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Impact of Blockchain in Enhancing Sustainable Supply-Chain Activities within Enterprises

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Abstract

Blockchain technology, as a distributed digital ledger with the features of transparency, traceability, and security, has the potential to contribute considerably to sustainable supply-chain management (SSCM) activities within enterprises and may already be used to achieve this in some instances. To gain an understanding of the importance of blockchain technologies in the implementation of SSCM, this study conducted an extensive literature review before investigating the ScienceDirect database of articles on SSCM and blockchain. The study used bibliometric and content analysis to analyze the ScienceDirect SSCM and blockchain publications and reveal their intellectual structure and publishing patterns. Findings were that the field of blockchain and SSCM is still emerging and the number of articles published in the field is growing swiftly in both developed and developing countries. Decision science; computer science; business management and accounting; economics; econometrics and finance; energy; engineering; environmental science; social science; and multi-disciplinary fields were found to be the areas in which the SSCM and blockchain are discussed within the ScienceDirect journals. The articles reviewed were published from 2018 to 2023. It was found that even though blockchain technologies are still in their early stage and developing in the space of supply-chain management, these technologies can play a vital role in executing SSCM activities.

Keywords

Sustainable supply-chain management1, Blockchain 2, Bibliometric analysis 3, Transparency 4, and Traceability 5.

1. Introduction

All stakeholders in a supply-chain system rely heavily on accurate data and strategic business procedures. However, a lack of mutual trust can be an obstacle to implementation (Al-Rakhami and Al-Mashari, 2021). Collaborative partnerships can be established through either trust-based interactions or electronically mediated exchanges (Myhr and Spekman, 2005). The implementation of a shared ledger as a security measure has the potential to eliminate the numerous audits that are currently necessary for supply-chain management systems and processes (Breese-Vitelli et al., 2019). A distributed ledger limits opportunistic behaviour and the influence of environmental and behavioural uncertainty (Schmidt and Wagner, 2019). The blocks within the network comprise transactions that are immutable, encrypted, and tamper-proof. A distributed network helps facilitate a decentralized consensus protocol that is responsible for validating these transactions.

Blockchain technology has been cited as a tool that can assist in the implementation of successful sustainable supply-chain management (SSCM) within industries (Munir et al., 2022). SSCM needs to consider all issues across the product lifecycle and the conduct of all suppliers in the supply-chain network (Fiksel, 2013). Ensuring that its business activities are conducted in an environmentally and socially sustainable operational manner is also a vehicle for

maintaining a company's profitability measures (Bastas and Liyanage, 2018), with the aim of improving the economic, social, and environmental outcomes of global supply-chain management (Koberg and Longoni, 2019). The implementation of sustainable practices throughout the supply chain has presented numerous obstacles and difficulties for industries such as manufacturers, however, which can be attributed to the effects of globalization, outsourcing, and offshoring (Khanfar et al., 2021). Globalization in particular complicates supply-chain management. According to Kshetri (2021), through the implementation of blockchain technology, diverse challenges faced by various stakeholders could be overcome. Blockchain could transform the supply chain towards sustainability as it records supply-chain transactions in a distributed ledger (Munir et al., 2022). Better product traceability, accountability, and resource efficiency are all ways in which a blockchain-based distributed ledger improves the sustainability of the supply chain. Blockchain technology also offers security to the supply chain, which may aid global supply-chain management (Saberi et al., 2019), with Paliwal et al. (2020) pointing to transparency and traceability as the primary benefits of using blockchain technology to achieve SSCM. The utilization of blockchain technology is known to increase the predictability of suppliers and to establish resilient and sustainable supply networks through its connectivity and fast, immutable information-sharing capabilities (Najjar et al., 2022). In addition to the features mentioned above, attributes such as smart-contract functionality, decentralization, and data privacy, in conjunction with a consensus mechanism, make it a useful tool for current supply chains, which are complex and multi-tiered (Mukherjee et al., 2021. When all nodes in a network agree on the legality of transactions and the balance of the ledger, this is called a consensus mechanism, while the smart contracts are legally binding agreements between two parties where the terms and conditions have been programmed into the computer code itself. Within this context, the study reported on in this paper aimed to investigate the importance of implementing blockchain technologies in SSCM through literature and bibliometric reviews of research conducted in the field.

1.1 Research questions

To gain an understanding of the importance of blockchain technology for SSCM, the following research question was developed for the study:

How are blockchain factors enhancing the role of sustainable supply chain management (SSCM) within supply chain networks?

