



# Blockchain technology-based sustainable management research: the status quo and a general framework for future application

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Received: 18 March 2022 / Accepted: 27 June 2022 / Published online: 6 July 2022  
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## Abstract

The problems of data leakage and unreliable information transfer in the management process make sustainability management an inevitable need for future development. Globally, there is increasing attention paid to blockchain technology and particularly its application in addressing sustainable management issues, both from academia and industry. Aiming to deepen the understanding of how blockchain technology could deal with sustainable management issues across different disciplines, this paper investigates the latest research on the application of blockchain technology in sustainable management published from 2017 to 2021. It is found that there is a drastic surge of publications in the recent 2 years. The analysis focuses on authors' origins, the collaboration network of the keywords, countries, and research topics covered. The application of blockchain technology in five key sectors of sustainable management, encompassing energy management, construction management, supply chain management, environmental management, and e-government management, is selected for further analysis detail. Also, a general framework for applying blockchain technology is proposed for broadening its use and dealing with sustainable management issues. The findings show that the identified 108 publications are distributed in 75 different journals, and scholars from China, the UK, and the USA have been working closely in BT-based sustainable management research. Blockchain technology is just emerging in sustainable management, and there is a great potential for applying blockchain technology to improve sustainable management performance and, more importantly, to provide solutions to quite a few long-lasting problems in these sectors. Opportunities for future research are also presented and discussed.

**Keywords** Blockchain technology · Sustainable management · Energy management · Construction management · Literature review

## Introduction

The blockchain technology (BT) refers to a digitally distributed data structure that records and shares data and

information between any two parties (peer-to-peer network) in a verifiable and tamper-proof way that applies globally (Lansiti and Lakhani 2017). It enables the evolution from the traditional centralized to the distributed network, which can be achieved securely without the need for a trusted authority (Dutta et al. 2020). It earned worldwide fame via bitcoin (Nakamoto 2008) and the associated cryptocurrency transactions (Islam et al. 2018). However, applying BT is not limited to bitcoin in the finance field. Over the last decade, its application has been promoted by various governments around the global. For example, a report by the UK government states that BT might have the capacity to “reform our financial markets, supply chains, consumer and business-to-business services, and publicly-held registers” (Andoni et al. 2019; Walport 2016). The US government published the Blockchain Promotion Act and the US Export Finance Agency Act for exploring BT promotion across government agencies and export–import banks (Dewey 2022). The Canadian federal government was experimenting with BT throughout different departments, particularly in the

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Canada Border Services Agency, intending to improve data quality and facilitate the movement of goods (Grant Simon and Matthew 2022). Theoretically, BT can be innovatively adopted to address various management issues, including the revolution of information and communication technology, and digital economics (Upadhyay 2020). During the period, there has been a rapid development of BT application across critical sectors of sustainable management, including environmental management (Pellegrini et al. 2020), supply chain management (Zelbst et al. 2019), and healthcare management (Biswas et al. 2020).

The past application of BT in different disciplines witnessed its strength in improving management effectiveness and efficiency. Specifically, it can effectively resolve the critical challenges for energy trading and the loopholes and bottlenecks of management in distributed energy systems, such as deception, malicious tampering, and subception (Cong and He 2019; Liu et al. 2020; Tasatanattakool and Techapanupreeda 2018). With the features of BT, the insufficient Building information modeling (BIM) can also be replenished, so that the transaction costs traditionally associated with construction projects can be reduced or removed, and consensus and information exchange in a meaningful manner can be reached (Li et al. 2019; Succar 2009). Furthermore, BT provides the probability of strict supervision for illegal dumping and occupation (Bennett et al. 2019; Pellegrini et al. 2020), product traceability, and food quality (Astill et al. 2019; Chen et al. 2021), and can resolve the problem of data security and authenticity among governments, citizens, and businesses (Fu and Zhu 2019; Ramsey et al. 2020).

An extensive review of BT-related literature tells that the current application of BT in addressing sustainable management issues is still at the infant stage. In detail, the concept of sustainable management is becoming known to scholars, which is proposed to achieve sustainable development. It is mainly applied to the green supply chain (An et al. 2021; Khan et al. 2021), sustainable transport systems (Ullah et al. 2019, 2021), sustainable environment (Pellegrini et al. 2020), and medical waste sustainability (Singh et al. 2022). Notably, sustainable management relies on information with several features, including high reliability, efficient transfer, and absolute truthfulness, which cannot be achieved by traditional information technology and is considered an impossible challenge. The blockchain as a emerging technology can perfectly adapt to the information needs of sustainable management, which given its significant potential for decentralization (Croman et al. 2016; Crosby et al. 2016), distrusting (Arvind Narayanan et al. 2016), transparency (Bonneau et al. 2015; Lin and Liao 2017), traceable and unforgeable (Karame et al. 2012), anonymity (Arvind Narayanan et al. 2016; Christidis and Devetsikiotis 2016), and credibility (Karame et al. 2012).

