sustainability

MDPI

Article

Knowledge Mapping Visualization Analysis of Research on Blockchain in Management and Economics

Yunfei Yang [1,2,*], Guifei Qu [2], Lianlian Hua [3,*] and Lifeng Wu [2]

[1] School of Engineering Science, University of Chinese Academy of Sciences, Beijing 100049, China
[2] School of Management Engineering and Business, Hebei University of Engineering, Handan 056038, China
[3] School of Management, Inner Mongolia University of Technology, Hohhot 010051, China
* Correspondence: hbgcdx2017@163.com (Y.Y.); hualianlian2010@imut.edu.cn (L.H.)

Abstract: As an emerging technology enabling economic, social, and environmental sustainability, blockchain has drawn considerable attention from the academic community in management and economics. It is essential to clarify this field's research status, hotspots, and evolution trends. This study took 642 pieces of literature on blockchain in management and economics from the Web of Science (WoS) as data sources. It combined the bibliometric knowledge mapping visualization and statistical analysis methods to conduct a systematic analysis. It is found that the United States and China are the primary core strengths, and highly influential research organizations and authors have emerged in this field. The research of blockchain in management and economics has the property of being interdisciplinary. Research hotspots are mainly distributed in the combination and application of blockchain technology and emerging technologies and the research on blockchain in supply chain management (SCM), supply chain finance, intellectual property, digital currency, and transaction costs. The evolution trends of research hotspots show a rule of overlapping commonness and individuality. This study systematically revealed the overall research development situation on blockchain in management and economics to provide some reference and inspiration for relevant researchers.

Keywords: blockchain; bibliometrics; knowledge mapping; VOSviewer; CiteSpace

Citation: Yang, Y.; Qu, G.; Hua, L.; Wu, L. Knowledge Mapping Visualization Analysis of Research on Blockchain in Management and Economics. *Sustainability* **2022**, *14*, 14971. https://doi.org/10.3390/su142214971

Academic Editors: Cheolho Yoon and Marc A. Rosen

Received: 28 September 2022
Accepted: 10 November 2022
Published: 12 November 2022

1. Introduction

In 2008, the generation of Bitcoin promoted the process of blockchain technology [1]. Blockchain is a distributive database recorded in cryptographic "blocks" or a shared ledger of whole transactions or digital events [2]. As a subversive, decentralized, and distributive "state-of-the-art" technique [3], blockchain has some unique advantages in that it ensures the permanence of transaction records, which are divided into separate blocks to prevent tampering [4]. In other words, if a record has been generated, it can never be tampered with without altering the original record, which guarantees the security of business operations [3]. Meanwhile, blockchain can substitute conventional paper tracking and manual monitoring systems, and it can protect the conventional approach of the value chain from inaccuracy [4]. Therefore, blockchain has applications in banking, finance, real estate, government, and other fields [5]. It has become an influential issue of study and exploration by the United Nations and some governments in recent years [6]. Thus, the research and development of blockchain have attracted extensive concern from all social circles.

The research of blockchain in management and economics has also raised scholars' concerns in the last few years. Meanwhile, with the continuous emergence of research findings in the subdivision of blockchain in management and economics, it is urgent to explore the research of blockchain in management and economics systematically. Some scholars have used literature reviews to sort out and analyze the research of blockchain in

management and economics, such as the analysis based on the comprehensive perspective of the research in this field [7]. Some scholars have also summarized and analyzed the research in this field from the micro perspective, such as the research of blockchain in the SCM [8,9], the research of blockchain in the food supply chain [10,11], and the research of blockchain in banking and finance [12,13]. Undoubtedly, these research findings are of great significance in enriching and deepening the research of blockchain in management and economics. However, suppose the analysis is mainly conducted by literature review and summary. In that case, the number of literature studied may be limited, particularly in the situation of a long period and large amount of literature, making it challenging to reveal the overall situation of the research field. Moreover, literature review and summary are mainly adopted, which will inevitably be affected by the subjectivity of researchers in the research and analysis process.

Bibliometric analysis is one of the most critical ways to evaluate scientific output [14]. It can explore the intrinsic relationship of publications, exploiting an innovative perspective to survey a particular scientific issue [15]. Bibliometric analysis is often closely associated with network visualization software [16]. A series of software, such as Pajek, UCINET, CiteSpace, and VOSviewer, can be adapted to draw knowledge mapping [17]. CiteSpace and VOSviewer are popular and relatively complemented knowledge mapping analysis software [18]. Specifically, CiteSpace is usually used in bibliometric research to explore and describe the emerging evolutionary tendency and dynamic condition of a research area [19]. Moreover, VOSviewer is a comprehensive bibliometric analysis tool [20]. It has a powerful knowledge mapping presentation function, applicable to many pieces of literature, and reveals the core and hot elements of research objects by adopting a density view [21,22]. Therefore, it is urgent to introduce bibliometrics to explore the research of blockchain in management and economics.

Some scholars have used bibliometric methods to explore blockchain in management and economics. For example, bibliometric methods are used to analyze blockchain in logistics supply chain management [23,24], human resource management [25], and financial services [26]. However, scholars' research on blockchain in management and economics combined with bibliometrics focuses on micro-specific fields, and the research findings are relatively few. Based on the comprehensive angle of management and economics, it is rare to use bibliometric analysis methods to explore the research findings on blockchain in management and economics. This study intends to systematically explore the literature on blockchain in management and economics using VOSviewer and CiteSpace software based on bibliometrics, thereby comprehensively revealing the research status, hotspots, and evolution trends of the research field. Specifically, this study concentrates on addressing the following problems:

RQ1: What is the yearly number of publications on blockchain in management and economics? What are the differences or characteristics of the distribution of yearly publications in major countries/regions?

