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Blockchain in the Food Supply Chain: A Literature Review and Bibliometric Analysis

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ABSTRACT

The food supply chain, a complex network of interconnected systems, faces numerous challenges, including food safety, traceability, and sustainability. Blockchain technology, with its inherent properties of immutability, transparency, and security, offers a promising solution to address these challenges. This systematic literature review aims to explore the current state of research and identify emerging trends in the application of blockchain technology to food supply chains. A comprehensive search of the Scopus database yielded 825 articles published between 2017 and 2023. The analysis focused on 161 articles that met specific inclusion criteria. Key themes identified in the literature include traceability, sustainability, food safety, halal food, and circular economy. Blockchain technology offers the potential to enhance transparency, efficiency, and sustainability in the food supply chain by enabling real-time tracking, reducing food waste, and ensuring food safety. The bibliometric analysis revealed a growing research community, with India emerging as a significant contributor. International collaboration is crucial for advancing the field and sharing knowledge. Future research directions include interdisciplinary collaboration, standardization, security, consumer education, and scalability. This study contributes to advancing these research directions by providing insights that enable researchers and industry practitioners to harness the full potential of blockchain technology in fostering a more efficient, transparent, and sustainable food supply chain.

1. Introduction

The globalized food supply chain, a complex network connecting producers, processors, distributors, and consumers, faces numerous challenges that threaten its integrity and sustainability (Sharma et al., 2024; Singh et al., 2023). Developing countries, in particular, struggle with infrastructure limitations, quality control, and product safety (Islam et al., 2022). Additionally, transportation inefficiencies, packaging standards, and traceability gaps, coupled with high levels of uncertainty, further complicate the food supply chain (Lahane et al., 2023; Rahbari et al., 2023). A significant threat to the food supply chain is food crime, where intentional food adulteration occurs for economic gain or malicious intent (Manning & Soon, 2016; Soon & Manning, 2019). This often

exploits the existing vulnerabilities within the supply chain, such as lack of transparency and traceability.

To address the multifaceted challenges, transparent and efficient information flow is crucial. Traditional methods struggle to provide this due to the complex and often fragmented nature of food supply chains. While not a silver bullet, blockchain technology offers a promising solution, alongside other strategies, to improve the food supply chain. By leveraging its decentralized nature and immutable ledger, blockchain can significantly improve transparency, efficiency, and traceability (Rogerson & Parry, 2020). This can help mitigate food fraud and enhance food safety (Duan et al., 2020; Goyal et al., 2023). Moreover, blockchain-enabled smart contracts can streamline processes and automate tasks, leading to increased operational efficiency.

The integration of blockchain technology can transform traditional food supply chains into intelligent, data-driven systems. For instance, RFID-based architectures combined with blockchain can create tamper-proof digital records and enable real-time quality monitoring (Mondal et al., 2019). Additionally, blockchain can track product origins, locations, and histories, thereby boosting consumer confidence (Cozzio et al., 2023). However, the widespread adoption of blockchain in the food industry is hindered by several challenges, including interoperability, privacy, and data security concerns, as well as the need for strong intra-organizational support (Sali et al., 2023).

The growing demand for sustainable and ethical food supply chains further strengthens the case for blockchain adoption (Wünsche & Fernqvist, 2022). Consumers increasingly expect transparency, traceability, and assurance of product authenticity. Blockchain technology can provide these assurances by enabling the tracking of products from farm to fork, ensuring that raw materials are sourced sustainably and ethically (Lin et al., 2019). By empowering all stakeholders in the food supply chain to collect and share reliable information, blockchain can enhance trust and confidence in food products (Gurrala & Hariga, 2022; Mahmud et al., 2021). This can give downstream actors a competitive edge and provide consumers with the peace of mind that comes from knowing the provenance of their food.

Blockchain technology offers a novel approach to data management, enabling secure and transparent transactions without the need for intermediaries (Mermer et al., 2018). Originating with the development of Bitcoin in 2008 by Satoshi Nakamoto, blockchain introduced a decentralized, public ledger that allows participants to independently verify transactions (Gaikwad, 2020). This technology utilizes a distributed network of interconnected blocks, each with a unique hash code, ensuring data immutability and security. This decentralized structure enhances the transparency and traceability of transactions, making them secure and verifiable (Friedman & Ormiston, 2022; Rajasekaran et al., 2022; Zheng & Lu, 2022).

In recent years, blockchain technology has emerged as a transformative force, extending its influence beyond digital currencies to various sectors, including education, healthcare, public safety, retail, and logistics (Bhushan et al., 2021; El Koshiry et al., 2023; Quan et al., 2023; Wang & Liu, 2023; Zhang et al., 2024; Zhu et al., 2024). The food industry, particularly concerned with potential food crises, has increasingly recognized the potential of blockchain to revolutionize the food supply chain (Jahanbin et al., 2023).

The food supply chain plays a critical role in ensuring the safety, hygiene, security, and quality of food products, including those with specific certifications like halal, kosher, organic, and fair trade (Accorsi et al., 2022; Khan et al., 2021; Patidar et al., 2023; Tieman et al., 2012). Research has highlighted the complexities and challenges within food supply chains, including food safety, product quality, on-time delivery, price fluctuations, public health risks, sustainability, traceability, globalization, coordination, and food (Chen et al., 2021; Gurrala & Hariga, 2022; Mor et al., 2018). To effectively address these challenges, strong interdisciplinary collaboration is essential, involving experts in operations management, strategy, organization, and risk control (Van Beusekom – Thoolen et al., 2024).

Blockchain technology offers a promising solution to address the challenges and complexities of the food supply chain. By leveraging blockchain's features of transparency, traceability, and security, the food industry can enhance consumer trust, reduce costs, and improve operational efficiency (Demestichas et al., 2020; Yang et al., 2021). The COVID-19 pandemic highlighted the potential of blockchain to foster resilience and adaptability in food supply chains (Kayikci et al., 2022).

However, the widespread adoption of blockchain in the food industry faces several barriers, including digital literacy, organizational culture, high implementation costs, privacy concerns, and data security challenges (Vivaldini, 2021; Yap et al., 2025). While some studies, like Elliot et al., (2024), have questioned the immediate cost-benefit ratio of blockchain adoption, the technology's potential to improve traceability, security, and efficiency remains significant. By examining academic publications, identifying influential authors and countries, and analyzing research trends, this study seeks to provide insights into the development and application of blockchain technology in the food industry. The findings of this study will be valuable for academics, policymakers, and industry professionals who are interested in leveraging blockchain, contribute to address the challenges facing the food supply chain.

This article aims to conduct a bibliometric analysis to explore the development and application of blockchain technology in the food supply chain. By examining publications, citations, and thematic trends, this research seeks to answer the following questions: (1) What are the current research trends in blockchain technology for the food supply chain? (2) What are the key themes and focus areas of blockchain research in this domain? (3) How is collaborative research being conducted in this field? (4) What are the practical applications and impacts of blockchain in the food supply chain?

2. Method

To identify relevant literature, a keyword-based search was conducted using the Scopus scientific database. Scopus was selected due to its comprehensive coverage, regular updates, and user-friendly interface (Govindan et al., 2024; Moretti & Herkovits, 2021; Singh et al., 2021). The literature selection process is illustrated in Fig. 1.