Therefore, it is necessary to promote more comprehensive and in-depth application of BT to realize sustainable social development. As a commonly applied technology, BT can be better exploited to deal with problems across the key sustainable management sectors, though a framework might help to adapt to the particular context of industries. Prior research efforts have been made to apply BT in various fields (Abou Jaoude and Saade 2019; Hasselgren et al. 2020; Makhdoom et al. 2020; Miglani et al. 2020; Paulavicius et al. 2019). However, the research status and directions of BT in the field of sustainable management remains to be clarified. Particularly there is still a lack of the general framework to apply BT in sustainable management as aforementioned. This paper aims to fill the research gap. On the one hand, this study seeks to understand the current status of research and research trends by systematically and critically reviewing papers on the application of blockchain technology in sustainable management. The outcomes are expected to assist scholars in gaining an in-depth understanding of previous research efforts on this topic and to grasp the directions for future research. On the other hand, establishing the general framework for BT application to help managers and researchers quickly comprehend the steps of blockchain implementation to accelerate the application of BT in sustainable management. The paper attempts to answer the following three research questions (RQs):

RQ1: What are the main research directions on blockchain technology-based (BT-based) sustainable management at present?

RQ2: What are the challenges and opportunities of BT-based sustainable management research?

RQ3: Is there a general framework for applying BT in addressing sustainable management issues?

## Research methodology

### Review approach

The principle of systematic literature review (SLR), was defined as “[...] a referential method to organize, synthesize and identify emerging paths and opportunities, as well as understanding the relevant issues, contradictions and limitations, based on previous studies. (Queiroz et al. 2020),” was followed to design the research methodology. SLR provides a timely and effective approach for investigating the issues and field concerned.

### Planning and conducting the review

The process for identifying and selecting papers is presented in Fig. 1, which involves four phases, including

identification, screening, eligibility check, and content analysis phase. Firstly, research databases, including Web of Science Core Collection, Springer, and Scopus, are used as the primary sources for searching the literature, which allows target papers to be found by the search terms and exported with their meta-information (Ante et al. 2021; Zupic and Cater 2015). Meanwhile, the back-reference list checking which selected papers from the reference in the target paper is implemented to identify additional relevant articles.

Secondly, to cover the holistic topics and keywords for BT-based sustainable management research, we use the following the search code: TS=(blockchain OR “block chain” OR cryptocurrency\* OR “distributed ledger”) AND TS=(energy OR construct\* OR “supply chain” OR “carbon emission” OR land OR water OR waste) AND TS=(management OR manage\*). The asterisk (\*) represents any group of characters in the research terms, such as “construct\*” covers both “constructor” and “construction.” The specific time frame is determined as a 5-year period (i.e.,

from 2017 to 2021), because the bitcoin whitepaper was published in 2008, and the first literature relevant to sustainable management was published in 2017.

Similar to some literature review papers (Syn and Ramaprasad 2019; Wang and Su 2020), scientific papers published in peer-reviewed journals are selected, while all other kinds of publications like proceedings, books, and technical reports are excluded for analysis. The found papers merely focusing on computer science are also excluded and the identification of the papers limit to the scope of the five key sustainable management sectors and the research categories of management business and operation research and management science. Furthermore, the language is limited to English.

**bibliometric analysis**

Co-citation analysis is conducted, the purpose of which is to measure the relationship between studies. It would be

**Fig. 1** Paper selection process

Phases	Input	Process	Output
Identification	Database: Web of Science Core Collection, Springer and Scopus Scope: ALL records Time span: 2017-2021	CODE: TS=(blockchain OR “block chain” OR cryptocurrency* OR “distributed ledger”) AND TS=(energy OR construct* OR “supply chain” OR “carbon emission” OR land OR water OR waste) AND TS=(management OR manage*)	Total records: 854 items
Screening	854 items: articles, conference papers, book chapters, reviews, articles in press Item time span: 2017-2021	Screening: title, author, source, keywords, abstract  - selected the document type of Articles and Review Articles - selected the research categories of Management, Business and Operations research management science	448 items
Eligibility	448 items: journal articles and reviews Item time span: 2017-2021	Assessing the full text articles for eligibility  - remove if not: written in English; available in full text version; associated with BT and/or management	108 items
Content analysis	108 items: journal articles and reviews Item time span: 2017-2021	Grouping the data into categories  - chronology of papers - measuring main authors’ contributions - classification of the identified papers - co-citation analysis	Result: - descriptive results - conceptual results - a general framework for future application

helpful to demonstrate the frequency with which earlier papers were cited by the later ones (Small 2010). This not only implies a timely relationship but also composes a network of papers. By doing so, the central study in the cluster of publications can be identified.

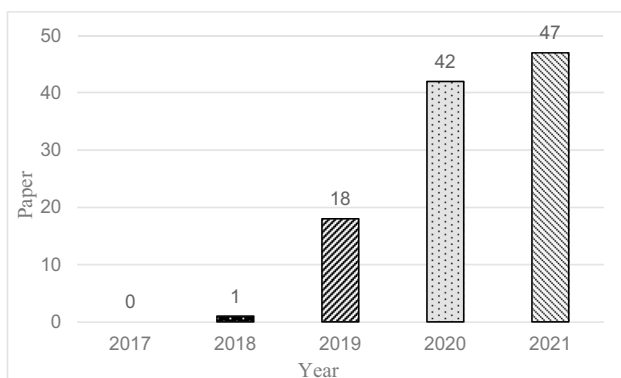
### A brief analysis of the identified studies

