Blockchain Applications in Digital Construction Supply Chains

Chen Wang, Huaqiao University, China
Benben Cui, Huaqiao University, China*
Yutong Tang, Huaqiao University, China

ABSTRACT

This article takes the relevant construction supply chain (CSC) literature of the Web of Science Core Collection Database in the past 20 years and its construction supply chain - blockchain as the object, and then aims to identify and analyze the articles related to the application of blockchain technology in the CSC, and analyze the related problems and potential of the CSC in the application of blockchain technology. An analysis and exploration of a total of 395 articles was conducted. Through VOS viewer software, the author in collaboration network, key term co-occurrence network, and theme classification visualization network of the research field are extracted. The research status of blockchain technology in the CSC is analyzed, and the two key issues of the CSC are focused on through literature reading, so as to explore the application prospects of blockchain technology, and make relevant discussions and some application prospects for the application of blockchain technology in the future.

KEYWORDS
blockchain, collaboration, information sharing, integration, visualization map

1. INTRODUCTION

The construction industry is one of the largest in the world, accounting for 13% of the world’s total gross domestic product (GDP) and 7% of the world’s total employment population (Barbosa, Woetzel, & Mischke, 2017). With artificial intelligence (AI), Internet of Things (IoT), virtual reality (VR), geographic information systems (GIS), digital photogrammetry, building information modelling (BIM), 3D printing, laser scanning, global positioning system (GPS), radio frequency identification physical equipment (RFID), augmented reality (AR) sensors, robotics, big data management and a series of new and more mature digital (Bhattacharyya, Maitra, & Deb, 2021; Wang, Wang, Sepasgozar, & Zlatanova, 2020)the level of uniformization in the construction industry has been continuously improved, and the way information is shared in the CSC has also changed.
The CSC is the means of delivering a construction project to the i.e., the project owner. It comprises a supply chain of materials, labor, and equipment involving multiple stakeholders, such as owners, general contractors (GCs), subcontractors, and various suppliers (Balasubramanian & Shukla, 2018; Butkovic, Kauric, & Mikulic, 2016; Fischer, Ashcraft, Reed, & Khanzode, 2017). Involves multi-stakeholder integration of supply chain processes, exchange of information and collaboration (J. C. Cheng, Law, Bjornsson, Jones, & Sriram, 2010; Fearne & Fowler, 2006; Hao, Du, Huang, Shao, & Yan, 2019). As a result, these lead to some of the problems in the CSC, such as inefficient logistics and inventory management, extended delivery times, wasted resources and processes, product out-of-specs, and conflicts among stakeholders. At this stage, the BIM collaborative management cloud platform can provide an information platform for cross-departmental data integration and collaborative sharing in the project CSC involving owners, designers, contractors and other participants, such as Li et al. (C. Z. Li, Xue, Li, Hong, & Shen, 2018; G. Xu, Li, Chen, & Wei, 2018; Zhai et al., 2019; Zhong et al., 2017) co-developed a practical cloud platform for microcontrollers in prefabricated buildings by adopting building information modeling (BIM) and the Internet of Things (IoT). These multidimensional IoT-BIM platforms can help collect real-time data to improve visibility and traceability of production, logistics, and on-site installations. Different stakeholders can then track the cost and progress of the project (C. Z. Li et al., 2021) which greatly improves the efficiency of information sharing. However, there are some problems with the promotion process of cloud platforms. Building Information Modeling (BIM) is difficult to achieve real-time improvements in the Internet of Things (IoT) when it comes to making changes (Xue & Lu, 2020). Random errors, noise, or malicious data generated by IoT sensors can lead to a single point of failure in IoT networks, degrading the data quality of BIM, and negatively impacting the trustworthiness of IoT BIM (Lee, Lee, Masoud, Krishnan, & Li, 2021). The lack of an information security system seriously hinders the sharing of information between all parties. Data privacy, trust, and intellectual property are key issues in the digital transformation of the construction industry (Ahmed, Tezel, Aziz, & Sibley, 2017; Sadeghi, Wachsmann, & Waidner, 2015). A secure information assurance system and a trusting approach to information exchange help improve the efficiency of information sharing within the building supply chain and ensure the achievement of overall project performance objectives. As a result, blockchain technology has attracted the attention of practitioners and researchers as a solution to the drawbacks of existing information sharing in the construction industry.