Sub-research questions

To answer this research question, three sub-research questions were posed:

- How do the transparency and traceability of blockchain technologies enhance SSCM activities?
- What is the impact of the implementation of blockchain technologies and sustainable supply-chain activities on incentives and stakeholder collaboration?
- How are blockchain technologies ensuring safety, cost savings, and operational efficiency to enhance SSCM?

2. Literature Review

According to Han and Rani (2022), the use of blockchain technology in SSCM has improved the safety, traceability, transparency, and efficiency of operations management procedures. Blockchain can play a pivotal role in the reduction of the sustainable-principle violations that are currently taking place in developing economies, as it promotes a sustainable supply chain (Kshetri, 2021). The five elements of blockchain – distribution, encryption, tokenization, immutability, and transparency – enable the advantages of blockchain technology in SSCM and play a crucial role in ensuring cost saving within supply-chain networks. The implementation of blockchain technology has the potential to impact the sustainable performance of manufacturers through the provision of transparency, traceability, real-time information sharing, and data-security capabilities (Khanfar et al., 2021). This literature review is structured according to the subjects of the sub-research questions set out above.

2.1 Traceability in SSCM and blockchain

Blockchain technology is widely regarded as a potential game-changer in the realm of supply-chain management, (Munir et al., 2022), even though there are several authors who have identified that blockchain technology specifically in the field of supply-chain management is emerging and in an early developmental stage (Kouhizadeh and Sarkis, 2018; Saberi et al., 2019; Ouariti and Bennouri, 2022). The advent of blockchain application development is intended to assist businesses, particularly in ensuring transparency in the supply chain of various commodities (Haughton et al., 2022). Its inherent transparency and tamper-proof nature are expected to increase the efficacy of the tracking and

tracing system (Munir et al., 2022). A blockchain-based solution eliminates the need for a secure centralized structure, middlemen, and information transfers; in addition, it improves performance and complies with strict security and integrity standards (Prashar et al., 2020).
The current global landscape is characterized by economic turmoil, political instability, widespread disease outbreaks, and the pervasive influence of social media, all of which have resulted in a shift in attitudes towards sustainability when compared to previous years (Mangla et al., 2022). Environmental concerns have led to the implementation of governmental and regulatory policies that have compelled firms to modify their supply chains (Manupati et al., 2020). Collectively, implementing blockchain systems can make it simpler for focal companies to collect data (e.g., certification, date, location, pricing, and quality) from their supply-chain partners, in this way improving SSCM (Sahoo et al., 2022). By certifying and recording data in real-time, blockchain enables a swift settlement that reduces transaction costs and boosts transparency across a supply-chain network (Sahoo et al., 2022). The term "swift settlement" is used to describe the efficient and quick execution of agreements and transactions within a supply chain using blockchain technology. This also has potential advantages for the food supply chain, such as quality preservation, fraud prevention, anti-counterfeiting measures, and cost reduction (Munir et al., 2022). The food industry supply-chain has witnessed a significant increase in globalization, which has increased the importance of farm-to-table food safety and quality certification (Prashar et al., 2020).

2.2. Enhancing Sustainability and Transparency in Supply Chain Management through Blockchain and IoT Technologies

In addition to traceability, the utilization of blockchain technology has the potential to enhance transparency (Munir et al., 2022). The concept of immutability in blockchain technology entails the requirement for all users to agree when modifying data and information within the system, while preserving previous records in distinct blocks (Khanfar et al., 2021). Blockchain technology can monitor orders, receipts, payments, and digital assets such as warranties and licenses in a consistent and transparent manner (Litke et al., 2019). Information is disseminated through a decentralized, open-access network among supply-chain members, and transactions require certification, verification, and access by members of the network community.

The issue of social sustainability is a significant consideration in the context of global supply chains, as it concerns protecting workers from exploitation and ensuring the provision of a secure working atmosphere (Venkatesh et al., 2020). Because of blockchain's immutability, orders, receipts, payments, and digital assets can be tracked reliably and without error, protecting employees from exploitation and guaranteeing a safe workplace for all.

Blockchain technology facilitates the establishment of reliable partnerships among supply-chain stakeholders, enhances food safety, enables humanitarian logistics, and fosters social justice. In this way it contributes to the social empowerment of supply chains (Rejeb and Rejeb, 2020). The integration of blockchain technology with other technologies, such as radio frequency identification (RFID), has the potential to enable real-time tracking of food supplies (Khanfar et al., 2021). This integration may lead to the optimization of food operations, the improvement of food safety and quality, and the reduction of unethical practices and social harms (Khanfar et al., 2021).