#### Year wise publication details

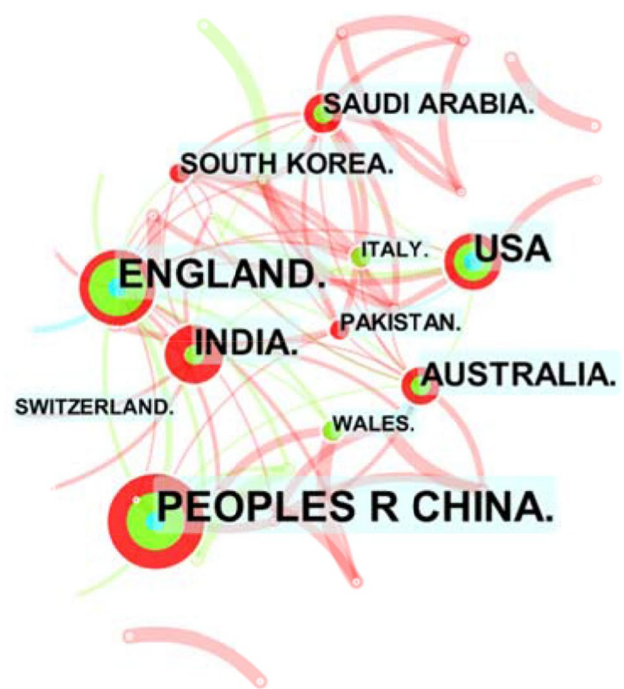
Figure 2 shows the publication frequency of BT-based sustainable management-related papers between 2017 and 2021. Overall, there are 108 papers identified for analysis from 75 different journals. Notably, nineteen journals (25.33%) published two or more papers, while only three journals (4%) published four or more. A closer examination tells that 27 review papers (25.00%) and 81 research papers (75.00%). The detailed journal-wise distribution of the identified papers is provided in Appendix Table 2.

#### Country collaboration network

BT-based sustainable management researches have been contributed by scholars from different countries. Country collaboration analysis is conducted so that the cooperation intensity and relationship between those countries can be better interpreted (see Fig. 3). In the figure, the size of the circle represents the frequency of published papers in any specific country, and the ties show the strength of cooperation between the countries connected. Notably, the scale of the circle is consistent with the number of papers in the countries. For instance, the corresponding nodes of China, the UK, and the USA are much larger than in other countries, indicating that scholars from the three countries have been working closely in BT-based sustainable management research. To facilitate a comprehensive understanding, the



**Fig. 2** The publication frequency of papers on BT-base sustainable management (2017–2021)



**Fig. 3** Country collaboration network

cooperation network among significant countries is provided in Table 1.

#### Co-occurrence frequency of keywords

A co-occurrence analysis was conducted with the indexed keywords in identified papers to understand the core intellectual topic addressed by the extant research with the VOSviewer software (He et al. 2021). Blockchain and management emerged as significant keywords in the overall network in Fig. 4, which can be explained by the size of the node and the lines between the keywords. From the perspective of clustering, all keywords are clustered into six groups with different colors, which occurred in other years. The blockchain, as one of the core keywords, connected various keywords in a different years, which were dyed different colors, including BIM, construction industry,

**Table 1** The main countries’ cooperation network

Countries	Countries with main collaborations
China	England, Russia, Vietnam, Germany
UK	China, India, Scotland, Germany, France, Wales
Australia	Canada, Netherlands, Sweden, China
US	Australia, Singapore, Hungary, England, United Arab Emirates, Austria
India	Singapore, Switzerland, Bangladesh, South Africa
Saudi Arabia	Pakistan, Iran, Italy, Egypt, South Korea, Spain



power, energy, sustainable city, and E-governance. The prominent combinations indicate the rising importance of specific characteristics of blockchain technology which has been useful in various fields of sustainable management. Notably, the other emerging technology, including the internet of things (IoT), big data (BD), and peer-to-peer (P2P), has developed and applied alongside BT. Therefore, it is necessary that notice the typical application of BT in various fields and its combined application with other technologies.

### BT application in key sectors of sustainable management

After a careful review of the identified papers from the research objective, five management sectors, including energy management, construction management, supply chain management, environment management, and E-governance management, are determined for further analysis. The sample distribution in these management sectors is described in Fig. 5.

#### Construction management

At present, the research on BT in the domain of construction management stays at a theoretical level (Li et al. 2020). However, the construction management processes, including planning, design, construction, and maintenance, provide good conditions and opportunities for applying BT (Anjum et al. 2017). Such a viewpoint is also supported by a few facts, including (1) the complex and fragmented