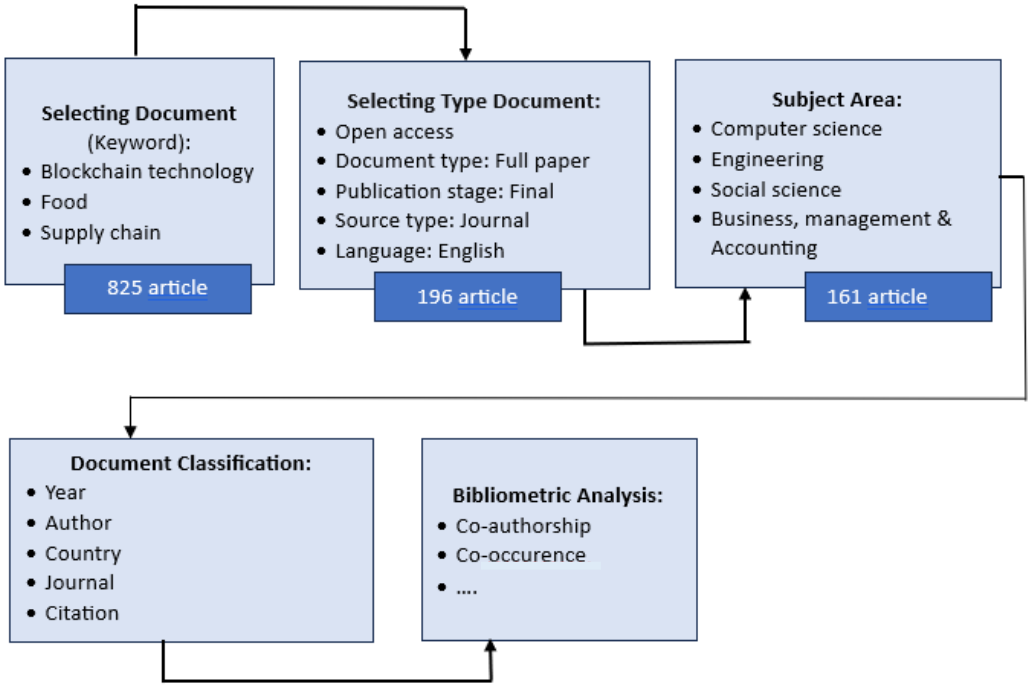

Fig. 1. Literature review framework

To conduct a comprehensive literature review, we utilized Scopus, a reputable database for high-quality, peer-reviewed articles. By employing the keywords "blockchain technology," "food," AND

"supply chain," we aimed to identify research specifically exploring blockchain's application within the food supply chain. To focus the analysis on the most relevant and impactful research, four subject areas with the highest number of publications related to blockchain in the food supply chain were chosen: Computer Science, Engineering, Social Science, and Business, Management & Accounting. This focused approach enabled a deeper dive into the core areas of blockchain technology application in the food industry. Articles were included based on the following criteria: (1) Open Access: To ensure widespread accessibility and reproducibility of research findings. (2) Full-Text Availability: To facilitate in-depth analysis and critical evaluation of the content. (3) Peer-Reviewed Journal Publication: To guarantee the quality and validity of the research. (4) English Language: To ensure clarity and ease of understanding for the researchers.

Subsequently, we categorized the selected articles based on publication year, author, country, subject area, and citation count. This classification provided a comprehensive overview of the evolution of blockchain research in the food supply chain, identifying emerging trends and popular topics. To further analyze the research landscape, we employed Vosviewer software, a tool that enabled the visualization of relationships between publications, researchers, and research themes (Kuzior & Sira, 2022; McAllister et al., 2022).

3. Results and Discussion

A systematic literature review was conducted to identify relevant research on the intersection of blockchain technology, food, and supply chain management. A comprehensive search of the Scopus database, executed on November 14, 2023, yielded 825 articles published between 2017 and 2023, with the earliest publications emerging in 2017. To refine the analysis, a rigorous selection process was applied. Articles were included based on the following criteria: open access, full-text availability, peer-reviewed journal publication, and English language. This process resulted in a focused dataset of 196 articles across 26 subject areas.

To further concentrate the analysis on the most impactful research, four subject areas with the highest number of publications were selected: Computer Science, Engineering, Social Science, and Business, Management & Accounting. This narrowed the dataset to 161 articles, forming the foundation for subsequent in-depth analysis. The findings of this study are presented in three sections. Section 4.1 provides an overview of the distribution of articles across various dimensions, including publication year, country of origin, journal, author, and citation. Section 4.2 delves into a bibliometric analysis using Vosviewer to uncover patterns and trends in the research landscape. Finally, Section 4.3 outlines the emerging research frontiers and potential avenues for future exploration.

3.1. Article Distribution

A systematic literature review was conducted to identify relevant research on the application of blockchain technology in food supply chains. While no specific time constraint was imposed on the search, the earliest publications on this topic emerged in 2017.

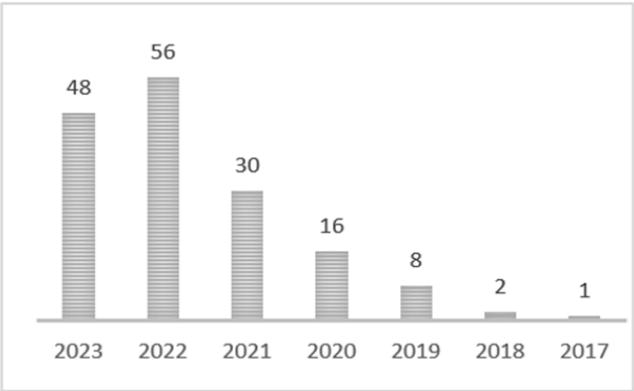

Fig. 2. Distribution of publications per year

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Fig. 2 illustrates the rapid growth of blockchain-related publications in the food supply chain sector between 2017 and 2023. A significant annual increase of approximately 91.4% was observed during this period, with 2022 marking the peak year, accounting for 34.8% of the total publications.

This surge in blockchain interest aligns with broader industry trends. The 2021-2022 period witnessed a marked escalation in blockchain adoption across multiple sectors. The burgeoning popularity of decentralized finance (DeFi) protocols and the emergence of non-fungible tokens (NFTs) as a novel asset class were pivotal drivers of this trend. Furthermore, the growing interest in cryptocurrencies, particularly Bitcoin, which reached its all-time high during this period, and the increasing number of blockchain-based projects contributed to a positive feedback loop, fostering further innovation and adoption.

It is important to note that while the data suggests a potential decline in publications from 2022 to 2023, further analysis is necessary to confirm this trend. Such a decline could be attributed to various factors, including shifts in research priorities or methodological approaches. Alternatively, it may be due to a delay in the publication process for articles submitted in 2023. Next, we delve into the geographic distribution of research, focusing on the countries of origin of the first authors of the articles. Fig. 3 provides a visual representation of this distribution.

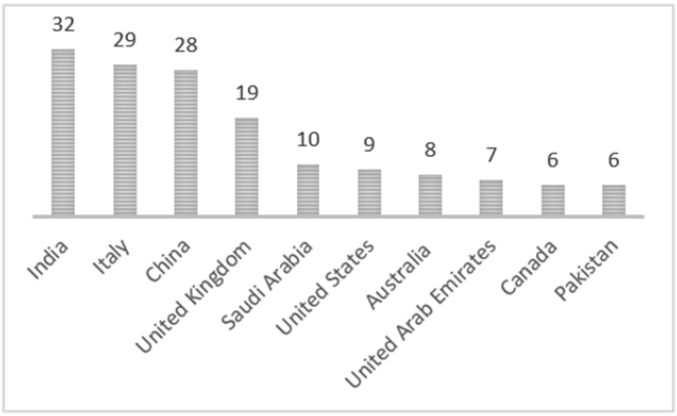

Fig. 3. Distribution of publications by country

Fig. 3 reveals the top 10 countries contributing to the body of knowledge in this field. India emerged as the leading contributor, with 19.8% of the articles. Indian researchers have delved into various aspects of blockchain technology, including bibliometric analysis (H.-Y. Chen et al., 2023; Sugandh et al., 2023) reverse logistics (Kazancoglu et al., 2023), and product traceability (Babu et al., 2023; Singh et al., 2023; Tan et al., 2023).