The integration of blockchain with other technologies such as RFID enables real-time monitoring of food supplies, thereby optimizing food operations, enhancing food safety and quality, and decreasing unethical practices. The use of blockchain technology has demonstrated its ability to establish trust within the realm of the Internet of Things (IoT) (Al-Rakhami and Al-Mashari, 2021). The emergence of Industry 4.0 has initiated a transformative shift in industrial processes that has forced organizations across all sectors to digitize their operations (Kadadevaramth et al., 2020). The implementation of digital technologies in supply chains has the potential to transform management processes significantly and enhance sustainability across multiple dimensions (Varriale et al., 2021). Some 70% of Fortune 500 companies have integrated IoT technology into their business operations (Kadadevaramth et al., 2020). The implementation of IoT serves a diverse range of functions, including predictive maintenance, the utilization of intelligent sensors on jet engines, and the implementation of smart grids for utility services and energy management (Kadadevaramth et al., 2020). Organizations that aim to advance their environmental policies and strategies can leverage blockchain technology to increase their environmental practices throughout the supply chain, lessen their burden on energy and natural resources, and provide eco-friendly products (Rejeb and Rejeb, 2020). The utilization of the IoT can potentially facilitate the observation, tracking, and monitoring of products, activities, and processes across company value-chain networks (Rejeb et al., 2019).

2.3 Incentives and stakeholder collaboration

The utilization of blockchain systems is attracting significant interest from stakeholders across various industrial domains, particularly within the logistics and supply-chain sectors (Litke et al., 2019). In 2016, IBM and Maersk initiated a blockchain pilot to improve the workflow and visibility of each shipment (Welty and Becerra-Fernandez, 2001). Multiple stakeholders, including trading partners, government authorities, and logistics companies, were involved, with each participant in this blockchain network able to view the progression of cargo through the supply chain and determine the location of a container in transit (Wang et al., 2019). The push from local and global governmental bodies, community stakeholders, and consumer demands to achieve sustainability objectives has prompted scholars to delve deeper into the potential of blockchain technology to facilitate and increase supply-chain sustainability (Saberi et al., 2019). The primary aim of sustainable supply chains is to establish and sustain lasting economic, social, and environmental benefits for all parties that are engaged in the provision of goods and services to markets (Rejeb and Rejeb, 2020). There is a plethora of evidence that businesses and society are adopting cutting-edge technologies, of which blockchain is one, to tackle critical issues related to economic, environmental, and social sustainability (Sahoo et al., 2022). One such example is the promotion of consumer green behaviour that can increase sustainability through a designed tokenization and intensive mechanism (Esmaeilian et al., 2020). A "intensive mechanism" is a system or strategy that actively encourages and motivates consumers to engage in sustainable practices. While "designed tokenization" is used to describe the process of developing and distributing digital tokens with the explicit goal of encouraging and rewarding environmentally responsible actions on the part of consumers. Using blockchain technology to construct a token-based incentive system and adopting intense ways to stimulate consumer participation in green behaviors, "designed tokenization and intensive mechanism" together constitute a comprehensive strategy to promote sustainability.

2.4 Safety

Blockchain technology has the potential to revolutionize supply-chain management by delivering decentralized security, dependability, and efficiency. This technology can facilitate trust between parties, improve visibility and transparency, and promote collaboration. In this section, we examine the various ways that blockchain technology can enhance supply-chain management safety, including by providing data security; counterfeit prevention; supply-chain visibility; trust and collaboration; a shared immutable ledger; and smart contracts. The primary principles that blockchain technology contributes to supply-chain management are security through decentralization and reliability (Breese-Vitelli et al., 2019). Data exchange can become more efficient and secure by virtue of the use of blockchain technology, which fosters trust between parties that might not otherwise have had confidence in each other's data (Al-Rakhami and Al-Mashari, 2021). Collaborative commerce software, also known as interaction technology, facilitates human collaboration in creating, designing, producing, implementing, and maintaining novel products and services while managing the legal and financial aspects of the transaction at the same time (Welty and Becerra-Fernandez, 2001). The multi-tiered, multinational nature of today's supply chain makes it difficult to assess the history and integrity of sourced material goods and to hold organizations accountable for their conduct. A solution based on blockchain technology eliminates the necessity for a secure centralized framework, intermediaries, and information exchanges. Such a solution, instead, enhances efficiency and adheres to a high degree of security and integrity (Prashar et al., 2020).