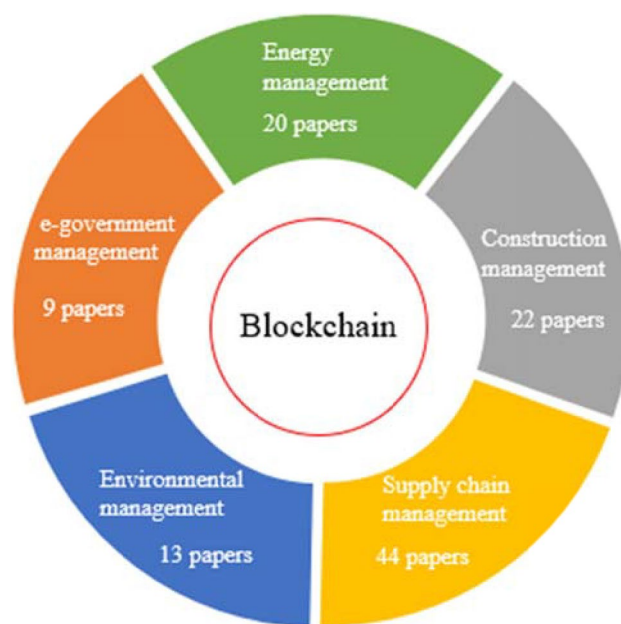
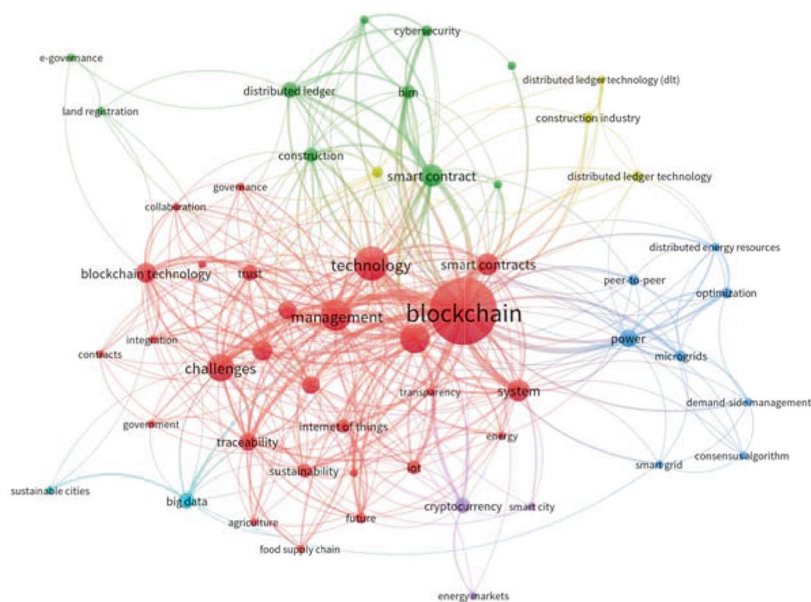


Fig. 5 The sample distribution in five management sectors

supply chains of the projects in the construction industry (Hunhevicz and Hall 2020); (2) the mutual trust problems existing in construction projects that originate from the interdependent action of numerous stakeholders (Pishdad-Bozorgi and Beliveau 2016; Zolin et al. 2004); and (3) the high volume of transactions among various entities and stakeholders (Kim et al. 2020). Therefore, BT can be applied to improving construction project performance under several scenarios, such as multidisciplinary data updates and

Fig. 4 Co-occurrence frequency of keywords



validation, information interface of the project, time-limited the transaction, and interaction in transaction (Anjum et al. 2017; Liu et al. 2019).

In the construction project lifecycle, blockchain can help tackle sustainable management issues related to data security and trusts, such as bidding and tendering, archiving documents, controlling model access, and updating transaction settlements during the planning and design stages (Li et al. 2019). In the phases of the construction and maintenance, the payment system of construction contract can be tricky. Yet, with the aid of blockchain, automatic payment can be achieved to improve project finance in the construction industry (Cardeira 2015; Wang et al. 2017). Furthermore, smart contracts based on the blockchain can also benefit facility management and maintenance (IEBC 2018), material procurement (Geipel 2017), and supply chain management (Kim and Laskowski 2018). Overall, using blockchain helps solve sustainable management issues regarding data and information management, contract, and finance management in the construction industry, which bears the potential to have a significant impact on construction management.

### Supply chain management

The data storage and management processes of the traditional supply chain are centralized and depend on third-party organizations (Howson 2020), which makes it challenging to meet the demands of consumers for traceable data and transparent commodity information. Yet, the unique features, including traceability, transparency, and immutability of blockchain, offer opportunities to improve supply chain management (Shahid et al. 2020). Blockchain technology was first applied in agriculture to establish a system for tracing agricultural products (Tian 2016). With the rapid development of research in different disciplines, current research of supply chain management with BT includes the multiple uses of BT to improve food supply chain management (Chen et al. 2021; Howson 2020; Shahid et al. 2020; Yadav et al. 2020), the adopt of BT to achieve sustainable supply chain management (Esmailian et al. 2020; Saberi et al. 2019), enhancing international supply chains by BT application (Y. L. Chang et al. 2020a, b; Choi et al. 2019), the management of internal, and external supply chain with BT (Di Vaio and Varriale 2020; Kim and Shin 2019).

Specifically, food supply chain management includes not only safety issues, but also origin fraud and quality defects (Aung and Chang 2014). The fisheries supply chain, as one of the major food supply chains, faces more common difficulties than the others (Howson 2020), including illegal and unregulated production (Young 2016); laboring under coercion (Vandergeest and Marschke 2020); material waste

(Wilcox et al. 2016); and food provenance missing. A sustainable supply chain has attracted the attention of academics and government, as an essential part of circular economy practices. With the use of blockchain technology, data and information of a supply chain can be disclosed to different stakeholders to improve its sustainability. Due to the security and authenticity of information realized by BT, supply chain risks can be minimized to improve business performance and reliability (Ivanov et al. 2018). Meanwhile, adopting BT in supply chain management can eliminate human errors and reduce transaction times (Saberi et al. 2019) and help achieve trust to benefit the consumers (Ward 2022). In addition, sustainable supply chain management with BT can not only mitigate greenhouse gas emissions and resource consumption, but also downsize the carbon footprint and tax (Kshetri 2018). Notably, the global supply chain has entered the digital era, and its management has become more challenging due to the associated uncertainties in the geopolitical, technological, and economic spheres (V. Chang et al. 2020a, b). Nevertheless, the adoption of blockchain technology in the global supply chain is still in its infancy. Several scholars explored the applications of BT in the global supply chain, including exploiting global supply chain information and facilitating the profit distribution across the global supply chain (Choi 2020; Deloitte. 2017; Hald and Kinra 2019). Therefore, the adoption of blockchain can be leveraged to tackle these issues and devote itself to meeting sustainable management goals of different supply chains.