Italian researchers have explored topics such as integrating blockchain with IoT (Pincheira et al., 2022; Singh et al., 2023), developing innovative business models (Mercuri et al., 2021), and leveraging RFID technology (Barge et al., 2020).

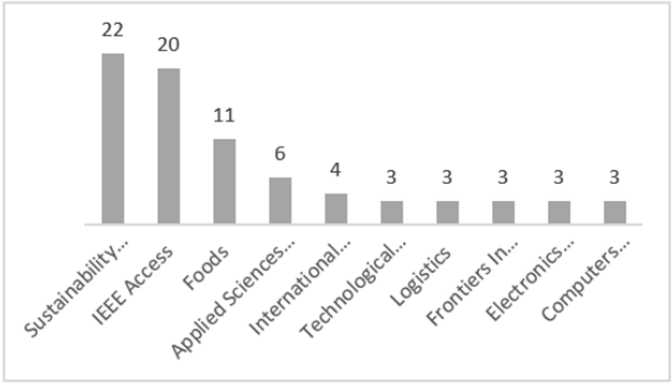

Fig. 4. Top 10 publisher

Fig. 4 presents the top 10 journals publishing research on blockchain and food supply chains. Sustainability Switzerland and IEEE Access emerged as the most prominent outlets, featuring articles on topics such as traceability, transparency, QR code integration, and IoT integration. Notably, 6% of the articles were published in Sustainability Switzerland, while 12.4% appeared in IEEE Access. Sustainability Switzerland has published articles exploring the application of blockchain for enhancing traceability and transparency in food supply chains (Cao et al., 2023; Tan et al., 2023) and the integration of QR codes (Bhatia & Albarrak, 2023; Dey et al., 2021).

The top 10 authors who are prolific in producing articles related to blockchain in the food supply chain are shown in Fig. 5, the figure shows that Xu, J and Zhang, X have the same number of publications, 6 articles each.

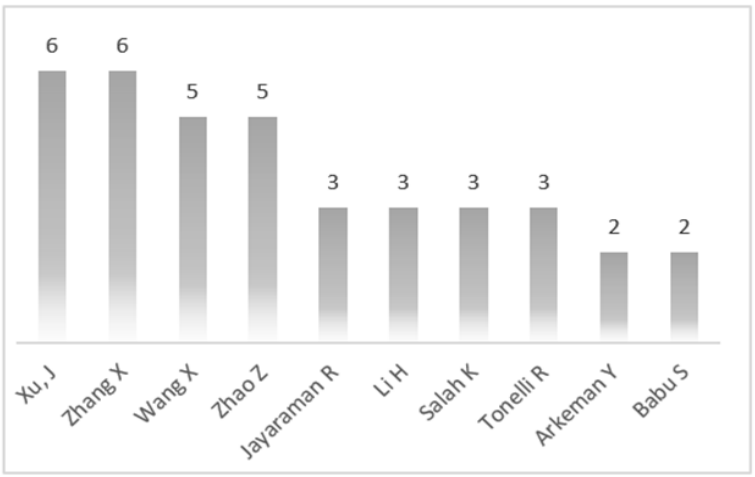

Fig. 5. Top 10 authors

A total of 6,039 citations were recorded for the 161 articles, indicating an average of 37.5 citations per article. Table 1, presents the top 10 most-cited articles.

Table 1. The 10 articles with the most citations

No	Title/ author	Citation
1	Blockchain technology in supply chain operations: Applications, challenges and research opportunities (Dutta et al., 2020)	507
2	Toward an ontology-driven blockchain design for supply-chain provenance (Kim & Laskowski, 2018)	452
3	Blockchain-Based Soybean Traceability in Agricultural Supply Chain (Salah et al., 2019)	381
4	Boundary conditions for traceability in food supply chains using blockchain technology (Behnke & Janssen, 2020)	377
5	Blockchain in Logistics and Supply Chain: A Lean Approach for Designing Real-world Use Cases (Perboli et al., 2018)	332
6	Food Safety Traceability System Based on Blockchain and EPCIS (Lin et al., 2019)	232
7	A blockchain-based smart contract system for healthcare management (Khatoon, 2020)	222
8	Blockchain: case studies in food supply chain visibility (Rogerson & Parry, 2020)	194
9	Blockchain-Driven IoT for Food Traceability with an Integrated Consensus Mechanism (Tsang et al., 2019)	190
10	Blockchain in agriculture traceability systems: A review (Demestichas et al., 2020)	171

To further delve into the relevance and trajectory of research on blockchain in food supply chains, a bibliometric analysis was conducted using Vosviewer software. By employing co-authorship and co-occurrence analysis, this study aimed to uncover patterns of collaboration among authors and countries within the field. Co-authorship analysis, with author and country as units of analysis, was utilized to visualize the collaborative networks and identify key players in the research community. The results of the co-authorship analysis are depicted in Fig. 6.

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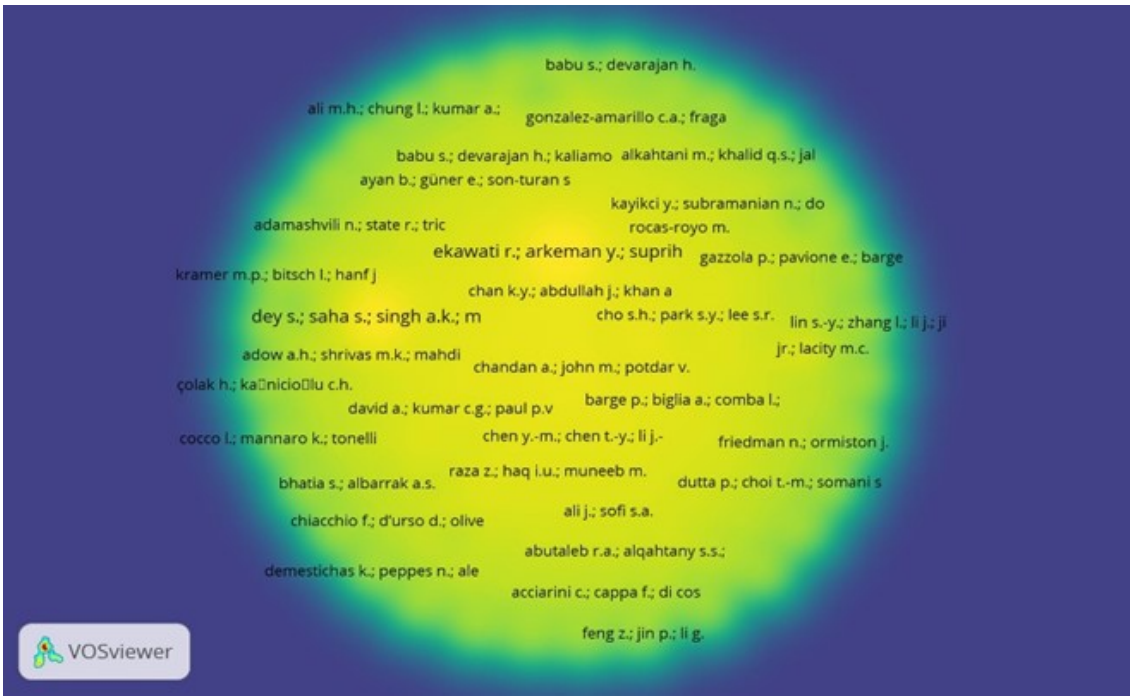

Fig. 6. Co-authorship (author)

Fig. 6 reveals that 160 authors collaborated on the 161 analyzed documents. The co-authorship analysis indicates that two articles, authored by Jr. Lacity, M.C. and Shew A.M., Snell H.A., Nayga R.M., Jr., and Lacity M.C., exhibited the highest total link strength value. Conversely, the remaining 158 authors had a total link strength value of 0, suggesting a lack of collaborative relationships among these authors. This finding highlights the limited collaboration within the field and potential opportunities for future interdisciplinary research.