RQ2: What is the cooperation status among countries/regions on blockchain in management and economics? Which research organizations have important influence in this field? What is the collaborative relationship among authors? Which authors have important academic influence in this field?

RQ3: Which journals of blockchain in management and economics are highly concerned and authoritative? What is the essential information revealed by important journals?

RQ4: Which references are the classics of blockchain in management and economics? What is the essential information revealed by critical references?

RQ5: What is the essential information revealed by the co-occurrence of keywords of blockchain in management and economics? What is the distribution of research hotspots in this field?

RQ6: What are the rules of the evolution of blockchain in management and economics?

The study's remaining sections are as follows: Section 2 describes data sources and the methods. Section 3 analyzes and discusses the research results of blockchain in management

and economics. Among them, Sections 3.1–3.4 explore the research status of this field from the four dimensions of the number of publications, research activities, journals, and references. Section 3.5 conducts co-occurrence and cluster on keywords to analyze the research hotspots. Section 3.6 conducts a timeline analysis of keywords and clarifies the evolution trend of this field. Section 4 illustrates the conclusions.

2. Materials and Methods

2.1. Data Sources

The research data came from the WoS and were collected by advanced retrieval. We set the retrieval formula as "AK = (Blockchain) AND WC = (Management OR Economics) AND LA = (English)" and chose the citation index as "All"; thus, 1071 pieces of literature were retrieved. To ensure the continuity and completeness of the data series, we excluded 83 papers published in 2022. The literature type was further selected as "Article", and the refined 642 pieces of literature were taken as the study's data source. In addition, the data of this study were collected on the afternoon of 13 April 2022.

2.2. Methods

This study adopted the bibliometric knowledge mapping visualization method and statistical analysis method. Specifically, CiteSpace and VOSviewer software were used to accomplish bibliometric research on the sample data of blockchain in management and economics. It can intuitively present the information, including the cooperation of countries/regions, the influence of research organizations, the cooperation and co-citation of authors, the co-citation of journals and references, the keywords co-occurrence and clustering, and the keywords timeline in the way of knowledge mapping visualization. Meanwhile, statistical analysis methods were used to sort out the relevant data of blockchain in management and economics, including the data related to the publications, the data related to the journals, the data related to references, and the related data of keywords co-occurrence.

3. Results and Discussion

3.1. Analysis of Publications

The analysis of yearly publications provides insight into the extent to which a theme engages scholars at various phases [27]. This study presented the statistical results of the WoS by the retrieval strategy above to clarify the yearly distribution of publications on blockchain in management and economics, as seen in Figure 1.

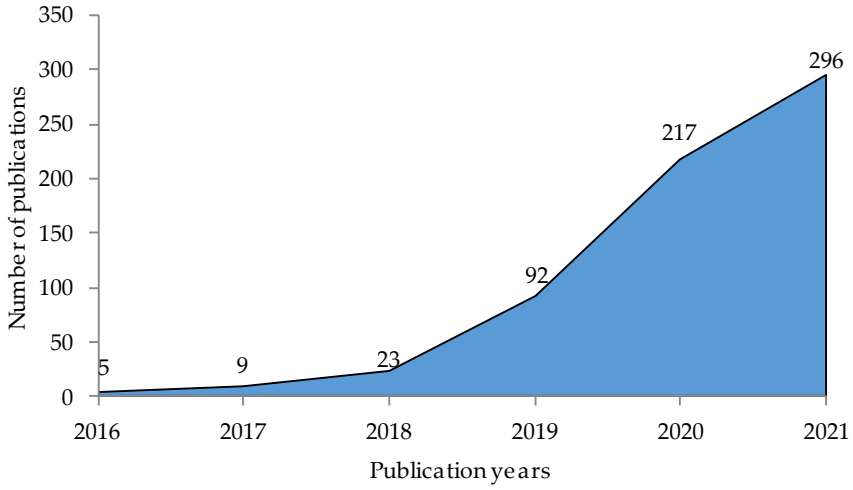
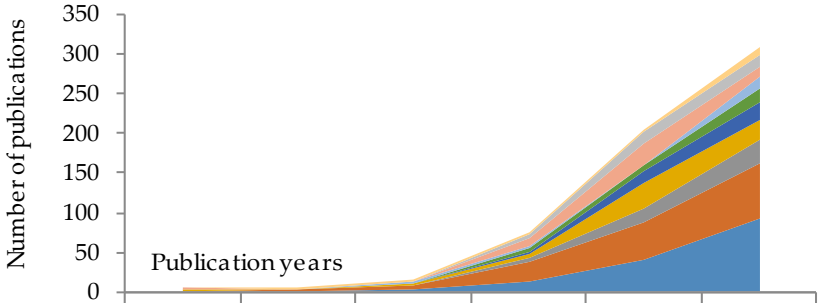


Figure 1. The yearly distribution of publications from 2016 to 2021.

Figure 1 indicates that the publications on blockchain in management and economics present a growing situation. The number of publications in this field can be summed

up in two phases. The first phase (2016–2018): The initial development phases. The overall number of publications is relatively small and the growth rate is relatively slow, indicating that blockchain research in management and economics receives little attention. The second phase (2019–2021): The phase of blowout growth. At this phase, the number of publications on blockchain in management and economics grows rapidly, with a growth rate of 300% in 2019 compared with 2018 and a growth rate of 135.87% in 2020 compared with 2019. Meanwhile, the number of publications at this phase account for 94.24% of the total publications, demonstrating that the research on blockchain in management and economics has attracted significant attention and recognition from international scholars.

This study organized and summarized the statistical results from the WoS to further analyze the yearly distribution of publications in major countries/regions on blockchain in management and economics, as seen in Figure 2.