### Environmental management

The critical elements of environmental management include the atmosphere, land, water, and waste, which provide the foundation for the people's living environment. Managing these factors has become increasingly complex with a surge in urbanization rate and economics in many countries. In particular, developing countries face more issues than developed countries in different aspects, such as wasteful land use, illegal land possession, lack of precise irrigation, insufficient water security supervision, and illegal waste dumping.

A few studies investigate the use of BT to tackle existing issues in the convention of environmental management. Bennett et al. (2019) offer a new operation mode and service for traditional land management with blockchain technology (Bennett et al. 2019), to improve the transparency of land records and transfers. Meanwhile, sustainable development goals are achieved through clear ownership and valuation to reduce fraudulent transactions with BT (Hughes et al. 2019; Pandey and Litoriya 2021; Thakur et al. 2020; Veeramani and Jaganathan 2020). Even though agriculture irrigation

and city water supply play an essential role in many countries, it is hard to perform comprehensive supervision and sophisticated management without advanced technology. Thus, some scholars explored the application of blockchain technology in this direction to achieve accurate, automatic, and real-time water billing and water quality monitoring to ensure the achievement of a number of relevant management (Ramsey et al. 2020), including guaranteed water security and precise irrigation management (Munir et al. 2019), and achieve water conservation goals (Ramsey et al. 2020). Also, waste management is a critical activity in the urban environment, which has the potential to contribute more to the development of a circular economy with technical support. The practice of waste management can be combined with BT and adherent platforms to realize digital waste management (Pellegrini et al. 2020). It can prevent not only illegal dumping but also reduce the cost and carbon emission of the recovery, which can be regarded as drivers for improving the environment and society (Berglund et al. 2020).

### Energy management

The blockchain research of the energy sector covered various areas, including the power grid (Calvillo et al. 2016; Di Silvestre et al. 2019), P2P network (Li 2016; Zhou et al. 2020), internet of energy (Miglani et al. 2020; Rifkin 2011), and energy transaction (Ahl et al. 2020). Among these areas, energy transaction focuses more on the management practice compared with the other aspects. It may be due to the tendency of each stakeholder to pursue their maximum interests, the traditional energy transaction management framework faces significant challenges and risks under the current conditions of energy management, such as security risks of spoofing, malicious tampering, and subterfuge (Liu et al. 2020; Noor et al. 2018; Van Cutsem et al. 2020). Therefore, researchers utilize BT to improve traditional energy management theories and tools.

The efficient demand-side forecasting and secure data transmission were perceived as crucial facilitators to an energy transition, which forms a context to impel the reformation of the traditional energy management transition toward a new paradigm of a distributed system for energy management. Those new technologies, e.g., BT, facilitate the implementation of a distributed energy systems that can break through the bottlenecks of traditional energy management (Tasatanattakool and Techapanupreeda 2018). Several advantages have been obtained with the application of BT in the energy field, including achieving the more efficient performance of energy transmission (Jin et al. 2017; Macrinici et al. 2018; Pop et al. 2018; Wang and

Su 2020), realizing simplified multi-layer trading systems (Kareem et al. 2020), capturing sustainable consumption (Ben Ruben et al. 2017), and developing decentralized energy trading and supply systems (Brilliantova and Thurner 2018; Casado-Vara et al. 2019; Wang et al. 2019; Zhang and Hao 2017).

### E-government management

Electronic government (E-government) commonly involves three domains, namely, government to citizen (G2C), government to government (G2G), and government to business (G2B). Information transmission is the basis of E-government, which provides a platform for different business organizations, citizens, authorities, and government agencies, to circulate data among themselves and improve performance effectively (Kumar and Bhalaji 2021). Due to the reason that it prone to cyber-attacks by culprits who purpose to steal vital information, an increasing number of scholars introduced BT to ensure data and information security (Fu and Zhu 2019). It is worth noting that the alliance chain, a type of blockchain, caught wide attention in E-government for its several characteristics and advantages, which overcome the disadvantage of the traditional system to promote the striding of government management to “smart government” (Fu and Zhu 2019; Kumar and Bhalaji 2021).

## Discussions

### The major function of BT in sustainable management

Various sectors have utilized the BT to improve their performance and management practices, including energy, environment, construction, supply chain, and E-government. Notably, it can be summarized that the previous studies have specifically categorized the use of BT in sustainable management into three aspects, namely, transactions, technical support, and supervision.

Specifically, the aspect of the transactions focused on financial transactions during management processes. The P2P network of the energy market is a classical application in transactions aspect (Li et al. 2019), which efficiently connects the contracting parties, provides more transparent transacting information, and denies the involvement of intermediaries to improve the performance of energy management (Wang and Su 2020). It was confirmed that payment systems and supply chain finance using blockchain technology greatly decreased the possibility of project failure in the construction industry

(Salah et al. 2019). The carbon trade and tax have attracted more studies to improve the performance of environmental management. However, the other parts also provided similar advantages for the environment, such as the land trade and water trade, which are concentrated on the aspect of demand and supply management.