The co-authorship analysis with the country unit of analysis is shown in Fig. 7.

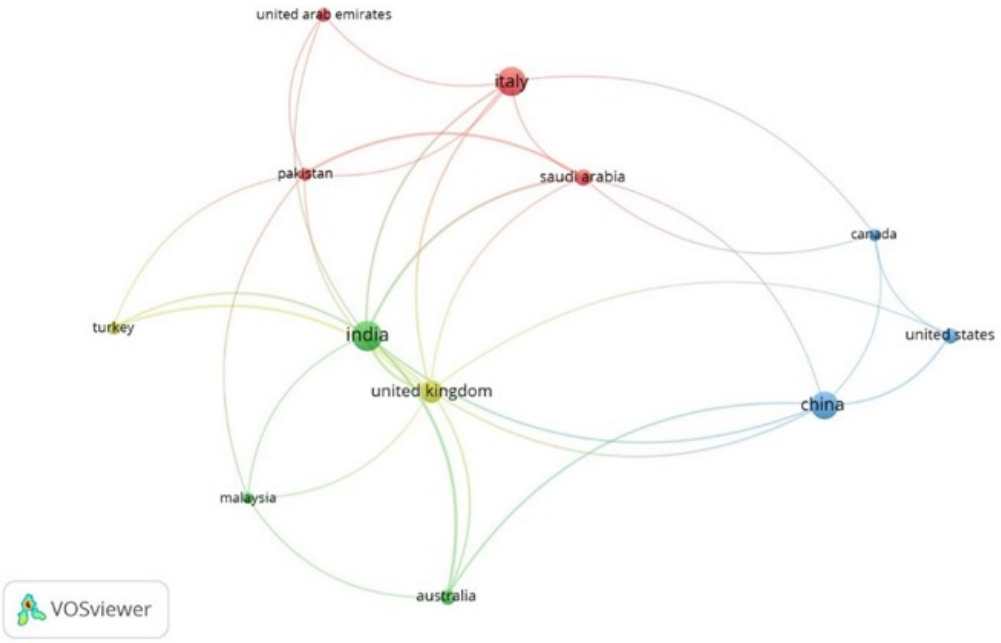

Fig. 7. Co-authorship (Country)

Fig. 7 illustrates the collaborative network among 12 countries involved in blockchain technology research for food supply chains, based on an analysis of 161 articles. The countries were selected based on a minimum document threshold of 5 and a citation count of 0. Table 2 presents the total link strength (TLS) for each country, providing insights into the extent of their collaborative involvement.

Table 2. Total link strength (TLS) for co-authorship (country)

No	Country	Document	Citations	TLS
1	India	32	904	19
2	United Kingdom	19	932	17
3	China	28	969	10
4	Saudi Arabia	10	127	10
5	Australia	8	137	9
6	Italy	29	736	8
7	Pakistan	6	101	8
8	Turkey	6	211	6
9	Canada	6	821	4
10	Malaysia	5	129	4
11	United States	9	292	4
12	United Arab Emirates	7	464	3

India has emerged as a significant player in collaborative research on blockchain technology for food supply chains. Indian researchers have explored various applications, including the use of blockchain to record and access data on non-perishable agricultural commodities within distribution chains (Babu et al., 2023). Notably, the co-authorship network reveals a dominance of non-Muslim countries with high total link strength (TLS) values or a substantial number of publications, including India, the UK, China, and Italy.

To further explore the thematic connections within the research field, a co-occurrence analysis of keywords was conducted. The results of this analysis are presented in Fig. 8.

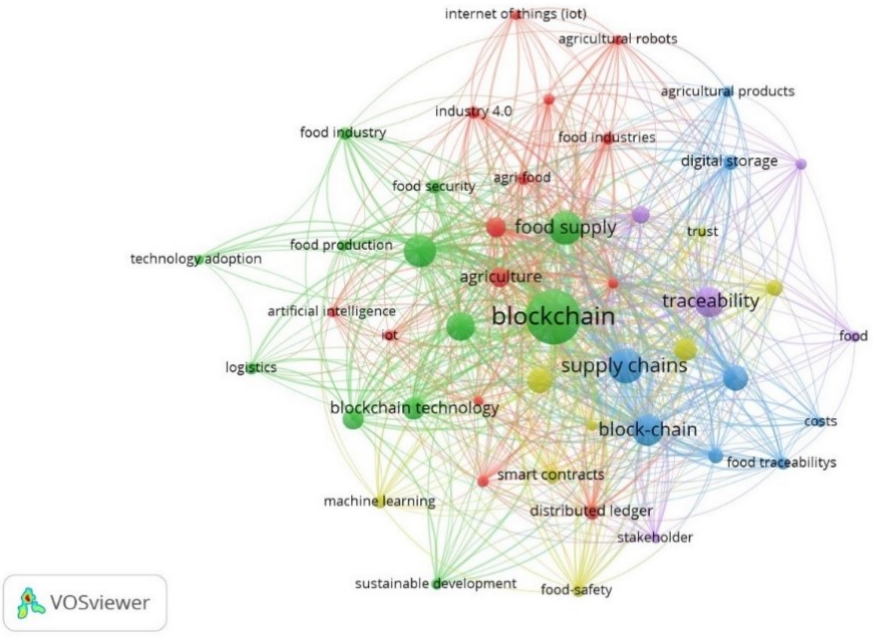

Fig. 8. Co-Occurrence keyword

Fig. 8 illustrates the keyword co-occurrence network, revealing the semantic relationships between key terms within the 161 analyzed articles. A total of 989 keywords were identified, with 47 meeting the specified threshold. Table 3 presents the top 10 keywords with the highest total link strength (TLS) values.

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Table 3. The highest TLS

No	Keyword	Occurrence	TLS
1	Blockchain	137	619
2	Food supply	53	360
3	Supply chains	57	351
4	Block-chain	46	325
5	Supply chain management	49	246
6	Traceability	40	227
7	Smart contract	24	170
8	Food supply chain	29	167
9	Supply chain	37	165
10	Food safety	30	155

Given the central role of blockchain technology in the research domain, it is unsurprising that "blockchain" emerged as the keyword with the highest total link strength (TLS) and an occurrence rate of 137. This indicates that the majority of articles within the dataset utilize "blockchain" as a core keyword.

A visual analysis of the Vosviewer results highlights the diverse connections between blockchain and other relevant topics, including food supply, supply chains, and supply chain management. This multifaceted nature of blockchain's applications underscores its potential to revolutionize various industries.