	2016	2017	2018	2019	2020	2021
CANADA	0	2	2	3	3	12
AUSTRALIA	1	1	0	5	15	13
GERMANY	1	0	1	10	25	14
TAIWAN	0	0	1	1	2	15
FRANCE	0	0	0	5	7	17
ITALY	0	1	0	3	14	22
ENGLAND	3	0	2	5	32	25
INDIA	0	0	1	6	19	30
USA	1	2	5	25	47	69
PEOPLES R CHINA	0	0	3	12	40	93

Figure 2. The yearly distribution of publications in major countries/regions.

As seen from Figure 2, the major countries/regions that publish findings on blockchain in management and economics include the United States and China, etc. These countries/regions are significant for promoting research and progress of the research field. The United States and China publish 149 and 148 in this field, respectively—significantly more than those in other countries/regions, which indicates that they play a leading role in this field. Moreover, from 2016 to 2018, the total number of publications on blockchain in management and economics were relatively few, so the differences in the number of publications among major countries/regions in this field are also relatively small. From 2019 to 2021, the number of publications of different countries/regions in this field significantly differed. Most countries/regions such as China and the United States have shown an apparent growth trend in their publications in this field. China, in particular, has the highest total publications from 2019 to 2021, and the growth rate is evident. However, some countries, such as the United Kingdom, Germany, and Australia, show a certain fluctuation in the number of publications. Further research shows that developed countries/regions are the central bodies of publications on blockchain in management and economics, indicating a certain correlation between the research and development in this field and economic development. Meanwhile, from the perspective of geographical location distribution, it

can be seen that the central bodies of blockchain in management and economics are mainly distributed in Asia, North America, Europe, and Australia.

3.2. Analysis of Research Activities

3.2.1. Analysis of Countries/Regions

Exploring country cooperation can reveal the intensity of the connection between countries and high-impact countries [28]. Given this, under the premise of analyzing the yearly distribution of publications in major countries/regions to further reveal the cooperation of countries/regions in this field, this study used VOSviewer. It ran the software to generate a national/regional cooperative knowledge map, as seen in Figure 3.

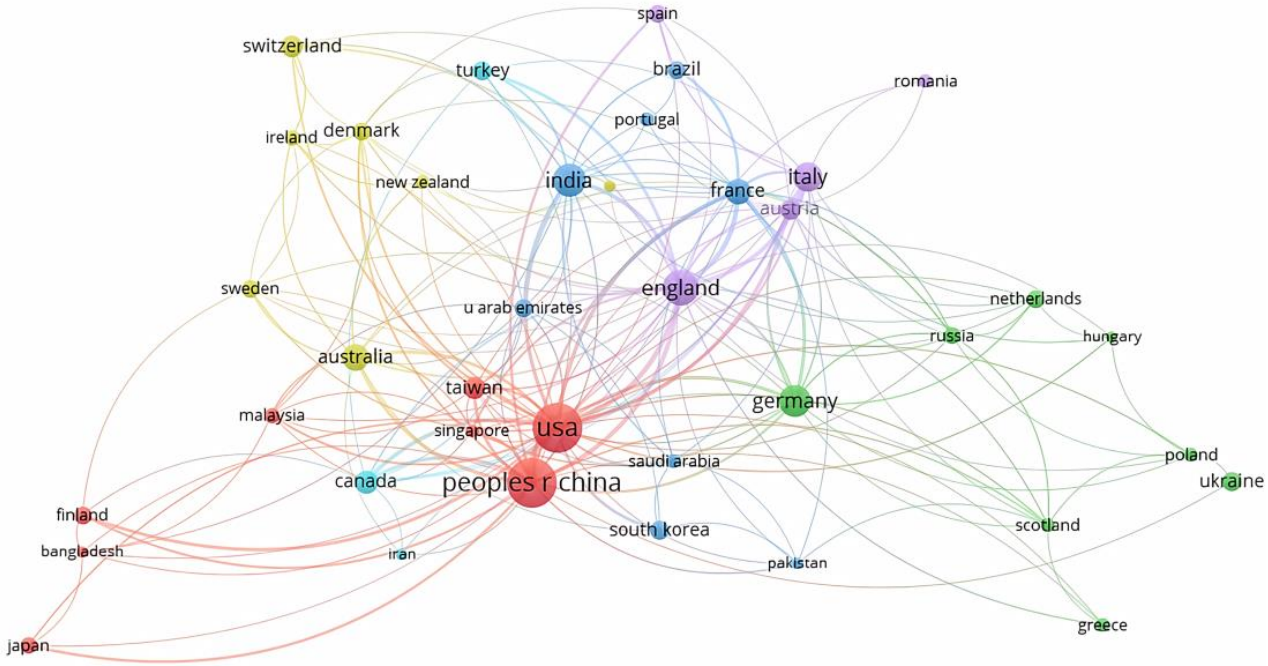


Figure 3. The network of countries/regions.

Figure 3 mainly includes nodes and links, etc. The node size and the number of publications of the countries/regions have a positive correlation. The thickness of links among nodes is positively correlated with the cooperative relationship among countries/regions. Meanwhile, the node's colors and their links in Figure 3 are different, and different colors represent research cooperation groups among different countries/regions. In other words, nodes with the same color have a closer cooperation relationship.

From the number of links among the nodes, it can be seen that a complex interactive network is formed among the nodes in Figure 3. Meanwhile, combined with the thickness of the links among the nodes, it can be seen that there are relatively few thicker links among the nodes in the network. Therefore, this indicates that countries/regions have a certain degree of cooperation relationship, but the intensity is moderate. According to the colors of the nodes and their links in Figure 3, the research on blockchain in management and economics has formed six major research collaboration groups. Further analysis indicates a cooperative relationship within the research groups and a certain cooperative relationship among the research groups regarding this field's research. Notably, some countries/regions with many publications have relatively close research cooperation relations, such as the cooperation between China and the United States, the United Kingdom, the cooperation between the United States and China, and Germany.