The paper authored by Aniello et al. (2019) addresses concerns related to the identification and tracking of procured parts across multiple sites in a supply chain to detect tampering. The approach proposed in their paper utilizes smart-contract and consortium blockchain technologies, which are decentralized, highly available, and provide robust assurances regarding the integrity of stored data and executed business logic. A smart contract refers to a contractual arrangement that is inherently self-executing, wherein the specific terms and conditions of the agreement are written straight into the source code of a blockchain platform. While a consortium blockchain is a form of blockchain network that is managed and controlled by multiple organizations or entities as opposed to a central authority. Big multinational corporations and small businesses are wholly reliant on global supply chains for supplying the ingredients and components used to manufacture their final products (Bhandari, 2018). The implementation of blockchain technology enhances the transparency and visibility of a supply chain (Prashar et al., 2020). Using smart-contract and consortium blockchain technologies enables a decentralized and secure method for addressing concerns regarding the identification and tracking of procured parts across multiple supply chain sites. Computer-based tools can improve inter-company human teamwork but in uncertain, risky, and previously undefined ways (Welty and Becerra-Fernandez, 2001). The real-time transparency and cost reductions that are made possible by blockchain technology increase the profitability and competitiveness of manufacturing companies, in this way ensuring the manufacturing industry's sustainability (Ko et al., 2018). The integration of blockchain technology with the IoT has the potential to

facilitate various application scenarios aimed at augmenting transparency in the value chain and fostering trust in business-to-business (B2B) interactions (Rejeb et al., 2019).
The implementation of blockchain technology, in conjunction with smart contracts and IoT applications, has the potential to effectively address numerous current challenges in supply-chain management. This approach can result in substantial cost savings as well as reductions in the time and resources required by companies (Bhandari, 2018). This information-sharing system can increase the supply chain's traceability, transparency, trust, and responsiveness. Through the use of smart contracts, a carbon taxation policy can also be implemented and monitored to promote the sustainability of the environment (Ko et al., 2018). In addition, blockchain is a scalable software designed for decentralized networks. It is able to facilitate efficient financial settlements among smart-contract participants, in this way eliminating the need for trusted third parties. The use of smart contracts within blockchain technology is vitally important in mitigating the adverse effects on both the economic and reputational aspects of a company (Sahoo et al., 2022).
In summary, blockchain technology, smart contracts, and IoT applications can improve supply-chain management, resulting in cost savings and improved traceability, transparency, trust, and responsiveness. Blockchain technology has the potential to enhance supply-chain administration significantly by offering a secure and dependable method for data exchange and collaboration. By combining blockchain technology with smart contracts and IoT applications, numerous supply-chain management challenges can be effectively addressed, resulting in significant cost savings and time reductions. Integrating blockchain technology into supply-chain management systems has the potential to transform how businesses operate and interact.

2.5 Cost-saving

Blockchain is a decentralized system that utilizes a ledger technology to document transactions between multiple parties in a secure and immutable manner (Pavlić Skender and Zaninović, 2020). The utilization of a distributed ledger-based blockchain methodology results in the reduction of both overall expenses and carbon footprints for companies that use it (Manupati et al., 2020). Blockchain technologies can be used for the automation of supply-chain activities, which also has the potential to reduce costs. Blockchain reduces transaction costs because it enables transparent and legitimate transactions (Schmidt and Wagner, 2019) and facilitates the transfer of data and assets without the need for a central intermediary (Pavlić Skender and Zaninović, 2020). The implementation of blockchain technology has the potential to enhance product traceability, which enables companies to reduce their contingent expenses. Blockchain technology is expected to improve the economic sustainability of the supply chain by enabling effective traceability, facilitating information sharing to enhance visibility, promoting transparency in processes, and decentralizing the entire structure.

Additionally, blockchain technology is anticipated to contribute to the attainment of environmental and social sustainability through the promotion of resource efficiency, accountability, smart contracts, trust development, and fraud prevention (Munir et al., 2022). Blockchain technology has the potential to enhance the sustainability and inclusivity of worldwide supply chains, as viewed through both economic and societal lenses (Bhandari, 2018). The implementation of this measure would yield substantial advantages for various groups, such as farmers and cotton harvesters, whose financial gains are greatly diminished by intermediaries (Bhandari, 2018).