3.2. Direction of future research

A comprehensive analysis of 161 articles on blockchain in the food supply chain identified six key research trends: First, Traceability Systems. Numerous studies have explored the application of blockchain technology to enhance data traceability in food supply chains. This includes tracking financial transactions (Babu et al., 2023), certifying products (Martinez-Castaneda & Feijoo, 2023), improving export performance (Akhtaruzzaman Khan et al., 2022), integrating with IoT (Gonzalez-Amarillo et al., 2023), and monitoring coffee transportation and storage (Valencia-Payan et al., 2022). Second, Sustainability. Researchers have investigated the potential of blockchain technology to contribute to sustainable food supply chains. This includes exploring synergies and conflicts, identifying opportunities and resistances, developing new economic models, and facilitating reverse supply chain operations (Nicola Friedman & Ormiston, 2022; Jraisat et al., 2023; Kohler et al., 2022; Rampone et al., 2023; Wünsche & Fernqvist, 2022).

Third, Food Safety. Blockchain technology offers a promising solution for improving food safety. Its ability to track and trace food products can help identify and mitigate potential contamination risks. Studies have highlighted the role of blockchain in enhancing food security, particularly in regions vulnerable to weather-related disruptions (Giganti et al., 2024; Peng et al., 2022; Yele & Litoriya, 2024). Four, Halal Food. Blockchain technology has the potential to ensure the halal integrity of food products throughout the supply chain. Researchers have explored the use of blockchain to track halal certifications, implement smart contracts for secure data storage, and address challenges related to complexity, costs, and regulatory compliance (Ali et al., 2021; Hidayati et al., 2023; Sidarto & Hamka, 2021).

Five, Circular Economy. The application of blockchain technology in circular economy models for food supply chains has gained increasing attention. Researchers have investigated the potential of blockchain to improve the efficiency and sustainability of food systems, reduce food waste, and enhance transparency (Okorie et al., 2022; Panghal et al., 2022). Six, Financial Integration and AI. Future research directions may involve integrating blockchain technology with financial systems to facilitate seamless transactions and ensure fair trade practices. Additionally, the convergence of blockchain and artificial intelligence offers significant potential to revolutionize the food supply chain. AI-powered blockchain solutions can enhance data analysis, decision-making, and predictive capabilities, leading to improved food safety, reduced waste, and optimized supply chain operations (Baciuliene et al., 2023; Onyeaka et al., 2023; Onyeaka & Ekwebelem, 2023; Ravishankar & Kulkarni, 2020).

These trends were identified based on the frequency and depth of research in each area, as well as the potential for future innovation and impact on the food industry. By analyzing the body of literature, it became evident that these areas have garnered significant attention and offer promising avenues for further exploration.

3.3. Discussion

The findings of this study provide valuable insights into the emerging landscape of blockchain technology in the food supply chain. A significant surge in research activity has been observed, indicating a growing interest in leveraging blockchain to address critical challenges within the food supply chain.

The bibliometric analysis offers a comprehensive overview of the research landscape, including country distribution, journal classification, and top authors. This analysis helps to identify key trends, emerging research areas, and influential researchers in the field. By understanding the geographical distribution of research efforts, we can identify potential areas for international collaboration and knowledge exchange. Furthermore, analyzing the top journals and authors can help to assess the quality and impact of research in this field.

Overall, this study contributes to a deeper understanding of the current state of blockchain research in the food supply chain. By identifying key trends and future research directions, this research can inform the development of innovative blockchain solutions to address pressing challenges in the food industry.

Key themes identified include traceability, sustainability, food safety, halal food, circular economy, financial integration, and AI. These themes highlight the potential of blockchain to enhance transparency, efficiency, and sustainability in the food supply chain. By tracking the journey of food products from farm to table, blockchain can improve traceability, reduce food waste, and ensure food safety. Additionally, blockchain can facilitate the development of sustainable supply chains by enabling the tracking of financial, environmental, and social impacts.

The analysis reveals a global collaborative effort among researchers from various countries. India, in particular, has emerged as a significant player in this field, contributing to a substantial portion of the published research. International collaboration fosters knowledge sharing, accelerates technological advancements, and promotes the global adoption of blockchain solutions.

Future research should consider interdisciplinary collaboration, standardization, security, and consumer education. By integrating blockchain with other emerging technologies like IoT and AI, researchers can develop innovative solutions to address complex challenges in the food supply chain. Standardization efforts are crucial to ensure interoperability and seamless integration of blockchain systems across different platforms. Furthermore, addressing security and privacy concerns is essential to build trust and confidence in blockchain-based solutions. Educating consumers about the benefits of blockchain technology can help foster wider adoption and acceptance. By addressing these research directions, researchers and industry practitioners can unlock the full potential of blockchain technology to create a more efficient, transparent, and sustainable food supply chain.

4. Conclusion

This research has delved into the evolving landscape of blockchain technology in the food supply chain, aiming to identify current trends, key themes, collaborative patterns, and practical applications. By conducting a comprehensive bibliometric analysis of 161 articles sourced from the Scopus database, this study has provided valuable insights into the field. The analysis revealed a significant increase in research activity related to blockchain and food supply chains, with a notable surge in publications from 2017 onwards. Key research themes identified include traceability systems, sustainability, food safety, halal food, and circular economy. These themes highlight the potential of blockchain to address critical challenges in the food industry, such as ensuring product authenticity, improving supply chain transparency, and enhancing food safety.

Looking ahead, future research should explore the integration of blockchain with financial systems to enable seamless transactions and ensure fair trade practices. Additionally, the convergence of blockchain and artificial intelligence offers exciting possibilities for optimizing supply chain operations, improving decision-making, and mitigating risks. Furthermore, the study examined collaborative patterns among researchers. While India emerged as a dominant player in the field, international collaborations were also observed, particularly with countries like the UK, China, and Italy. These collaborative efforts have facilitated knowledge sharing and accelerated technological advancements. By leveraging the power of blockchain technology, the food industry can achieve greater efficiency, transparency, and sustainability, ultimately benefiting both producers and consumers.

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References

Accorsi, R., Bortolini, M., Gamberi, M., Guidani, B., Manzini, R., & Ronzoni, M. (2022). Simulating product-packaging conditions under environmental stresses in a food supply chain cyber-physical twin. *Journal of Food Engineering*, *320*, 110930. https://doi.org/10.1016/j.jfoodeng.2021.110930

Akhtaruzzaman Khan, M., Emran Hossain, M., Shahaab, A., & Khan, I. (2022). ShrimpChain: A blockchain-based transparent and traceable framework to enhance the export potentiality of Bangladeshi shrimp. *Smart Agricultural Technology*, *2*, 100041. https://doi.org/10.1016/j.atech.2022.100041

Ali, M. H., Chung, L., Kumar, A., Zailani, S., & Tan, K. H. (2021). A sustainable Blockchain framework for the halal food supply chain: Lessons from Malaysia. *Technological Forecasting and Social Change*, *170*, 120870. https://doi.org/10.1016/j.techfore.2021.120870

Babu, S., Devarajan, H., & Kaliamoorthy, V. (2023). Blockchain and IPFS: A Permanent Fix for Tracking Farm Produce. *Revue d'Intelligence Artificielle*, *37*(2), 267–274. https://doi.org/10.18280/ria.370203

Baciuliene, V., Bilan, Y., Navickas, V., & Civín, L. (2023). The aspects of artificial intelligence in different phases of the food value and supply chain. In *Foods*. mdpi.com. https://www.mdpi.com/2304-8158/12/8/1654

Barge, P., Biglia, A., Comba, L., Ricauda Aimonino, D., Tortia, C., & Gay, P. (2020). Radio Frequency IDentification for Meat Supply-Chain Digitalisation. *Sensors*, *20*(17), 4957. https://doi.org/10.3390/s20174957