Blockchain is a peer-to-peer (P2P) distributed data structure that cryptographically and securely stores a series of data information into the blockchain in chronological order (J. Li, Greenwood, & Kassem, 2019). Blockchain was introduced in 2008 in a white paper on Bitcoin, the world’s first cryptocurrency, proposed by Satoshi Nakamoto (Nakamoto, 2008). Yoo (Yoo, 2017) argues that blockchain is an encrypted digital distributed ledger technology that is stored in public or private networks on many computers, allowing participants in the network to exchange various transaction data between them. This distributed database maintains an ever-growing list of information records in a decentralized manner, with each list on the network storing a copy of the chain and using a consensus mechanism to verify transactions to ensure the immutability of the chain, forming blocks that prevent tampering and adjustment (Bashir, 2017; Duan, Zhang, Gong, Brown, & Li, 2020; Nakamoto, 2008). Services and application platforms built through blockchain technology can be divided into public blockchains, private blockchains, and public-private consortium blockchains according to the level of accessibility (Al Barghuthi, Ncube, & Said, 2019; Corbet, Lucey, & Yarovaya, 2018; Mensi, Al-Yahyaee, & Kang, 2019; Oh & Shong, 2017; Scully & Höbig, 2019). Through these services and platforms, key product dimensions can be highlighted and detailed: nature, quality, quantity, location, and ownership (Saberi, Kouhizadeh, Sarkis, & Shen, 2019). Based on these characteristics, blockchain applications can at least play a role in reducing costs, accelerating the digitization of physical processes, increasing reliability, reducing risk, and enhancing sustainability in terms of chain management (Kshetri, 2018). For example: Turk and Kline (Turk & Kline, 2017) have studied the potential of blockchain technology in building information management, arguing that blockchain
can improve the reliability and credibility of construction logs, the work performed and the number of materials recorded. In addition, the study shows that blockchain technology can also provide secure storage of privacy-sensitive sensor data during the facility maintenance phase (Turk & Klinc, 2017). Wang et al. (Z. Wang et al., 2020) has developed a blockchain-based information management framework for the supply chain of prefabricated construction projects that can improve the timely delivery of prefabricated components and enable stakeholders to track the cause of disputes in the supply chain. Xiong et al. (Xiong, Xiao, Ren, Zheng, & Jiang, 2019) A blockchain-based framework for information sharing in the building supply chain is proposed to eliminate intermediaries in transactions and enhance the security of transactions by designing private key distribution protocols. Both the above research and industry cases demonstrate the potential application value of blockchain in CSC management. Therefore, the purpose of this paper is to grasp the application status of blockchain technology in the building supply chain through the method of literature review, scientifically and quantitatively summarize and analyze the development of the green model of the building supply chain, determine the current technical level and examine the future challenges and opportunities. Explore new solutions that building supply chain management offers through blockchain technology and how these solutions can be adopted to improve performance, sustainability, and safety in the future. The structure of this article is as follows: Section 1 is the introduction, followed by section 2 Research Methods, and Part 3 Bibliometric Analysis. Parts 4 and 5 are an analytical discussion of the application of blockchain technology in the CSC. Section 5 is the conclusion and related outlook of the analysis of the application of blockchain technology.

2. RESEARCH METHODS

The overall methodological stance adopted for this study is a mixed philosophical stance of hermeneuticist and (Al-Saeed, Edwards, & Scaysbrook, 2020; Roberts, Pärn, Edwards, & Aigbavboa, 2018; Smith et al., 2021; Spellacy, Edwards, Roberts, Hayhow, & Shelbourn, 2020) systematically analyzing existing literature using a scientific metrology method using existing literature as a valuable data source (Aghimien et al., 2021; Chamberlain, Edwards, Lai, & Thwala, 2019; Edwards et al., 2021; Nazir et al., 2020). Reduce the potential impact of researcher bias by applying quantitative and qualitative data analysis methods (Bryman, 2016; Saunders, Lewis, & Thornhill, 2019). This paper provides a systematic review of literature through the visual exploration of VOSviewer software and the ability to create bibliometric networks (Van Eck & Waltman, 2020).

2.1 Database Selection

As a comprehensive academic information resource database, WOS Core Collection Database includes more than 12,000 authoritative and influential academic journals in the field, with strong academic representation. Therefore, the WOS Core Collections Database was chosen as the source of literature to investigate trends through a preliminary review of the WOS Database.