3.2.2. Analysis of Research Organizations

The number of research organizations' publications maps a specific field's publication pattern, and the research trends can be quickly found by exploring core research organizations' research findings [29,30]. This study used VOSviewer to calculate the publications of the research organizations on blockchain in management and economics. According to the calculation results of VOSviewer, the research organizations with more than five publications were counted, as seen in Figure 4.

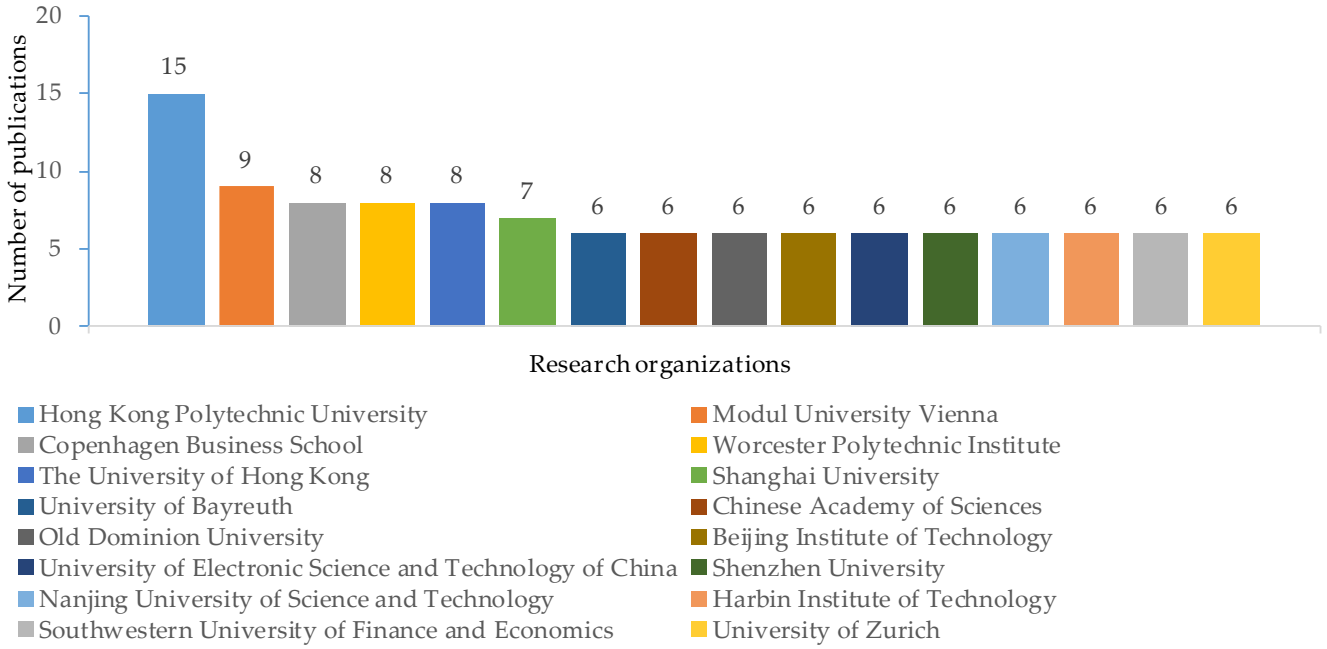


Figure 4. Research organizations with more than five publications.

As seen from Figure 4, regarding the scientific research output capability of research organizations on blockchain in management and economics, the Hong Kong Polytechnic University has the most publications. It is significantly higher than other research organizations, which shows that the research organization has a strong scientific research strength in this field. Meanwhile, Modul University Vienna, Worcester Polytechnic Institute, Copenhagen Business School, and the University of Hong Kong, etc. also have many publications in this field. These research organizations have been critical in furthering the advancement of this field. In addition, an analysis of the attributes of the research organizations in Figure 4 reveals that universities are the core force in advancing the scientific output of blockchain in management and economics. Among them, China has the most significant number of research organizations. It can be seen that China has made a significant contribution to promoting the research process in this field.

To reveal the influence of the research organizations in this field, VOSviewer was used to generate a density visualization knowledge map, as shown in Figure 5.

Figure 5 reveals the density distribution of research organizations on blockchain in management and economics and shows a gradual change from green to red. The distribution zone of research organization nodes is closely related to their importance. In other words, the more the nodes tend towards the red zone, the higher the influence; the more the nodes tend towards the green zone, the lower the influence. As shown in Figure 5, the research organizations located in the red zone include the Beijing Institute of Technology, the University of Hong Kong, University of Sussex, Copenhagen Business School, and Hong Kong Polytechnic University, etc. It follows that these research organizations are influential in this field. Combined with Figure 4, we can find that research organizations such as Hong Kong Polytechnic University, Copenhagen Business School, and the University of

Hong Kong have significant influence and have many publications. Therefore, it can be considered that the influence of these research organizations in this field is prominent.