The aspect of technical support is considered one of the most important parts, which encompasses multiple applications of blockchain technology in sustainable management. The platform and database were identified as the crucial components for supporting data-driven management. A few blockchain-based energy commodity trading platforms with large banks and trading companies (Gallacher and Champion 2019). Blockchain technology has changed the long-standing “paper” transaction model and then turned it into a more transparent, more convenient and cheaper “electronic” model for oil and gas companies, and commodity traders (Wang and Su 2020). Meanwhile, the new model provided a few advantages for improving the transparency of commodity transactions and reducing the risk of fraud. However, it is notable that the importance of sensitive information for all parties was stored in various servers supported by blockchain to provide accuracy and security database and visualized database for management practice. Therefore, information sharing and updating can be better supported, which facilitates more efficient supply chain management.

The aspect of supervision was regarded as a necessary segment for realizing sustainable management goals, which applies to the project lifecycle and the management process. In addition, blockchain technology helps energy companies automatically to track the information of renewable energy automatically. For example, the utility of BT in sustainable energy management is confirmed by a pioneer user in the renewal industry as, “this innovation shows us that it is a crucial catalyst in the process of decarbonising the economy, allowing traceable, secure and rapid transactions.” (Iberdrola 2019) Therefore, on the one hand, the use of BT to create an effective supervision way can reduce the illegal dumping and illegal occupying of land, water, and waste fields, which provides a new path for sustainable development. On the other hand, BT ensures untampered data, which can guarantee accurate information, such as place of origin, transferring record, temperature, and humidity of the goods in the supply chain.

### Challenges of blockchain technology applying in management

The emerging technologies, like BT, hardly adapted to variable demands without suitable government policy, law, and regulatory environment at the macro-level. Also, the

application of those technologies in management process cannot achieve rapid development and promotion, even with BT (Li et al. 2019). Among the functional domains of BT, P2P electricity market has expanded slowly (Zhu et al. 2020), while smart city seldom attempts to employ BT. Therefore, it is essential to ensure a an appropriately developed environment that allows the use of blockchain to thrive in the long term and facilitate its further use.

The conflict between blockchain and conventional management practices cannot be ignored at the micro-level (Li et al. 2019). The current management system may be contrary to the conditions required by BT. For example, some conventional practices may be matched with the new system, resulting in the failure of BT adoption in practice. Therefore, the conflict between existing management systems and blockchain use must be addressed when promoting such an integration. It is also quite challenging to select an appropriate theory or design new coordinate mechanism for its development.

From a technical perspective, there are several potential drawbacks to blockchain technology, including suffering from the over-51% attack (Mistry et al. 2020), high development cost (Kumari et al. 2020), lack of reliable data standards, and low fault tolerance of the system (Salah et al. 2019). However, the use and development of BT in the domain of sustainable management are problematic due to the lack of experienced personnel to support BT use. Therefore, it remains a challenge to ensure the availability of BT use standards and concordant mechanisms for sustainable management.

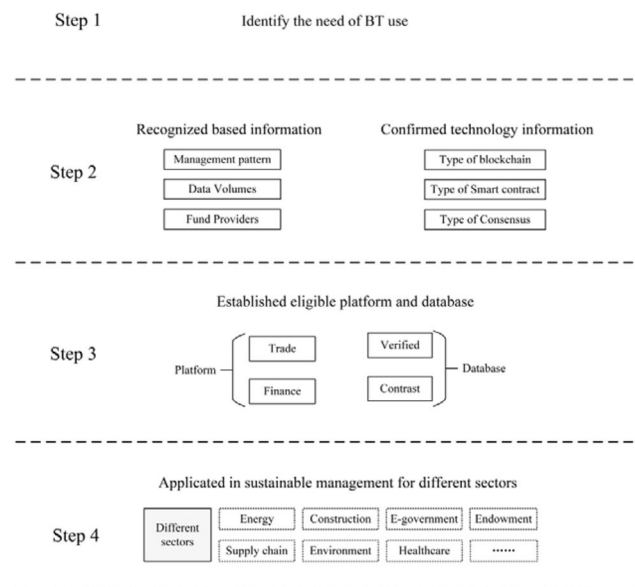


Fig. 6 The step of applying BT in sustainable management



## General steps for applying BT in sustainable management

Generally, as identifying the need and necessity of BT use in a specific field is the first step, especially in the management process as illustrated in Fig. 6. Such an effort can help avoid the interruption of the original management model and process caused by the abrupt application of blockchain. Meanwhile, it can also contribute to improving the management efficiency and realizing the technical effectiveness of blockchain in management practice. Notably, the application of BT in practice mainly involves finance and information and mainly depends on the characteristics of the sector in which BT is applied. In addition, the identification of the internal and external properties was considered a major application of blockchain technology in management. The internality and externality are interpreted as the requirements of the platform for different elements, which can help to select the types of blockchain adoption, smart contract, and consensus system. Therefore, the aforementioned step ranked second. The third step relies on the above step to establish a financial platform and realize standardized information processing, including verification, comparison, and preconditioning. It has four main features, which are high transfer speed, good reliability, satisfactory security, and high efficiency. The fourth step is the beginning of the managerial application, which is based on the framework of BT. At present, it is mainly used to trace the goods information in the supply chain and construction project management, identify geographic information and supervise relevant illegal behavior in environment management, support energy trading platform in energy management, enable policy and regulation communication, and penalty information recorded in E-government. Therefore, there are four steps for blockchain technology to function in sustainable management, which provides a new management approach for practitioners.