Behnke, K., & Janssen, M. F. W. H. A. (2020). Boundary conditions for traceability in food supply chains using blockchain technology. *International Journal of Information Management*, *52*, 101969. https://doi.org/10.1016/j.ijinfomgt.2019.05.025

Bhatia, S., & Albarrak, A. S. (2023). A Blockchain-Driven Food Supply Chain Management Using QR Code and XAI-Faster RCNN Architecture. *Sustainability*, *15*(3), 2579. https://doi.org/10.3390/su15032579

Bhushan, B., Sinha, P., Sagayam, K. M., & J, A. (2021). Untangling blockchain technology: A survey on state of the art, security threats, privacy services, applications and future research directions. *Computers & Electrical Engineering*, *90*, 106897. https://doi.org/10.1016/j.compeleceng.2020.106897

Cao, S., Xu, H., & Bryceson, K. P. (2023). Blockchain Traceability for Sustainability Communication in Food Supply Chains: An Architectural Framework, Design Pathway and Considerations. *Sustainability*, *15*(18), 13486. https://doi.org/10.3390/su151813486

Chen, H.-Y., Sharma, K., Sharma, C., & Sharma, S. (2023). Integrating explainable artificial intelligence and blockchain to smart agriculture: Research prospects for decision making and improved security. *Smart Agricultural Technology*, *6*, 100350. https://doi.org/10.1016/j.atech.2023.100350

Chen, L., Guttieres, D., Levi, R., Paulson, E., Perakis, G., Renegar, N., & Springs, S. (2021). Public health risks arising from food supply chains: Challenges and opportunities. *Naval Research Logistics (NRL)*, *68*(8), 1098–1112. https://doi.org/10.1002/nav.22020

Cozzio, C., Viglia, G., Lemarie, L., & Cerutti, S. (2023). Toward an integration of blockchain technology in the food supply chain. *Journal of Business Research*, *162*, 113909. https://doi.org/10.1016/j.jbusres.2023.113909

Demestichas, K., Peppes, N., Alexakis, T., & Adamopoulou, E. (2020). Blockchain in Agriculture Traceability Systems: A Review. *Applied Sciences*, *10*(12), 4113. https://doi.org/10.3390/app10124113

Dey, S., Saha, S., Singh, A. K., & McDonald-Maier, K. (2021). FoodSQRBlock: Digitizing Food Production and the Supply Chain with Blockchain and QR Code in the Cloud. *Sustainability*, *13*(6), 3486. https://doi.org/10.3390/su13063486

Duan, J., Zhang, C., Gong, Y., Brown, S., & Li, Z. (2020). A Content-Analysis Based Literature Review in Blockchain Adoption within Food Supply Chain. *International Journal of Environmental Research and Public Health*, *17*(5), 1784. https://doi.org/10.3390/ijerph17051784

Dutta, P., Choi, T.-M., Somani, S., & Butala, R. (2020). Blockchain technology in supply chain operations: Applications, challenges and research opportunities. *Transportation Research Part E: Logistics and Transportation Review*, *142*, 102067. https://doi.org/10.1016/j.tre.2020.102067

El Koshiry, A., Eliwa, E., Abd El-Hafeez, T., & Shams, M. Y. (2023). Unlocking the power of blockchain in education: An overview of innovations and outcomes. *Blockchain: Research and Applications*, *4*(4), 100165. https://doi.org/10.1016/j.bcra.2023.100165

Elliot, V., Floden, J., Overland, C., Raza, Z., Staron, M., Woxenius, J., Basu, A., Rajput, T., Schneider, G., & Stefansson, G. (2024). CEOs' understanding of blockchain technology and its adoption in export-oriented companies in West Sweden: a survey. *Journal of Global Operations and Strategic Sourcing*, *17*(4), 661–684. https://doi.org/10.1108/JGOSS-07-2020-0038

Friedman, Nicola, & Ormiston, J. (2022). Blockchain as a sustainability-oriented innovation?: Opportunities for and resistance to Blockchain technology as a driver of sustainability in global food supply chains. *Technological Forecasting and Social Change*, *175*, 121403. https://doi.org/10.1016/j.techfore.2021.121403

Gaikwad, A. S. (2020). Overview of Blockchain. *International Journal for Research in Applied Science and Engineering Technology*, *8*(6), 2268–2270. https://doi.org/10.22214/ijraset.2020.6364

Giganti, P., Borrello, M., Falcone, P. M., & Cembalo, L. (2024). The impact of blockchain technology on enhancing sustainability in the agri-food sector: A scoping review. *Journal of Cleaner Production*. https://www.sciencedirect.com/science/article/pii/S0959652624018274

Gonzalez-Amarillo, C. A., Fraga Vazquez, A., Ramirez-Gonzalez, G. A., Mendoza-Moreno, M. A., & Corrales Muñoz, J. C. (2023). BIoTS-Path: Certification Transmission of Supply Chains Based on Blockchain–Internet of Things Architectures by Validating the Information Path. *Mathematics*, *11*(19), 4108. https://doi.org/10.3390/math11194108

Govindan, K., Jain, P., Kr. Singh, R., & Mishra, R. (2024). Blockchain technology as a strategic weapon to bring procurement 4.0 truly alive: Literature review and future research agenda. *Transportation Research Part E: Logistics and Transportation Review*, *181*, 103352. https://doi.org/10.1016/j.tre.2023.103352

Goyal, A., Kanyal, H. S., & Sharma, B. (2023). Analysis of IoT and Blockchain Technology for Agricultural Food Supply Chain Transactions. *International Journal on Recent and Innovation Trends in Computing and Communication*, *11*(3), 234–241. https://doi.org/10.17762/ijritcc.v11i3.6342

Gurrala, K., & Hariga, M. (2022). Key Food Supply Chain Challenges: A Review of the Literature and Research Gaps. *Operations and Supply Chain Management: An International Journal*, 441–460. https://doi.org/10.31387/oscm0510358

Hidayati, J., Vamelia, R., Hammami, J., & Endri, E. (2023). Transparent distribution system design of halal beef supply chain. *Uncertain Supply Chain Management*, *11*(1), 31–40. https://doi.org/10.5267/j.uscm.2022.12.003

Islam, N., Nazir, W., & Khalid, N. (2022). Conceptual Study of Problems And Challenges Associated With The Food Supply Chain in Developing Countries. *Arab Gulf Journal of Scientific Research*, 100–117. https://doi.org/10.51758/AGJSR-02-2021-0013

Jahanbin, P., Wingreen, S. C., Sharma, R., Ijadi, B., & Reis, M. M. (2023). Enabling affordances of blockchain in agri-food supply chains: A value-driver framework using Q-methodology. *International Journal of Innovation Studies*, *7*(4), 307–325. https://doi.org/10.1016/j.ijis.2023.08.001

Jraisat, L., Jreissat, M., Upadhyay, A., & Kumar, A. (2023). Blockchain Technology: The Role of Integrated Reverse Supply Chain Networks in Sustainability. *Supply Chain Forum: An International Journal*, *24*(1), 17–30. https://doi.org/10.1080/16258312.2022.2090853

Kayikci, Y., Durak Usar, D., & Aylak, B. L. (2022). Using blockchain technology to drive operational excellence in perishable food supply chains during outbreaks. *The International Journal of Logistics Management*, *33*(3), 836–876. https://doi.org/10.1108/IJLM-01-2021-0027