2.6 Operational efficiency

The incorporation of blockchain components enhances the efficiency of production procedures and fosters adaptability, durability, and promptness within extant supply chains over an extended period (Mukherjee et al., 2022). The utilization of IoT technology encompasses various applications, such as the monitoring of products to enhance operational efficiency in warehousing, manufacturing, and transportation (Rejeb et al., 2019). The implementation of a streamlined trust model in IoT-based supply-chain management can enhance security while reducing computational, storage, and latency demands associated with data sharing (Al-Rakhami and Al-Mashari, 2021). Integrating blockchain technology also introduces a dimension of sustainability that aligns with the circular economy paradigm prevalent in contemporary society (Mukherjee et al., 2022). Therefore, it is imperative for companies to assess and contrast the relative importance of the conventional supply chain and the blockchain-based supply chain in facilitating the integration of sustainability principles into contemporary supply-chain management practices (Mukherjee et al., 2022). Most modern supply chains are linear, highly complicated networks involving a wide range of stakeholders, which can lead to a lack of visibility and data, and to nonstandard practices (Pavlić Skender and Zaninović, 2020). Blockchain technologies are meant to eliminate intermediaries, human error, and manual and paper-based processes.

3. Methods and Data Collection

This study made use of bibliometric analysis as its methodology. Bibliometric methods have been used to find, for example, the most prolific writers by isolating scientific paradigms, fusions, and divergences of scientific disciplines and journals from different domains (Ikpaahindi, 1985). Literature is expanding and transforming at a rate that makes it impossible for a librarian or information worker with traditional bibliographic skills and methods to keep up (Chaurasia, 2008). Bibliometrics is an emerging thrust area of research and has now become a well-established part of information research and a quantitative approach to the description of documents. In this study, bibliometric methods were used to analyse data extracted from ScienceDirect journals. Tools for bibliometric analysis assist in identifying essential research contributions, key research fields, and linkages between models and research domains (Bai and Sarkis, 2022). The ScienceDirect is a digital repository offered by Elsevier, an academic publishing company, which grants users access to academic literature. The platform provides users with access to a vast collection of over 30,000 electronic books and 4,000 journals. The data analysed for this study came from the 308 documents that were selected by ScienceDirect through simply searching for "blockchain" and "sustainable supply chain management." The data analysis was aimed at answering the study's three sub-research questions, which concern the importance of blockchain and SSCM. In addition, the literature review showed traceability and transparency, operational efficiency, cost savings, and safety to be the benefits of using blockchain technologies.

4. Data Collection

With the literature review pointing to the potential of blockchain technology in SSCM to improve the safety, traceability, transparency, and efficiency of operations management procedures, it is important understand the current state of research in this field. This paper presents an analysis of the leading subject areas, document types, and keywords related to SSCM and blockchain. The information provided shows that Engineering and Computer Science are the leading subject areas in this field, followed by Environmental Science and Business Management, Economics and Accounting, and lastly Social Science. The most common types of documents on this topic are journal articles, followed by conference papers, reviews, book chapters, and books. The top five keywords related to SSCM and blockchain are "Blockchain", "Supply Chain Management", "Sustainability", "Sustainable Development", and "Blockchain Technology" (see Table 1).

4.1 Leading subject areas

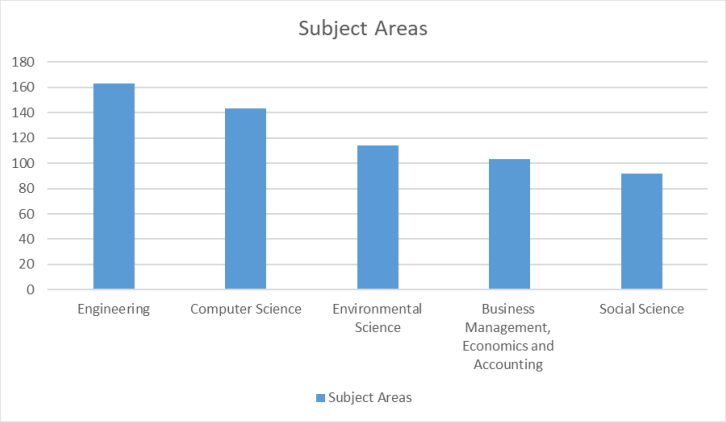

Figure 1. Leading Subject Areas of SSCM and Blockchain

Five leading areas were extracted from the ScienceDirect journals and are shown in Figure 1, with Engineering being the leading area, followed by Computer Science; Environmental Science; Business Management, Economics, and Accounting; and lastly Social Science. The numbers in the Y-axis of the graph in Figure 1, refers to the number of documents published under each subject area. Engineering and Computer Science are clearly leading, as the fields of SSCM and blockchain are dominated by quantitative studies and applications while other areas are still in the early stages and are publishing fewer documents in these fields. Environmental Science is also a leading field, mainly because researchers in this area are largely associating sustainability with environmental aspects rather than social and economic factors. The social aspects of SSCM are known to be neglected when compared to the environmental and economic factors, which explains the Social Science area being last of the five leading areas of SSCM and blockchain.