## The opportunity for future research

Blockchain technology has been practiced to facilitate sustainable management. However, there are still a number of problems remaining to be solved or revealed. The following discourse refers to the key sustainable management sectors to point out the potentials of BT use that future research can explore.

In the supply chain sector, the use of disruptive technologies, including blockchain, big data platforms, and even decision systems, continuously transforms supply chain management (Pournader et al. 2020). Yet, some features are found in relevant research. On the one hand, dramatically increasing academic literature focus on a single aspect rather than the framework that accommodates the implementation and integration of those technologies. On the other hand,

the trust issues in sharing information and signing contracts should be managed. For example, to deal with information dissymmetry on the trade and financial information transmission between buyer and seller (Wang et al. 2021), to let all the relevant supply chain partners have access to the same sets of accurate data or ensure an instantaneous signed contract (Saberli et al. 2019). They will have some theoretical implications to contribute, so researchers should investigate the integration of BT and hardware in the supply chain. It is also fairly important to explore how the relationship between various supply chain partners may change and what influences contracting and coordination mechanisms, is when trusted information sharing and instantaneous trade systems based on blockchain technology are well adopted in the supply chain.

In the construction sector, the construction project involves a complex network of stakeholders, who have multiple different needs and goals. For example, owners pay more attention to the transparency of information sharing, while contractors tend to have opportunistic behavior (Lee et al. 2020; Lin et al. 2019). In the future, understanding the influencing mechanism and the key driving factors for applying blockchain in the construction industry can significantly improve the performance and success of projects. Notably, the platform to share information cannot be ignored and will become the impetus to break through the traditional limitations and address managerial issues, which is similar to applying them to the supply chain sector. The primary purposes of such an adoption are to improve data security, reduce privacy issues, and remove the probability of data missing during the process of transferring data to external systems.

In the other sectors, including E-government, environment, and energy sectors, researchers can pay more attention to the application of BT in the management process. The regulation of the environment and energy is an important management task. Therefore, based on the abovementioned information platform, management, and regulation, the framework should be improved and practiced with blockchain technology. The trade aspect of E-government was ignored in the research field, which mainly included government procurement and payment. The features of blockchain technology can effectively prevent illegal behaviors such as tax evasion, bribery, and stakeholder conflicts.

Healthcare plays an essential role in national public infrastructures, which supports the fundamental guarantee of national production and effectively curbs the spread of the epidemic. BT has become a fundamental technology in the digital revolution of the healthcare sector. Likely in the future, such applications in the field of medicine could include electronic health records (Skiba 2017), health insurance (Engelhardt 2017), biomedical and drug research (Brennan and Lunn 2016), drug procurement and supply,

and medical education (Radanovic and Likic 2018). In particular, shared healthcare resources and information in the public medical policy field can flow into different organizations and institutions in a reliable way with the aid of a BT-enhanced information system. Such a function has significant importance. For example, in the current COVID-19 pandemic or influenza pandemic, it is crucial to share some of the patients' information, which has tamper-proof properties, with many organizations, and the transmission time cannot be lost (Radanovic and Likic 2018). Blockchain had the potential to keep valuable time from unnecessary lost, while at the same time assisting in controlling the epidemic. Endowment has become a severe issue for society with the global aging trend. On the one hand, it proposes a challenge for the health care system and economic development. It requires not only a perfect medical aid system and accurate information records, but also a strong economy to support it. On the other hand, it provides an opportunity for technological development and increasing employment in the related fields.

## Conclusions and future work

This study analyses the current research on BT-based sustainable management, which reviews 108 papers from the databases of Web of Science Core Collection, Springer, and Scopus during the period of 2017–2021. The empirical results support that blockchain as a promising technology indeed promotes the revolution of the sectors, including construction, energy, environment, supply chain, and E-government. The long-term value of BT will gradually be revealed, especially in sustainable management during the government and industrial revolution. Therefore, a few conclusions are presented as follows.

From the frequency of publications in BT-based sustainable management research, after 2017, BT attracted wide attention from more scholars around the world. With the increasing trend of innovations in sustainable management with BT, such diffusion is confirmed in the reviewed literature. The development and reformation of various industries have been greatly promoted, which makes blockchain have a broad development prospect. The basic research of the blockchain in sustainable management is in its infancy, so this paper concludes that research in this field will continue to flourish in the coming years.

Regarding the country-wise ranking of blockchain studies in sustainable management, China is the country with the

most relevant articles published in the world. It should be noted that India ranks third after the US regarding the number of paper published in this field, and the fourth is the UK. Such a result means that developing countries are paying more effort to develop scientific and technical innovation research and are gradually beginning to be a pioneer of BT use research. Therefore, revealing that emerging counties have devoted substantial research and development expenses and policies to support the basic research, their gap with developed countries is gradually narrowed.