2.2 Search Rules and Control Criteria

1) The target literature was selected as an English paper published in the past 20 years.
2) Further cleaning and filtering of the sample is required to ensure that only relevant items are included in subsequent analyses. Apply specific criteria (including paper type, language, year, and journal) to filter search results and find the latest papers related to compatibility. That is: (ALL (“Blockchain”) AND ALL (“Construction Supply Chain”)) AND (EXCLUDE (DOCTYPE, “cp”)) AND (EXCLUDE (LANGUAGE, “German”) OR EXCLUDE (LANGUAGE, “Chinese”)) or exclude(language, “Lithuanian”) or exclude(language, “Portuguese”)).
3) In order to avoid differences between different research directions, the index journals are limited to journals related to the construction industry. For example: Journal of Architectural
Engineering and Management, Engineering Construction and Construction Management, Building Automation, etc.

Through the preliminary search of the WOS core collection database, 395 papers related to the CSC were retrieved, constituting the CSC literature. Figure 1 shows the distribution of papers in the journals searched. The further addition of the qualifier blockchain results in only 17 documents constituting the relevant building supply chain — blockchain literature, See Table 1 for details.

2.3. VOSviewer Software Visual Co-occurrence Analysis

Contribution analysis of the CSC is carried out using a preliminary search database. A co-occurrence analysis of keywords was created using the titles and abstracts of the literature to understand the main keywords and topics used in the supply chain of the sample building. A co-author network is conducted using a complete counting method to showcase authors who contribute to the CSC. Since these analytical analyses do not provide insight into the literature, and since the application of blockchain technology in the construction industry is in its infancy, a content analysis is also carried out at the end.

3. RESULTS

Figure 2 shows a co-occurrence analysis graph of keywords created using the database literature from the preliminary search. The size of the node indicates the number of publications that contain these keywords, and the larger the number, so the larger the node, the larger the body of knowledge in the field. Different colors indicate the number of years the institute is in. Through the difference in color, we find that blockchain technology appears in a corner of the upper left corner of Figure 2 as the latest technology applied to the CSC. The application of blockchain technology as an emerging technology in the CSC is still in the exploratory stage, and there is a lack of relevant research.

Figure 3 shows a network of co-authors created using the full count method, which takes into account the weight of each co-author to the paper as “1”. Therefore, the total weight of the article will be equal to the number of authors of the article (Perianes-Rodriguez, Waltman, & Van Eck, 2016).

Figure 1.
Map of article distribution in the construction supply chain based on selected journals
Each circle in Figure 3 represents an author whose diameter size is equal to the number of publications of corresponding authors indexed in WOS. The approximate strength of a co-author link between corresponding authors is expressed by the distance between the two circles. Colors such as green or yellow indicate clusters of authors with strong co-author links. Figure 3 shows that there are 160 co-authors in the literature, with a minimum of 1. This clearly shows that there are many co-author sets that are not related to each other and that different subdomains may be studied in the literature.

### 3.1 Literature Exploration and Analysis

In order to further explore the application prospects of blockchain technology in the CSC, we will conduct a detailed review of the searched construction supply chain and construction supply chain–blockchain literature, and explore the role of blockchain technology in promoting the CSC in combination with other relevant research on blockchain technology. First of all, in order to identify the
key issues in the CSC, based on the searched CSC literature, we reviewed the abstracts and keywords of each article from 2010 to mid-2022, identified some high-frequency issues of CSC, sorted out the problems faced by the CSC, and integrated some characteristics of the CSC (see Table 2 for details). The most important issues in the CSC at present involve multi-stakeholder collaboration and integration, information sharing, green supply chain management and sustainability, etc. which are also partially reflected in the keyword co-occurrence analysis chart. Based on the advantages...
of blockchain technology, we will focus on the two aspects of multi-stakeholder collaboration and integration and information sharing in the CSC

3.2 Collaboration and Integration

Collaboration and integration between different stakeholders in the CSC plays a vital role in green supply chain management (GSCM) and sustainable processes in the CSC. GSCM and sustainable processes are designed to reduce environmental damage to the construction industry. The net green outcome of a building project is the sum of the efforts of different stakeholders at all stages of the supply chain, from initial design to finish-of-life demolition, and the GSCM approach was seen as a way to streamline the decentralization efforts of the green sector. In the GSCM process, focus is on green innovation, operation, evaluation and decision-making.