Kazancoglu, Y., Ozbiltekin-Pala, M., Sezer, M. D., Luthra, S., & Kumar, A. (2023). Resilient reverse logistics with blockchain technology in sustainable food supply chain management during COVID-19. *Business Strategy and the Environment*, *32*(4), 2327–2340. https://doi.org/10.1002/bse.3251

Khan, I. S., Ahmad, M. O., & Majava, J. (2021). Industry 4.0 and sustainable development: A systematic mapping of triple bottom line, Circular Economy and Sustainable Business Models perspectives. *Journal of Cleaner Production*, *297*, 126655. https://doi.org/10.1016/j.jclepro.2021.126655

Khatoon, A. (2020). A Blockchain-Based Smart Contract System for Healthcare Management. *Electronics*, *9*(1), 94. https://doi.org/10.3390/electronics9010094

Kim, H. M., & Laskowski, M. (2018). Toward an ontology-driven blockchain design for supply-chain provenance. *Intelligent Systems in Accounting, Finance and Management*, *25*(1), 18–27. https://doi.org/10.1002/isaf.1424

Kohler, S., Bager, S., & Pizzol, M. (2022). Sustainability standards and blockchain in agro-food supply chains: Synergies and conflicts. *Technological Forecasting and Social Change*, *185*, 122094. https://doi.org/10.1016/j.techfore.2022.122094

Kuzior, A., & Sira, M. (2022). A Bibliometric Analysis of Blockchain Technology Research Using VOSviewer. *Sustainability*, *14*(13), 8206. https://doi.org/10.3390/su14138206

Lahane, S., Paliwal, V., & Kant, R. (2023). Evaluation and ranking of solutions to overcome the barriers of Industry 4.0 enabled sustainable food supply chain adoption. *Cleaner Logistics and Supply Chain*, *8*, 100116. https://doi.org/10.1016/j.clscn.2023.100116

Lin, Q., Wang, H., Pei, X., & Wang, J. (2019). Food Safety Traceability System Based on Blockchain and EPCIS. *IEEE Access*, *7*, 20698–20707. https://doi.org/10.1109/ACCESS.2019.2897792

Mahmud, A., Ding, D., & Hasan, M. M. (2021). Corporate Social Responsibility: Business Responses to Coronavirus (COVID-19) Pandemic. *SAGE Open*, *11*(1). https://doi.org/10.1177/2158244020988710

Manning, L., & Soon, J. M. (2016). Development of sustainability indicator scoring (SIS) for the food supply chain. *British Food Journal*. https://doi.org/10.1108/bfj-01-2016-0007

Martínez-Castañeda, M., & Feijoo, C. (2023). Use of blockchain in the agri-food value chain: State of the art in Spain and some lessons from the perspective of public support. *Telecommunications Policy*, *47*(6), 102574. https://doi.org/10.1016/j.telpol.2023.102574

McAllister, J. T., Lennertz, L., & Atencio Mojica, Z. (2022). Mapping A Discipline: A Guide to Using VOSviewer for Bibliometric and Visual Analysis. *Science & Technology Libraries*, *41*(3), 319–348. https://doi.org/10.1080/0194262X.2021.1991547

Mercuri, F., della Corte, G., & Ricci, F. (2021). Blockchain Technology and Sustainable Business Models: A Case Study of Devoleum. *Sustainability*, *13*(10), 5619. https://doi.org/10.3390/su13105619

Mermer, G. B., Zeydan, E., & Arslan, S. S. (2018). An overview of blockchain technologies: Principles, opportunities and challenges. *2018 26th Signal Processing and Communications Applications Conference (SIU)*, 1–4. https://doi.org/10.1109/SIU.2018.8404513

Mondal, S., Wijewardena, K. P., Karuppuswami, S., Kriti, N., Kumar, D., & Chahal, P. (2019). Blockchain Inspired RFID-Based Information Architecture for Food Supply Chain. *IEEE Internet of Things Journal*, *6*(3), 5803–5813. https://doi.org/10.1109/JIOT.2019.2907658

Mor, R. S., Bhardwaj, A., & Singh, S. (2018). A structured-literature-review of the supply chain practices in dairy industry. *Journal of Operations and Supply Chain Management*. https://periodicos.fgv.br/joscm/article/view/72265

Moretti, C., & Herkovits, D. (2021). Victims, perpetrators, and bystanders: A meta-ethnography of roles in cyberbullying. *Cadernos de Saude Publica*, *37*(4). https://doi.org/10.1590/0102-311X00097120

Okorie, O., Russell, J., Jin, Y., Turner, C., Wang, Y., & Charnley, F. (2022). Removing barriers to Blockchain use in circular food supply chains: Practitioner views on achieving operational effectiveness. *Cleaner Logistics and Supply Chain*, *5*, 100087. https://doi.org/10.1016/j.clscn.2022.100087

Onyeaka, H., & Ekwebelem, O. C. (2023). A review of recent advances in engineering bacteria for enhanced CO2 capture and utilization. In *International Journal of Environmental Science and Technology*. Springer. https://doi.org/10.1007/s13762-022-04303-8

Onyeaka, H., Tamasiga, P., Nwauzoma, U. M., Miri, T., Juliet, U. C., Nwaiwu, U., & Akinsemolu, A. A., (2023). Using artificial intelligence to tackle food waste and enhance the circular economy: Maximising resource efficiency and minimising environmental impact: A Review. In *Sustainability*. mdpi.com. https://www.mdpi.com/2071-1050/15/13/10482

Panghal, A., Sindhu, S., Dahiya, S., Dahiya, B., & Mor, R. S. (2022). Benchmarking the Interactions among Challenges for Blockchain Technology Adoption: A Circular Economy Perspective. *International Journal of Mathematical, Engineering and Management Sciences*, *7*(6), 859–872. https://doi.org/10.33889/IJMEMS.2022.7.6.054

Patidar, S., Sukhwani, V. K., & Shukla, A. C. (2023). Modeling of Critical Food Supply Chain Drivers Using DEMATEL Method and Blockchain Technology. *Journal of The Institution of Engineers (India): Series C*, *104*(3), 541–552. https://doi.org/10.1007/s40032-023-00941-0

Peng, X., Zhang, X., Wang, X., Li, H., Xu, J., Zhao, Z., & Wang, Y. (2022). Research on the Cross-Chain Model of Rice Supply Chain Supervision Based on Parallel Blockchain and Smart Contracts. *Foods*, *11*(9), 1269. https://doi.org/10.3390/foods11091269

Perboli, G., Musso, S., & Rosano, M. (2018). Blockchain in Logistics and Supply Chain: A Lean Approach for Designing Real-World Use Cases. *IEEE Access*, *6*, 62018–62028. https://doi.org/10.1109/ACCESS.2018.2875782

Pincheira, M., Vecchio, M., & Giaffreda, R. (2022). Characterization and Costs of Integrating Blockchain and IoT for Agri-Food Traceability Systems. *Systems*, *10*(3), 57. https://doi.org/10.3390/systems10030057

Quan, G., Yao, Z., Chen, L., Fang, Y., Zhu, W., Si, X., & Li, M. (2023). A trusted medical data sharing framework for edge computing leveraging blockchain and outsourced computation. *Heliyon*, *9*(12), e22542. https://doi.org/10.1016/j.heliyon.2023.e22542

Rahbari, M., Arshadi Khamseh, A., & Mohammadi, M. (2023). Robust optimization and strategic analysis for agri-food supply chain under pandemic crisis: Case study from an emerging economy. *Expert Systems with Applications*, *225*, 120081. https://doi.org/10.1016/j.eswa.2023.120081

