also the challenges that impede the successful implementation of blockchain technology in supply chain management. We identified five important areas of future improvements that are crucial for the wider adoption of BCT in the SCM, and significant challenges that are hindering the successful implementation of BCT in SCM.

7.2. Managerial implications

In addition to its theoretical contributions, this study also has significant managerial and practical implications. While previous studies have extensively discussed the adoption drivers and barriers of blockchain technologies in the supply chain management (SCM) field (e.g., Kouhizadeh et al., 2021; Baharmand et al., 2021), this study advances the field by identifying the current development benefits and future development trends of blockchain applications in SCM. As a result, this study provides valuable insights for various stakeholders within the supply chain, such as supply chain managers, practitioners, consultants, and policymakers, seeking to gain a deeper understanding of the utilization of blockchain in SCM.

For supply chain managers and business practitioners, our research offers valuable insights into making informed decisions about adopting BCT in SCM initiatives. On the one hand, although prior research has identified various contribution of blockchain technologies for SCM (e.g., Karamchandani et al., 2021; Li et al., 2020; Chod et al.,2020), this research provides a comprehensive overview of not only the benefits but also the key enablers and barriers that are associated with blockchain's deployment in supply chain. This comprehensive understanding can assist practitioners in developing a strategic perspective of the potential opportunities and disruptive effects of BCT on SCM before making any critical decision. On the other hand, this research highlights the importance of balancing the benefits and costs of BCT adoption to optimize their supply chain operations for increased efficiency and profitability. It is crucial to note that while opportunities do exist, they come with challenges and risks, and the study has shown that BCT is a double-edged sword. Therefore, careful consideration and planning are required before implementing BCT in SCM. To this end, our framework of the adoption and application of blockchain in SCM can effectively support focal companies in weighing the pros and cons of BCT adoption and implementation.

Moreover, the findings of this study indicate that it is imperative for network orchestrators to accord priority to shared value creation and encourage cooperative and collaborative relationships among participants of the supply chain. These insights are crucial for managers in constructing robust and resilient supply chain networks that can adapt to market fluctuations and customer demands. To achieve this objective, practitioners are advised to contemplate the standardization of BCT and the establishment of a unified BCT platform as critical measures in overcoming the “engagement barriers” that may arise due to the incompatibility issues among supply chain partners with varying business models (Anjum et al., 2017).

For policy makers, the research results highlight the significance of mitigating regulatory uncertainties through refining the regulatory framework to enable the extensive adoption of BCT in SCM. Government policies that safeguard and endorse particular firms, such as small-scale firms in emerging economies that poses a limited understanding of BCT, are critical in surmounting the sociocultural obstacles that impede their acceptance of BCT. Furthermore, given that BCT is an essential trend stimulated by Industry 4.0, this research highlights the necessity of cultivating skilled professionals equipped with the requisite and experience to ensure the successful implementation of BCT in SCM.

7.3. Limitations and future research

While this study provides valuable insights into the potential benefits and challenges of adopting BCT in SCM, it is important to recognize its limitations. One limitation is that it mainly considers academic studies and only includes a few industrial evidences, which may result in a narrow perspective of the technology's advancements and applications. To gain a more comprehensive understanding of how BCT is being used in SCM, future research should review more practitioner-based publications and consult a broader range of sources to identify the latest trends in the development of BCT.

Furthermore, although we endeavoured to select qualified studies by using appropriate keywords such as “blockchain” and “supply chain management”, we acknowledge that some relevant articles may have been omitted from our sample. Therefore, future research should aim to incorporate a more diverse set of sources (e.g., papers published in engineering and technical journals since 2018). Additionally, our discussion of future development opportunities is based on conceptual analysis since we only focus on academic articles. Therefore, future research should closely monitor the latest trends in blockchain deployments in the business field and incorporate more empirical evidence into these discussions.

CRediT authorship contribution statement

Keru Duan: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gu Pang:** Writing – review & editing, Validation, Methodology, Conceptualization. **Yong Lin:** Writing – review & editing, Visualization, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests that could have appeared to influence the work reported in this paper. Our co-author, Dr. Yong Lin is a member of the *Journal of Digital Economy* editorial board, he was not involved in the editorial review or the decision to publish this article and had no access to information regarding its review.

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