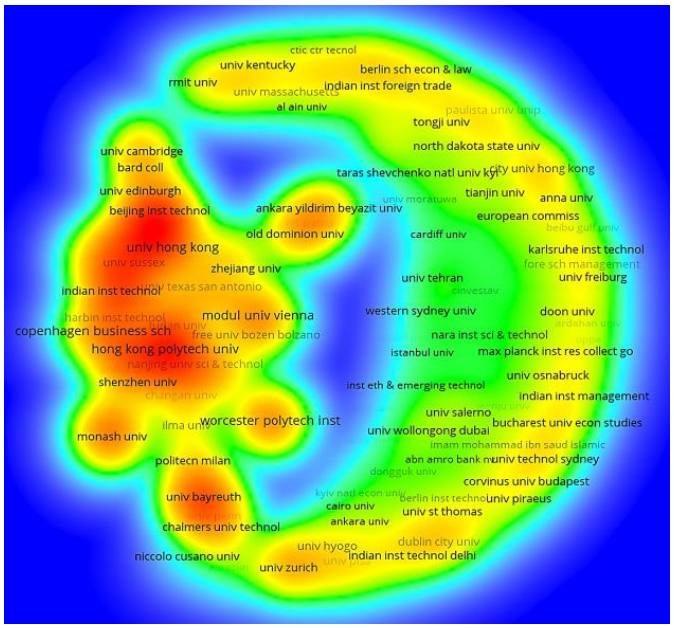
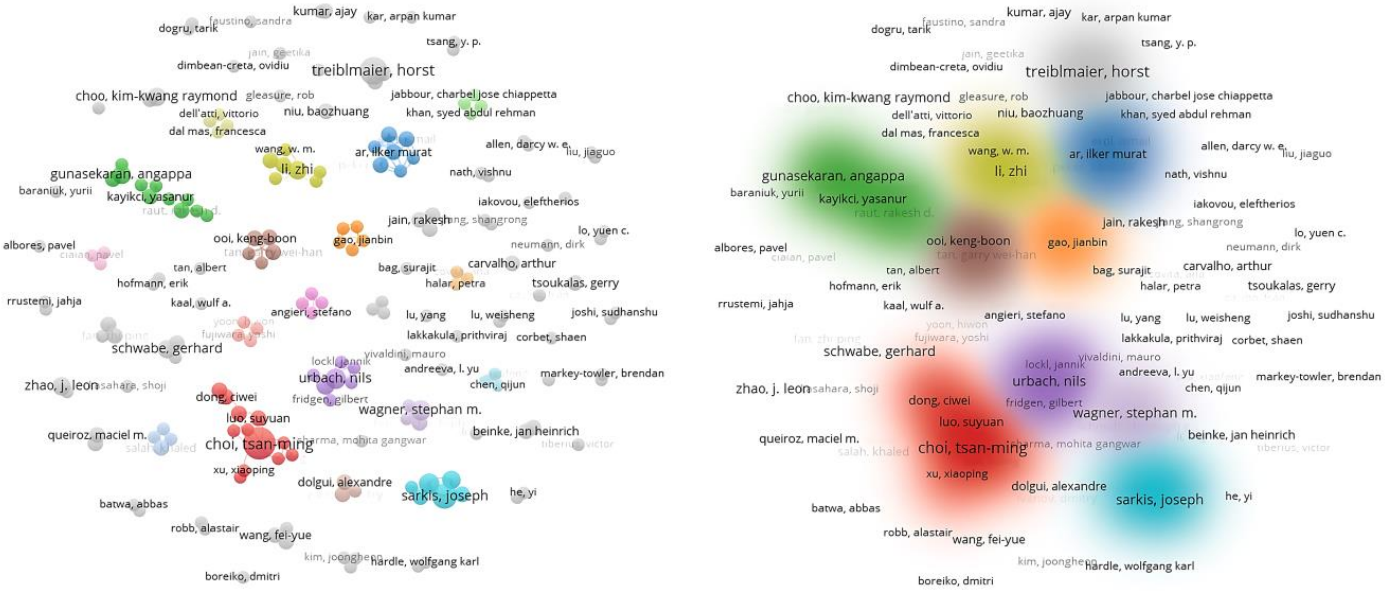


Figure 5. The item density visualization of research organizations.

3.2.3. Analysis of Authors

The author's cooperation research can map the influential scholars and the intensity of cooperation and reveal the critical influence of team cooperation on scientific research [31]. This study used VOSviewer to explore the authors in this field. It generated the knowledge mapping of the author's network visualization and cluster density visualization, as shown in Figure 6a,b.



(**a**) (**b**)

Figure 6. Author's network and cluster density: (**a**) author's network visualization; (**b**) author's cluster density visualization.

According to the size of the network nodes in Figure 6a, the network nodes corresponding to authors such as Tsan-Ming Choi, Treiblmaier, Horst, Sarkis, and Joseph et al. are relatively large, which indicates that the authors have a high number of publications. As can be seen from the links among the network nodes, the overall number of node links in Figure 6a is relatively small, there are some isolated nodes around the network, and the network structure is relatively loose. Therefore, it can be considered that the author's cooperation intensity on blockchain in management and economics is general on the whole. However, some collaborative relationships among authors are also shown in Figure 6a. In order to clarify the cooperative groups of authors, it can be found from Figure 6b that the author groups with cooperative relationships form clusters, such as the red area, green area, and purple area in Figure 6b.

In addition, the author's co-citation network can be generated to provide academic guidance through mapping the co-citation relations between the authors [32]. To further explore the author's information in this field, VOSviewer was used. The software running results are seen in Figure 7.

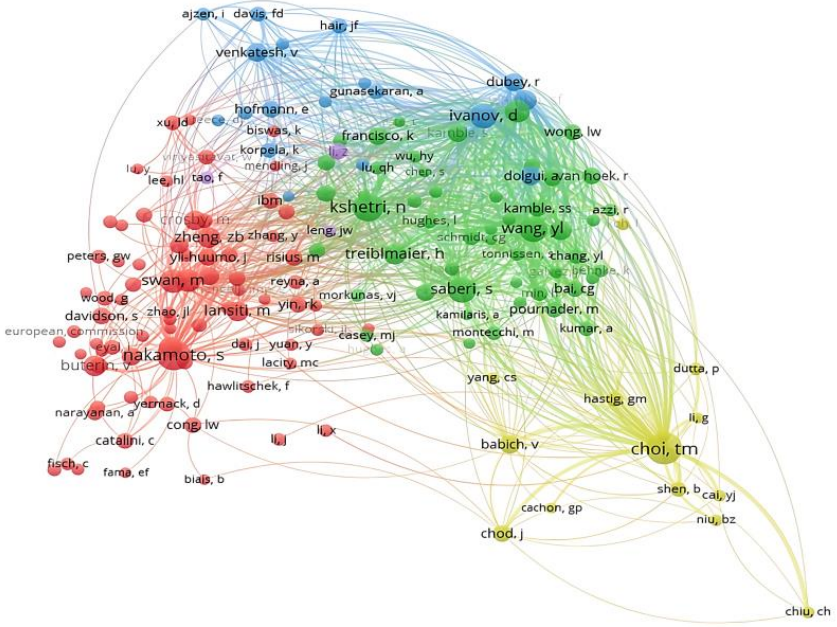


Figure 7. The network of author's co-citation.