4.2 Document types

The ScienceDirect database clearly identifies the types of documents utilized for a particular topic. For the particular topics of SSCM and blockchain, the corresponding documents include journal articles, book chapters, books, conference papers, and reviews. As shown in Figure 2, journal articles are the most prevalent document type, followed by conference papers, reviews, and conference reviews. Last on the list are book chapters and complete books. When compared to journal articles and conference papers, the number of books in any field is usually lower.

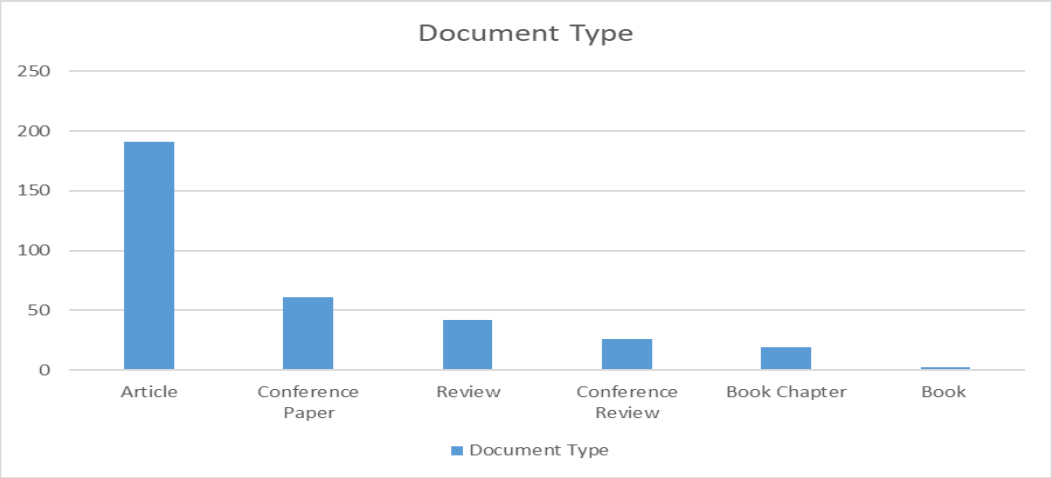

Figure 2. Types of Blockchain and SSCM Documents

As the data was taken from the ScienceDirect database, it makes sense that articles are the leading document type, as databases generally contain a large number of journals and reference journal articles over conference papers, books, and book chapters. Certain databases exclusively accept original journal articles and do not have room for books and book chapters. This makes the findings of the research presented in these articles able to be considered accurate as most of the articles accepted are of good quality and have been rigorously reviewed by experienced and expert reviewers in the field. The methodology used is also rigorous.