The results of the keyword cluster analysis show that the existing studies pay more attention to the supply chain and construction industry, especially, the food supply chain and smart city, and try to solve the problems of information tampering and information traceability encountered in these sectors. Notwithstanding, scholars strive to understand and utilize the characteristics of BT, such as trustworthiness, privacy, and transparency, and combine the use of BT with IoT, BIM, and the Internet, to overcome the problems and breakthrough bottlenecks in relevant management practice. Thus, the use of BT can enhance the security in information exchange, reduce the possibility of information fraud, and finally, help achieve the goal of intelligent management.

In summary, the multiple characteristics of BT provided a feasible solution for sustainable management. More importantly, although the developed countries have put forward the basic theory of this technology, developing countries are playing a more critical role in the global blockchain technology research system. In particular, the total number of articles published by China and India has exceeded that of the USA and the UK, which could originate from the developing economies' determination of economic and industrial reformation that may not be paid equal attention to by developed countries.

However, as review-based research, this study has certain limitations. Firstly, although a broad list of keywords was used in leading research databases, which may overlook a few important works owing to the dispersion in the function of the employed keywords in this field. Secondly, this study did not consider "gray literature," i.e., the general non-academic literature, including technical reports, newspapers, blogs, and webpages. Future research can be directed to improving BT implementation framework and revealing the evolution of the BT research in the field of sustainable management.

## Appendix

Table 2

**Table 2** Journal-wise distribution of selected papers

Journal name	No. of articles	Per. of articles
Sustainability	6	5.56%
IEEE Access	6	5.56%
Automation in Construction	5	4.63%
Journal of Cleaner Production	4	3.70%
Journal of Enterprise Information Management	3	2.78%
International Journal of Production Research	3	2.78%
International Journal of Logistics-Research and Applications	3	2.78%
International Journal of Information Management	3	2.78%
Ieee Transactions on Engineering Management	3	2.78%
Engineering Construction and Architectural Management	3	2.78%
Tehnicki Vjesnik-Technical Gazette	2	1.85%
Technological Forecasting and Social Change	2	1.85%
Operations Management Research	2	1.85%
International Journal of Production Economics	2	1.85%
Information Systems and E-Business Management	2	1.85%
Computer Communications	2	1.85%
Applied Energy	2	1.85%
Annals of Operations Research	2	1.85%
Wireless Personal Communications	1	0.93%
Trends in Food Science & Technology	1	0.93%
Transportation Research Part E-Logistics and Transportation Review	1	0.93%
Transactions on Emerging Telecommunications Technologies	1	0.93%
Trac-Trends in Analytical Chemistry	1	0.93%
Sustainable Production and Consumption	1	0.93%
Resources Conservation and Recycling	1	0.93%
Renewable & Sustainable Energy Reviews	1	0.93%
Project Management Journal	1	0.93%
Production and Operations Management	1	0.93%
Omega-International Journal of Management Science	1	0.93%
Nature Energy	1	0.93%
Mathematical Problems in Engineering	1	0.93%
Marine Policy	1	0.93%
Management Decision	1	0.93%
Land Use Policy	1	0.93%
Land	1	0.93%
Kybernetes	1	0.93%
Ksii Transactions on Internet and Information Systems	1	0.93%
Ksce Journal of Civil Engineering	1	0.93%
Journal of Signal Processing Systems for Signal Image and Video Technology	1	0.93%
Journal of Parallel and Distributed Computing	1	0.93%
Journal of Modern Power Systems and Clean Energy	1	0.93%
Journal of Management in Engineering	1	0.93%
Journal of Intelligent & Fuzzy Systems	1	0.93%
Journal of Innovation & Knowledge	1	0.93%
Journal of Infrastructure Systems	1	0.93%

**Table 2** (continued)

Journal name	No. of articles	Per. of articles
Journal of Information Security and Applications	1	0.93%
Journal of Construction Engineering and Management	1	0.93%
Journal of Business Logistics	1	0.93%
Journal of Building Engineering	1	0.93%
Journal of Ambient Intelligence and Humanized Computing	1	0.93%
International Journal of Physical Distribution & Logistics Management	1	0.93%
International Journal of Operations & Production Management	1	0.93%
International Journal of Logistics Management	1	0.93%
International Journal of Interactive Multimedia and Artificial Intelligence	1	0.93%
International Journal of Environmental Research and Public Health	1	0.93%
International Journal of Emerging Markets	1	0.93%
International Journal of Electrical Power & Energy Systems	1	0.93%
Information Systems Frontiers	1	0.93%
Information Development	1	0.93%
Ieee Transactions on Industry Applications	1	0.93%
Frontiers in Energy Research	1	0.93%
Environment Development and Sustainability	1	0.93%
Energies	1	0.93%
Electronics	1	0.93%
Computers & Electrical Engineering	1	0.93%
Computer Journal	1	0.93%
Buildings	1	0.93%
Building Research and Information	1	0.93%
Atmosphere	1	0.93%
Applied Sciences	1	0.93%
Advanced Engineering Informatics	1	0.93%
Total	108	100.00%



**Author contribution** Wenbo Du: conceptualization, formal analysis, investigation, methodology, software, writing—original draft; Xiaozhi Ma: investigation, review, and editing; Hongping Yuan: methodology, review, and editing; Yue Zhu: data curation, validation, review, and editing.

**Funding** This study was financially supported by the National Social Science Foundation of China (grant number: 20BGL187).

**Data availability** Not applicable.

## Declarations

**Competing interests** The authors declare no competing interests.

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