Figure 7 depicts the author's co-citation network of research on blockchain in management and economics, in which the size of the network nodes is positively correlated with the author's citation frequency. Based on Figure 7, we can find that the most frequently cited authors in this field are Choi TM., Nakamoto S., and Kshetri N. et al. These authors have great academic influence, which is significant for boosting the development in this field. Choi TM., in particular, has the most publications and citation frequency. Therefore, it can be considered that the author is the main subject of the research on blockchain in management and economics.

3.3. Analysis of Journals

Journal co-citation analysis has the function of exploring the structure and attributes of the discipline and presenting the whole structure of the discipline and attributes of the journal [33]. Given this, in this study, VOSviewer was adopted to conduct journal co-citation analysis, thereby generating the co-citation network of journals for research on blockchain in management and economics, as seen in Figure 8.

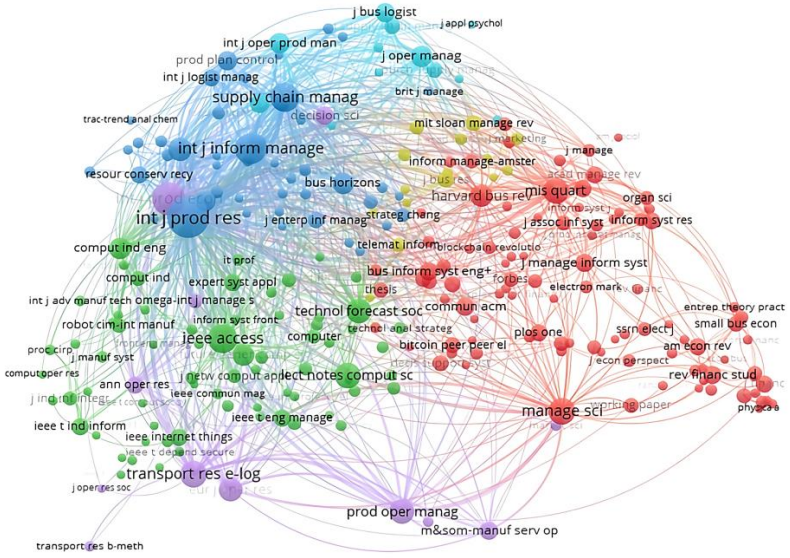


Figure 8. The co-citation network of journals.

The size of the network nodes and the journal citation frequency positively correlate in Figure 8. According to Figure 8, we can find that journals such as the *International Journal of Production Research* and the *International Journal of Production Economics* have relatively large nodes, so these journals have a higher citation frequency. Meanwhile, Figure 8 also presents the six clusters of co-citation journals, such as the green node area, the purple node area, and the red node area. In general, the co-citation journals in the same cluster have high homogeneity regarding research themes.

In order to further explore the essential information revealed by journals, this study conducted statistics on the top 10 journals on the number of research publications and co-citation frequency of blockchain in management and economics, as shown in Table 1. The caveat is that the related data regarding publications came from the WoS. Meanwhile, the related data regarding co-citation came from the calculation results of the VOSviewer software.

Table 1 indicates that the number of publications in the top 10 journals of blockchain in management and economics accounts for 33.49% of the total, which reflects the concentration of papers published in these journals to a certain extent. Meanwhile, according to the co-citation frequency of journals, the co-citation frequency of the top 10 journals in this field is higher than 300, which reveals that these journals have a high scientific research reputation in this field to a certain extent.

Combined with the comprehensive analysis of the number of journal publications and citation frequency in Table 1, we can find that journals such as the *International Journal of Production Research* and the *International Journal of Production Economics* have a high citation frequency and a relatively high number of publications. Therefore, this confirms the attention and authority of these journals in the field. According to the category quartile and impact factor of journals, it can be seen that many journals in Table 1 have a category quartile of Q1 and a high impact factor, which to a certain extent reflects that these journals have a tremendous academic influence on this field. Moreover, it can be seen from the category of journals that the journals in Table 1 involve not only management and economics fields but also computer science and information science, etc., which also reflects the interdisciplinary characteristics of the research in this field.

Table 1. The number of publications in journals and citations of co-citation journals.

No.	Published in Journals	Documents	No.	Source	Citations
1	IEEE Transactions on Engineering Management	49	1	International Journal of Production Research	1180
2	International Journal of Production Research	42	2	International Journal of Production Economics	630
3	IEEE Systems Journal	26	3	International Journal of Information Management	546
4	Annals of Operations Research	15	4	Supply Chain Management: An International Journal	466
5	Transportation Research Part E: Logistics and Transportation Review	15	5	IEEE Access	446
6	Expert Systems with Applications	14	6	Management Science	387
7	International Journal of Production Economics	14	7	Transportation Research Part E: Logistics and Transportation Review	373
8	Journal of Enterprise Information Management	14	8	Lecture Notes in Computer Science	351
9	Logistics Basel	13	9	MIS Quarterly	337
10	Technology Innovation Management Review	13	10	Technological Forecasting and Social Change	304

3.4. Analysis of References

References co-citation networks present the most frequently cited and influential references so that new scholars can conveniently tap into a particular field of research [34]. Given this, this study adopted VOSviewer for the co-citation analysis of references, as seen in Figure 9.