4.3 Leading keywords

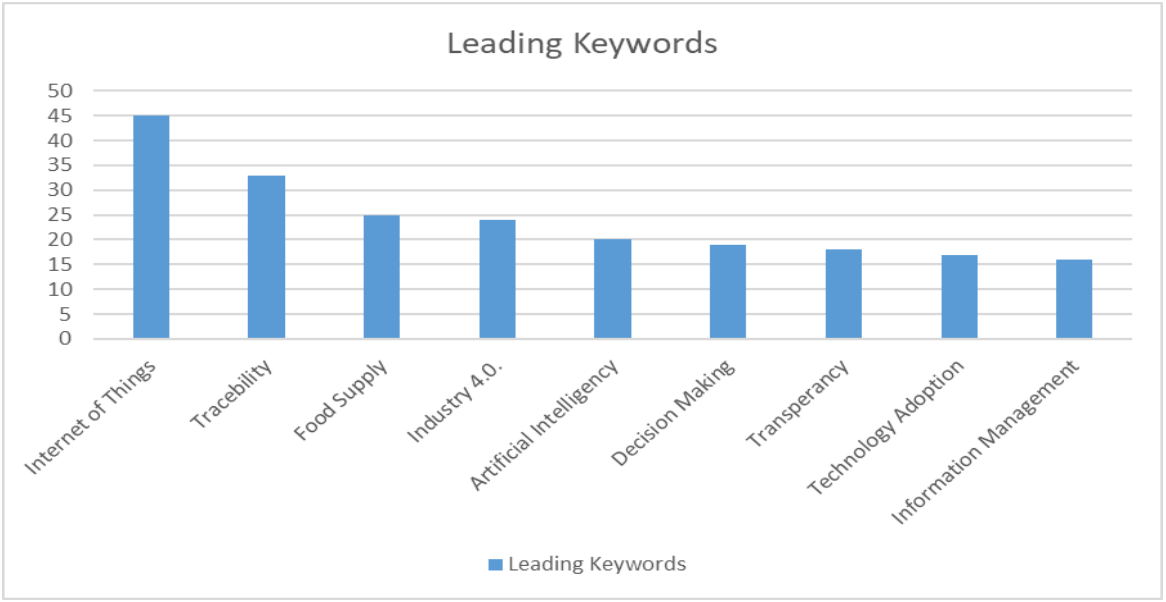

Figure 3. Leading Blockchain and SSCM Words

For the keywords from the ScienceDirect database related to blockchain and SSCM, the highest word count was 226, but the words selected were from the 45 highest counts. The words in Figure 3, are the most counted words starting from 45 words upto 17 words. The reason for this was that the words with the highest counts were obvious concepts, such as "blockchain", "supply chain management", "sustainability", "sustainable development", and "blockchain technology", as displayed in Table 1, which lists the top five keywords. Figure 3 shows the keywords that are discussed in the research in the field on the topic of blockchain and SSCM.

Table 1. Top Five Keywords

No	Keywords	Count
1.	Blockchain	226
2.	Supply Chain Management	180
3.	Sustainability	113
4.	Sustainable Development	112
5.	Blockchain Technology	57

These are the most common keywords influenced by the topic of blockchain and SSCM. Figure 4 outlines the other leading keywords, with counts ranging from 14 to 10 words. These keywords do form part of the leading keywords presented in Figure 3, which clearly represent the kind of discussion found within research on blockchain and SSCM. The keywords represent concepts discussed under the main concepts or subtitles reviewed in the literature review of this study.

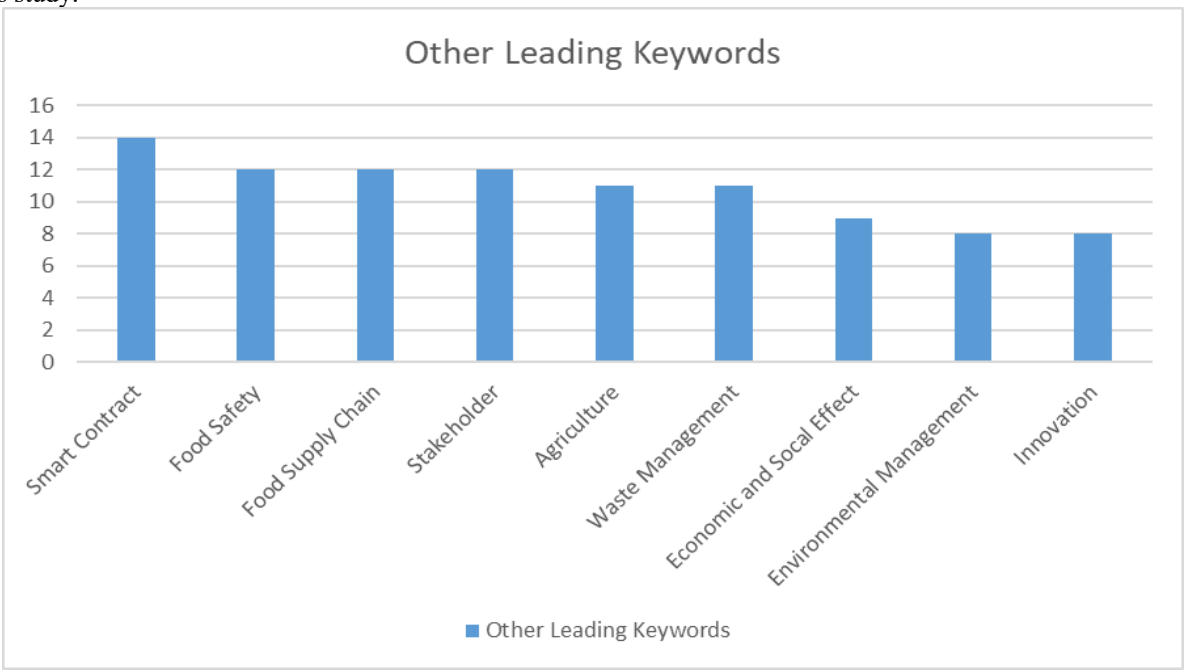

Figure 4. Other Leading Keywords for Blockchain and SSCM

Figure 4 shows the other leading keywords from the research papers found in the ScienceDirect journals. This group of words comes after the keywords presented in Figure 3 above. All the words are relevant to the topic of SSCM and