Some (Guo, Yu, & Gen, 2020; Long, Liu, Li, Chen, & Health, 2020; Yin, Li, & Xing, 2019; Zhu, Fang, Shi, Wang, & Li, 2018) supply chain processes by leveraging an evolutionary game approach to explore the impact of different stakeholders in the CSC, promoting shared values and incentives. In particular, governments play a vital role in the green transformation of the building supply chain, and collaboration and integration among other stakeholders can be fostered through government incentives and penalties. Collaboration and integration between different stakeholders (Akan, Dhavale, & Sarkis, 2017; Balasubramanian & Shukla, 2018; Dallasega & Rauch, 2017; Du et al., 2019; Gaur & Vazquez-Brust, 2019; Jiang, Lu, & Xu, 2019) helps to effectively implement GSCM and enhance sustainability in the CSC. Long-term collaborative collaboration among stakeholders in the CSC can significantly reduce emissions and improve the economic performance of the supply chain (Du et al., 2019; Jiang et al., 2019). The economic performance generated by working together to reduce emissions will create a positive and reinforcing cycle that continuously improves the sustainability of CSCs if they can be linked to shared values and incentives to improve sustainable processes. Long-term partnerships can better leverage the performance of proactive management in terms of clearly defined roles, initiative in project planning, regular performance measurement, and problem early warning (Meng, 2020). Collaboration in the supply chain enables stakeholders to identify root causes and solutions for rework and defects (Taggart, Koskela, & Rooke, 2014). Abedi et al. (Abedi, Rawai, Fathi, & Mirasa, 2014) leverages cloud computing technology to mitigate poor

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<th>Table 2. Characteristics of the CSC in terms of organizational relationships, lead core, product characteristics, information flow, process management, supplier management, etc</th>
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<td><strong>Project</strong></td>
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planning and scheduling, reduced design flexibility, long production lead times, problems such as heavy prefabricated components, and poor coordination in the field. Or facilitate collaboration by developing an information-sharing system (Isatto, Azambuja, & Formoso, 2015; London & Singh, 2013) to improve supply chain planning and management (Abedi et al., 2014).

3.3 Information Sharing

The sharing of information is also critical to reducing emissions and improving the sustainability of CSCs (Akan et al., 2017; Karlsson, Rootzén, & Johnsson, 2020; Kim, Woo, Rho, & Chung, 2016). The construction industry has long been plagued by the problem of information silos, lacking effective communication. The reason for the information island is that the construction project involves numerous participants, there are various information transactions, and there is not a full understanding between the different project participants. Therefore, there is a large number of information asymmetries in the entire large construction market environment. In the entire CSC management process, each participant cannot fully provide the information they have, and the participants will choose to hide the real information for their own interests, and even cover up the information that is unfavorable to themselves out of private interests. In addition, in addition to the participation in the main body of their own information asymmetry, information in the transmission process will gradually produce deviations, the supply chain of node enterprises often according to the adjacent upstream enterprises to implement the company’s plan, due to the continuous distortion of information in the transmission process, downstream enterprises cannot grasp the real effective information, usually resulting in inconsistent with the requirements of upstream enterprises, which exacerbates the difficulty of information sharing in the CSC.

If information transparency can be enhanced, information flow can be effectively tracked, and participants’ trust can be increased to fundamentally solve the problem of information silos, so as to determine a feasible GSCM solution. It will reduce emissions and enhance sustainability. In terms of reasonable incentives and punishments that can promote business cooperation and information sharing in the supply chain (Hao et al., 2019) mutual trust among stakeholders in the CSC is essential. A reliable communication platform can facilitate knowledge sharing among stakeholders. The decentralized nature of CSCs presents the challenge of sharing knowledge (Saini, Arif, & Kulonda, 2019). The main challenge is the traditional way of working with construction organizations. Challenges and obstacles are divided into technical, coordination, integration and organizational issues. Management factors, such as coordination and organizational issues, rather than technological development issues, are the main reasons for the excessive implementation period of information exchange. Reasonable rewards and punishments can stimulate stakeholder interest in sharing knowledge, thereby enhancing trust among stakeholders (Hao et al., 2019). While these studies can demonstrate that the main barriers to sharing tacit knowledge within the CSC are traditional methods and management factors that work in construction organizations, including coordination and organizational deficiencies. Despite these valuable findings, governance systems that provide reasonable rewards and punishments have not been studied. In addition, there is a lack of research on how to overcome the serious obstacles caused by traditional organizational structures.