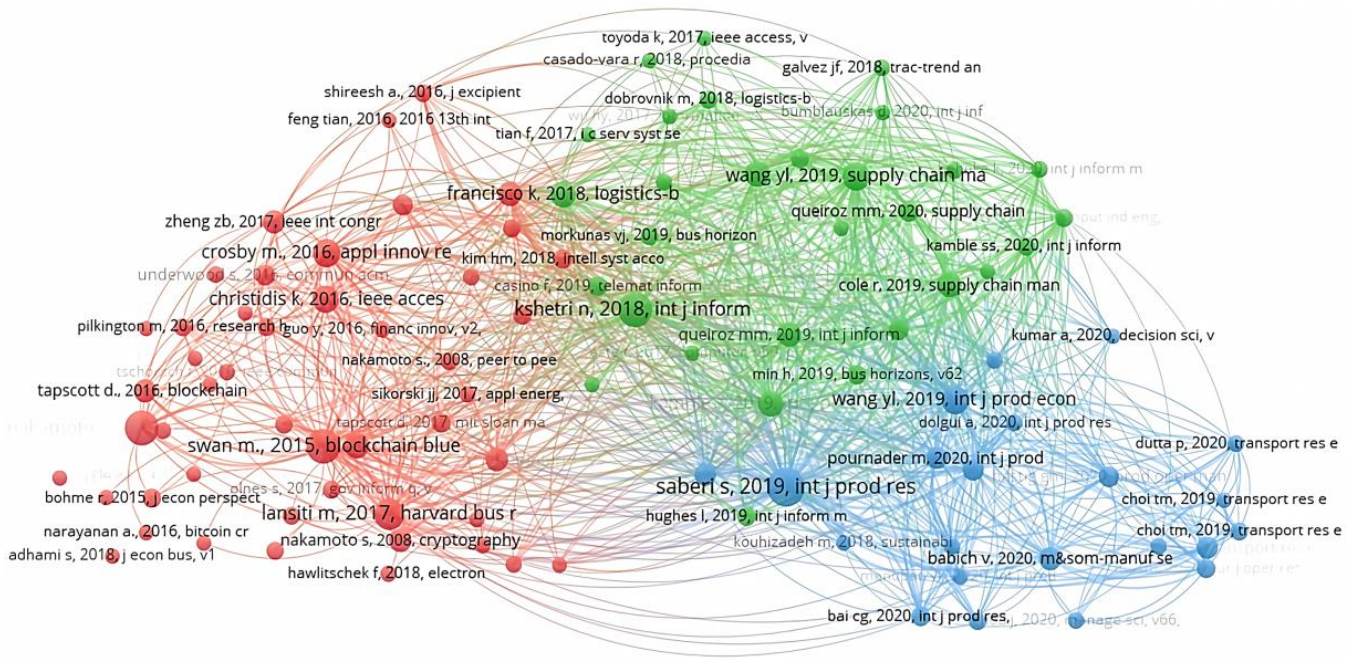


Figure 9. The co-citation network of references.

Figure 9 presents the visual network of references co-citation of research on blockchain in management and economics. Among them, the size of the network nodes is positively correlated with the citation frequency of references. In other words, the larger the network

nodes are, the higher the citation frequency of references is; otherwise, the lower the citation frequency of the references is. According to Figure 9, we can find that the nodes corresponding to some references in the network are relatively large, such as the reference published by the scholar Saberi S. in 2019, the reference published by Kshetri N. in 2018, and the reference published by Swan M. in 2015. Therefore, these references have a high citation frequency. Meanwhile, the references with similar research contents in this field in Figure 9 depict different cluster areas, such as the red node area, the green node area, and the blue node area in Figure 9.

In order to explore the information carried by the co-citation references of blockchain in management and economics, the top 10 cited references were counted through the calculation results of VOSviewer, as seen in Table 2. It should be noted that the reference ranked the ninth citation frequency was found during the statistical process, which showed "no title captured" in the calculation result of the software. Given this, this study conducted extended statistical processing. In other words, the reference ranked as the ninth citation frequency was excluded, and the references ranked as the tenth and eleventh citation frequencies were selected for statistics. Meanwhile, the node of the reference that show "no title captured" was also not displayed in Figure 9.

Table 2. References of nodes with high co-citation frequency.

No.	Author	Publication Year	Cited References	Citations
1	Saberi, Sara et al.	2019	Blockchain technology and its relationships to sustainable supply chain management	124
2	Kshetri, Nir	2018	1 Blockchain's roles in meeting key supply chain management objectives	105
3	Swan, Melanie	2015	Blockchain: Blueprint for a new economy	104
4	Nakamoto, Satoshi	2008	Bitcoin: A peer-to-peer electronic cash system	99
5	Lansiti, Marco et al.	2017	The truth about blockchain	79
6	Wang, Yingli et al.	2019	Making sense of blockchain technology: How will it transform supply chains?	67
7	Wang, Yingli et al.	2019	Understanding blockchain technology for future supply chains: a systematic literature review and research agenda	66
8	Crosby, Michael et al.	2016	Block Chain technology: Beyond bitcoin	66
9	Christidis, Konstantinos et al.	2016	Blockchains and smart contracts for the internet of things	60
10	Kamble, Sachin et al.	2019	Understanding the Blockchain technology adoption in supply chains-Indian context	58

The co-citation references of blockchain in management and economics in Table 2 have a high citation frequency, confirming the classics of these references in this field. Moreover, according to the years of publication, most of the literature was published within the study period (2016–2021). However, some literature was published earlier than the research period, which laid an essential foundation for deepening the research of blockchain in management and economics. Especially in the reference published in 2008, "Bitcoin: A peer-to-peer electronic cash system", "Nakamoto, Satoshi" proposed a way to solve

the double-spending problem by adopting a peer-to-peer network [35]. Therefore, the blockchain ushers a revolutionary way of recording "digital truth" [36]. Moreover, from the research content involved in the references, the highly co-cited references in this field focus on exploring the utilization of blockchain in SCM and the level of blockchain technology.