blockchain and were therefore included as part of the top 18 leading keywords. The words are found to be relevant and linked to the keywords presented in Figure 3. For example, the Internet of Things is linked to innovation and smart contracts, which are linked to the agricultural supply chain. There are many applications that researchers have invented using blockchain smart contracts in the agricultural sector. The agricultural sector is essential for every country, developed and developing, and these smart innovations are linking stakeholders all over the world, which is uplifting the economic and social factors of many countries. Through environmental management, waste is reduced, and focal companies are ensuring food safety through the food supply chain, which advocates the traceability and transparency of the supply-chain activities.

In conclusion, the analysis of the leading subject areas, document types, and keywords related to SSCM and blockchain provides valuable insights into the current state of research in this field. The dominance of engineering and computer science as leading subject areas suggests that quantitative studies and applications are at the forefront of research in this area. The prevalence of journal articles as the most common type of document indicates that rigorous peer-review processes are being applied to research in this field. The top five keywords related to SSCM and blockchain highlight the key concepts and topics being discussed in the literature. Overall, this analysis provides a useful snapshot of the current state of research on the use of blockchain technology in SSCM.

4.5 Proposed improvements

The following improvements are proposed to increase the understanding and advancement in the implementation of blockchain technology in the SSCM domain:

- Further study is needed to delve deeper into the potential advantages and obstacles associated with the implementation of blockchain technology in SSCM. The research should concentrate on practical use cases and real-world examples.
- Increased cooperation among scholars in prominent fields such as Engineering; Computer Science; Environmental Science; Business Management, Economics and Accounting; and Social Science would be beneficial to devise interdisciplinary methodologies for the investigation of SSCM and blockchain technology. Different faculties or disciplines can work together on a combined project.
- Further advancement of stringent peer-review mechanisms is necessary to guarantee the excellence and dependability of research in this domain.
- There has been a notable shift towards emphasizing the social and economic dimensions of sustainability in the context of SSCM and blockchain research, in conjunction with the traditional focus on environmental considerations. This could be further encouraged by academic institutions and governmental institutions.

4.6 Validation

Google Scholar was used to verify some of the sources and also check whether the data analysed from the ScienceDirect databases corresponded with the data found on Google Scholar. In the search of “sustainable supply chain management”, the results of the first 25 articles from 2018-2023 were downloaded and Atlas.ti was used to check the leading words, and then compare the words with the keywords found in the data from the ScienceDirect journals. The comparison revealed that the leading words appeared on both sites. Word clouds were developed using the first 25 articles from ScienceDirect journals and 25 articles from Google Scholar and slight differences were found between the two clouds. The document types retrieved from Google Scholar were also checked against the ScienceDirect documents. Document types across the two sites were also found to be slightly different, as books and reviews such as of conferences were excluded through the selection of peer-reviewed journals only for the 25 downloaded Google Scholar articles. A comparative analysis was conducted on the data obtained from ScienceDirect and Google Scholar for the subject of sustainable supply chain management. The findings indicated that there were common prominent terms present on both platforms, albeit with modest variations in the word clouds and document categories.

5. Conclusion

This research shows the potential of blockchain technology to tackle significant obstacles within supply-chain management and enhance SSCM. The extensive literature review and biometric analysis point to the utilization of blockchain technology as useful for promoting transparency and traceability within supply-chain operations. Blockchain technology provides a clear view of supply-chain activities, which in turn promotes sustainability and enables stakeholders to evaluate environmental impacts, social responsibility initiatives, and the financial aspects of a supply chain. Encouraging businesses to adopt blockchain technology and engage in collaborative efforts with

stakeholders has the potential to advance the adoption of sustainable practices. Furthermore, the implementation of blockchain technology guarantees security in financial transactions, lowers expenses, and increases operational efficacy through the automation of supply-chain activities and the establishment of trust among supply-chain members. It would benefit the field for future study to explore industry-specific implementations of blockchain technology in managing the supply chain, taking into account the needs of and obstacles faced by diverse sectors such as healthcare, manufacturing, or food supply chains.

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