Rajasekaran, A. S., Azees, M., & Al-Turjman, F. (2022). A comprehensive survey on blockchain technology. *Sustainable Energy Technologies and Assessments*. https://www.sciencedirect.com/science/article/pii/S2213138822000911

Rampone, F., Lecca, F., Giolito, P., & Romano, M. (2023). Blockchain in the agrifood sector: From storytelling to traceability fact-checking up to new economic models. *Economia Agro-Alimentare*, *25*(2), 97–114. https://doi.org/10.3280/ecag2023oa14958

Ravishankar, B., & Kulkarni, P. (2020). When Block Chain and AI Integrates. *2020 International Conference on Mainstreaming Block Chanin Implementation (ICOMBI)*. https://ieeexplore.ieee.org/abstract/document/9203037/

Rogerson, M., & Parry, G. C. (2020). Blockchain: case studies in food supply chain visibility. *Supply Chain Management: An International Journal*, *25*(5), 601–614. https://doi.org/10.1108/SCM-08-2019-0300

Salah, K., Nizamuddin, N., Jayaraman, R., & Omar, M. (2019). Blockchain-Based Soybean Traceability in Agricultural Supply Chain. *IEEE Access*, *7*, 73295–73305. https://doi.org/10.1109/ACCESS.2019.2918000

Sali, N., Biwalkar, S., Swamy, A., Khadilkar, N., & Sahu, S. (2023). Blockchain in Food Supply Chain: Benefits, Challenges and Review. *International Journal for Research in Applied Science and Engineering Technology*, *11*(4), 4654–4661. https://doi.org/10.22214/ijraset.2023.50661

Sharma, A., Bhatia, T., Singh, R. K., & Sharma, A. (2024). Developing the framework of blockchain-enabled agri-food supply chain. *Business Process Management Journal*, *30*(1), 291–316. https://doi.org/10.1108/BPMJ-01-2023-0035

Sidarto, L. P., & Hamka, A. (2021). Improving Halal Traceability Process in the Poultry Industry Utilizing Blockchain Technology: Use Case in Indonesia. *Frontiers in Blockchain*, *4*. https://doi.org/10.3389/fbloc.2021.612898

Singh, A., Gutub, A., Nayyar, A., & Khan, M. K. (2023). Redefining food safety traceability system through blockchain: findings, challenges and open issues. *Multimedia Tools and Applications*, *82*(14), 21243–21277. https://doi.org/10.1007/s11042-022-14006-4

Singh, G., Rajesh, R., Daultani, Y., & Misra, S. C. (2023). Resilience and sustainability enhancements in food supply chains using Digital Twin technology: A grey causal modelling (GCM) approach. *Computers & Industrial Engineering*, *179*, 109172. https://doi.org/10.1016/j.cie.2023.109172

Singh, R., Khan, S., Dsilva, J., & Centobelli, P. (2023). Blockchain Integrated IoT for Food Supply Chain: A Grey Based Delphi-DEMATEL Approach. *Applied Sciences*, *13*(2), 1079. https://doi.org/10.3390/app13021079

Singh, V. K., Singh, P., Karmakar, M., Leta, J., & Mayr, P. (2021). The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. *Scientometrics*, *126*(6), 5113–5142. https://doi.org/10.1007/s11192-021-03948-5

Soon, J. M., & Manning, L. (2019). Developing anti-counterfeiting measures: The role of smart packaging. *Food Research International*. https://www.sciencedirect.com/science/article/pii/S0963996919302790

Sugandh, U., Nigam, S., Misra, S., & Khari, M. (2023). A Bibliometric Analysis of the Evolution of State-of-the-Art Blockchain Technology (BCT) in the Agrifood Sector from 2014 to 2022. *Sensors*, *23*(14), 6278. https://doi.org/10.3390/s23146278

Tan, J., Goyal, S. B., Singh Rajawat, A., Jan, T., Azizi, N., & Prasad, M. (2023). Anti-Counterfeiting and Traceability Consensus Algorithm Based on Weightage to Contributors in a Food Supply Chain of Industry 4.0. *Sustainability*, *15*(10), 7855. https://doi.org/10.3390/su15107855

Tieman, M., van der Vorst, J. G. A. J., & Che Ghazali, M. (2012). Principles in halal supply chain management. *Journal of Islamic Marketing*, *3*(3), 217–243. https://doi.org/10.1108/17590831211259727

Tsang, Y. P., Choy, K. L., Wu, C. H., Ho, G. T. S., & Lam, H. Y. (2019). Blockchain-Driven IoT for Food Traceability With an Integrated Consensus Mechanism. *IEEE Access*, *7*, 129000–129017. https://doi.org/10.1109/ACCESS.2019.2940227

Valencia-Payan, C., Grass-Ramirez, J. F., Ramirez-Gonzalez, G., & Corrales, J. C. (2022). A Smart Contract for Coffee Transport and Storage With Data Validation. *IEEE Access*, *10*, 37857–37869. https://doi.org/10.1109/ACCESS.2022.3165087

Van Beusekom – Thoolen, P., Holmes, P., Jansen, W., Vos, B., & de Boer, A. (2024). Interdisciplinary challenges associated with rapid response in the food supply chain. *Supply Chain Management: An International Journal*, *29*(3), 444–459. https://doi.org/10.1108/SCM-01-2023-0040

Vivaldini, M. (2021). Blockchain in operations for food service distribution: steps before implementation. *International Journal of Logistics Management, The*. https://doi.org/10.1108/ijlm-07-2020-0299

Wang, Q., & Liu, Y. (2023). Blockchain for public safety: A survey of techniques and applications. *Journal of Safety Science and Resilience*, *4*(4), 389–395. https://doi.org/10.1016/j.jnlssr.2023.09.001

Wunsche, J. F., & Fernqvist, F. (2022). The Potential of Blockchain Technology in the Transition towards Sustainable Food Systems. *Sustainability*, *14*(13), 7739. https://doi.org/10.3390/su14137739

Yang, L., Zhang, J., & Shi, X. (2021). Can blockchain help food supply chains with platform operations during the COVID-19 outbreak? *Electronic Commerce Research and Applications*, *49*, 101093. https://doi.org/10.1016/j.elerap.2021.101093

Yap, T. L., Nayak, R., Vu, N. T. H., Bui, D. T., Pham, T. T. T., & Allen, D. W. E. (2025). Adopting blockchain-based traceability in the fruit supply chain in a developing economy: facilitators and barriers. *Information Technology & People*, *38*(1), 419–441. https://doi.org/10.1108/ITP-02-2023-0168

Yele, S., & Litoriya, R. (2024). Blockchain-based secure dining: Enhancing safety, transparency, and traceability in food consumption environment. In *Blockchain: Research and Applications*. Elsevier. https://www.sciencedirect.com/science/article/pii/S2096720923000623

Zhang, K., Choi, T.-M., Chung, S.-H., Dai, Y., & Wen, X. (2024). Blockchain adoption in retail operations: Stablecoins and traceability. *European Journal of Operational Research*, *315*(1), 147–160. https://doi.org/10.1016/j.ejor.2023.11.026

Zheng, X. R., & Lu, Y. (2022). Blockchain technology–recent research and future trend. *Enterprise Information Systems*. https://doi.org/10.1080/17517575.2021.1939895

Zhu, X., Qi, Z., Chiong, R., Zhang, P., & Ren, M. (2024). The dilemma of introducing blockchain technology into an assembly supply chain: A double-edged sword of profit and upstream invasion. *Computers & Industrial Engineering*, 188, 109830. https://doi.org/10.1016/j.cie.2023.109830