3.4 Advantages of Applying Blockchain Technology in the CSC

Blockchain is a distributed ledger (J. Li et al., 2019) that mathematically stores blocks of data, coding and linking on multiple nodes (Abeyratne, Monfared, & Technology, 2016; Pala, Edum-Fotwe, Ruikar, Peters, & Doughty, 2016; Saini et al., 2019; Samaniego, Jamsrandorj, & Deters, 2016) to improve data security (Watanabe et al., 2015), traceability and transparency (Badzar, 2016; Tian, 2016). The technology provides a transparent, time-stamped chain of responsibility that enables authentication of products, services, transactions, documents (certificates) and information. At the heart of blockchain technology is the joint maintenance of transactions and databases by all currently participating nodes, making transactions based on cryptographic principles rather than
trust. Technically, a block is a data structure that records transactions, mainly including two parts: the block head and the block body. The block body is mainly used to record transaction information, record all the computing nodes participating in the transaction on the main chain or part of the main chain, and then the transaction data is hashed to obtain the Merkel tree root value of the block body. In addition, blockchains allow for smooth data transfer, and for public blockchains, for the AEC industry data interoperability between different applications can be achieved. Blockchain makes shared data immutable and traceable. In addition, smart contracts enable construction stakeholders to establish digital rules or contracts using data stored in a blockchain network. By leveraging these two key advantages that differentiate blockchain technology from other IT technologies, the construction industry will be able to enhance sustainability and facilitate collaboration and information sharing in the supply chain (Betti, Khoury, Hallé, & Montreuil, 2019; Longo, Nicoletti, Padovano, d’Atri, & Forte, 2019; Zhang et al., 2020). Blockchain technology creates true sharing, which will eliminate the need for value generated between service providers and purchasers by third-party middlemen and middlemen. As a result, blockchain can help streamline procurement and payment processes and optimize the flow of materials, enhance trust between stakeholders, and create truly open purchasing arrangements based on accounting, which is necessary for collaboration and certification in the industry. In addition, the CSC has been committed to the application of various information technologies, such as cloud-based information sharing systems, to promote supply chain collaboration and information sharing. While these technologies can provide an effective platform for information sharing and management, they are not yet fully effective in enhancing sustainability and facilitating collaboration and information sharing. Lack of trust in data prevents stakeholders from collaborating and sharing information. In addition, since the data is not trustworthy, it cannot be used as a basis for implementing smart contracts to monitor and reward mutually agreed efforts to enhance sustainability and collaboration. Blockchain makes shared data immutable and traceable. In addition, smart contracts enable construction stakeholders to establish digital rules or contracts using data stored in a blockchain network. The benefits of tamper-proof and traceable information sharing and smart contracts can also enhance collaboration in the supply chain. Data authenticity, integrity, and traceability in blockchain promote trust among stakeholders such as systems and cognition-based trust (Qian & Papadonikolaki, 2020) and fast trust (Dubey, Gunasekaran, Bryde, Dwivedi, & Papadopoulos, 2020).

3.5 Disadvantages of Applying Blockchain Technology in CSCs

From the cognitive side of blockchain, since blockchain has a public chain and a private chain, the full potential of blockchain can only be achieved through public blockchain, because private blockchain is not much different from distributed databases in terms of data security (Tezel, Papadonikolaki, Yitmen, & Hilletofth, 2020). How to weigh the use of public chains and private chains requires a wise comparative analysis of the business types of the blockchain, so the advantages and disadvantages of the public chain and the private chain in the blockchain should be correctly communicated to the managers of the participating entities on the CSC. Managers in the current supply chain lack the motivation to use blockchain technology, and even if they adopt it, it is more to control the application of the blockchain than to improve the efficiency of transactions between all parties. From the performance point of view, the technical level of the blockchain has not yet reached a certain height, the number of transactions that can be processed per second on the blockchain is limited, and with the continuous advancement of construction projects, a large amount of transaction data will be generated in the supply chain, which will produce a series of performance problems. In addition, in the AEC industry, there are no substantial example use cases in blockchain-based asset tokenization, SCM, and procurement (Tezel et al., 2020). In addition, the development of blockchain technology has not yet formed a good interaction with the laws, regulations and management methods related to construction projects, and the lack of blockchain-based governance frameworks and mechanisms in the construction industry will affect the operability of the technology in the CSC.
4. DISCUSSION AND CONCLUSION

In the process of transformation and upgrading of the construction industry, it is necessary to promote the sharing of information in the CSC. Blockchain technology can enhance information sharing, and blockchain can improve supply chain transparency, ensuring information sharing and thus increasing trust among stakeholders. In addition to the collaboration and integration and information sharing presented in this article, the two core issues of the building supply chain, blockchain applications can potentially solve and improve other problems in the CSC: (1) green supply chain management and co-ownership Continuity, (2) tracking of material logistics, and (3) counterfeiting of information, etc. But in this article, we mainly analyze the two problems of collaboration and integration and information sharing, and analyze the potential of blockchain technology to solve problems. Blockchain technology because of its decentralized trust, prevention of tampering and other characteristics, the application of blockchain can have a significant impact on supply chain traceability and traceability, as well as anti-counterfeiting and product authenticity, in solving the problem of cooperation between various entities in the CSC Problems such as low integration, difficulty in information sharing, lack of trust, difficulty in regulatory traceability, and information security show great potential. In the future, with the further development and improvement of blockchain technology, we can build a mutually trusting building supply chain alliance with the help of the blockchain + smart contract model to achieve continuous value-added of the project value stream.

The first opportunity for the use of blockchain technology in the construction industry is related to the improvement of data systems and information flow, and blockchain can constitute a layer of trust on the Internet of various digital transactions in the construction industry, making those information technology-based industries the main beneficiaries, especially in facilities management, smart cities, digital twin creation, and material procurement management. For example, the optimization of decentralized procurement processes and the implementation of material sources in the construction industry increase the sustainability of the entire supply chain. If all material certificates and quality inspections during construction were stored and shared in a blockchain system, this would make measuring sustainability much easier. Second, blockchain can serve as a trusted communication medium between participating entities in the supply chain, promoting the creation of a decentralized public data environment in the future. At the same time, the digitalization of the construction industry is accelerated by overcoming major digital barriers related to trust, transparency, data traceability, etc. For example, systems with transparent chains of custody encourage good behavior and drive quality, which in turn sets high-quality products and trusted suppliers apart and establishes long-term partnerships. Finally, while the traceability and transparency features in blockchain are applicable to large public client organizations in the construction industry, small organizations can compete with large organizations by forming a trust-based procurement framework through blockchain. Leverage smart contracts to support automated payments, source tracking, contract management, disintermediation, data ownership and control, and trust-building procurement and supply chain activities. The value that blockchain technology can provide is deployed at the beginning of the procurement process and can facilitate collaboration among various stakeholders. All transactions completed by participants will be stored and recorded on the blockchain during procurement and delivery, providing oversight of deliveries and enhancing the regulatory system. As a result, blockchain technology can support new business models that can form a truly open ledger.

Given the increasing prevalence of over-hyping the concept of “blockchain” and related products, it is necessary to conduct a rational and systematic analysis of blockchain technology. Blockchain technology offers disruptive latest business solutions in multiple areas, including supply chain management, and managers on the supply chain currently lack the motivation to use blockchain technology, and even if the technology is adopted, it is more to control the application of the blockchain than to improve the efficiency of transactions between all parties. Future related research may be aimed at the following aspects: blockchain technology can improve product quality inspection and
assurance, and studying the impact of blockchain technology on supply chain performance related to quality issues may be an area worth exploring; From the performance point of view, the technical level of the blockchain has not yet reached a certain height, the number of transactions that can be processed per second on the blockchain is limited, and with the continuous advancement of construction projects, a large amount of transaction data will be generated in the supply chain, which will produce a series of performance problems; From the perspective of supply chain efficiency, it will be of great significance to study the role of blockchain technology on the rate increase of supply chain processes. In addition, the development of blockchain technology cannot form a good interaction with the laws and regulations and management methods related to construction projects, and there is a lack of blockchain-based governance frameworks and mechanisms in the construction industry, which will affect the operability of the technology in the construction supply chain. As the scalability and scalability of blockchain are further revealed, the supply chain integration value chain based on multiple blockchains is also a possible future research area.

Blockchain as an emerging technology has been shown to benefit supply chain operations in other industries, such as food consumer markets, healthcare, and finance. The application of blockchain technology in the CSC is an emerging area of research and development in the construction industry. The application prospects of blockchain technology can be uncovered through key issues in the CSC. To further adapt to blockchain technology, the most important step is to identify the key issues facing the CSC and identify the main influencing factors for solving the problem, reflecting on how blockchain technology can potentially combine with these factors. However, a comprehensive review of blockchain-based solutions to key problems is conducted. However, at this stage, there is a lack of relevant research to provide theoretical guidance, determine the causal relationship between the key problems faced by the CSC and the potential solutions of the application of blockchain technology, and establish a basis for effective management of blockchain implementation.
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