In order to further explore the critical reference information of blockchain in management and economics, this study conducted statistics on the top 10 most-cited references from the WoS, as shown in Table 3.

Table 3. References with high citation frequency.

No.	Author	Publication Year	Cited References	Citations
1	Xu, Li Da et al.	2018	Industry 4.0: state of the art and future trends	892
2	Saberi, Sara et al.	2019	Blockchain technology and its relationships to sustainable supply chain management	612
3	Ivanov, Dmitry et al.	2019	The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics	380
4	Treiblmaier, Horst	2018	The impact of the blockchain on the supply chain: a theory-based research framework and a call for action	201
5	Kamble, Sachin et al.	2019	Understanding the Blockchain technology adoption in supply chains-Indian context	190
6	Choi, Tsan-Ming et al.	2019	The mean-variance approach for global supply chain risk analysis with air logistics in the blockchain technology era	147
7	Choi, Tsan-Ming	2019	Blockchain-technology-supported platforms for diamond authentication and certification in luxury supply chains	131
8	Schmidt, Christoph G. et al.	2019	Blockchain and supply chain relations: A transaction cost theory perspective	123
9	Hastig, Gabriella M. et al.	2020	Blockchain for supply chain traceability: Business requirements and critical success factors	118
10	Chang, Yanling et al.	2020	Blockchain in global supply chains and cross border trade: a critical synthesis of the state-of-the-art, challenges and opportunities	114

According to the years of publication in Table 3, the number of pieces of literature published in 2019 accounted for a relatively high proportion. The reason may be related to the yearly distribution of publications mentioned above. Specifically, 2019 is a turning point for the research findings of blockchain in management and economics to enter the blowout growth phase. The emergence of new theoretical perspectives, methodologies, and technologies during the year has laid a foundation for leading the scientific process in this field. Therefore, it promotes the production of more highly cited pieces of literature to a certain extent.

From the perspective of citation frequency, we can find that the references in Table 3 have a high citation frequency, so it can be considered that these references are crucial for deepening this field. From the research content involved in the references in Table 3, it can be seen that most of the highly cited references in this field are weighted in the findings of SCM driven by blockchain technology. Meanwhile, it is also highly correlated with the information revealed by the references in Table 2, which indicates that SCM is a hot topic

in this field. The further analysis combined with Table 2 also shows that some references are highly cited and co-cited, such as "Blockchain technology and its relationships to sustainable supply chain management" and "Understanding the blockchain technology adoption in supply chains-Indian context", revealing the influence and classics of these references in this field.

3.5. Analysis of Research Hotspots

3.5.1. Analysis of Keywords Co-Occurrence

Keywords co-occurrence is an efficient and vital way to mine the knowledge and present a perspective of the knowledge structure and research development situation [37]. It mainly explores the frequency of keywords and the link intensity between co-occurrence keywords [38]. Given this, this study used CiteSpace to generate knowledge mapping of keywords co-occurrence on blockchain in management and economics, as shown in Figure 10.

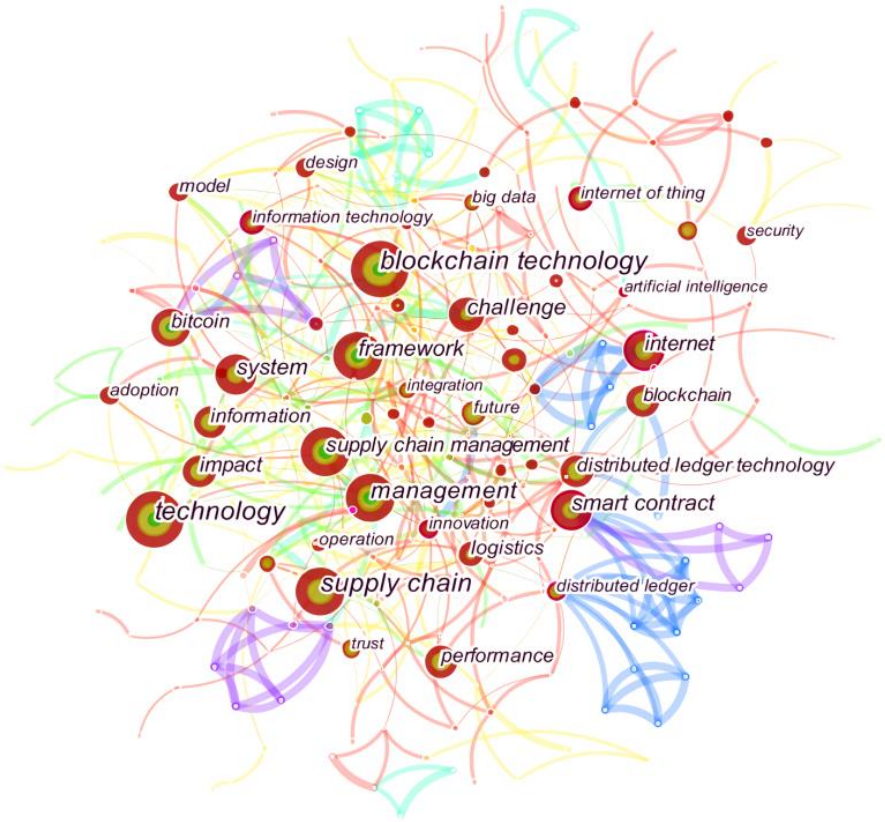


Figure 10. Keywords co-occurrence visualization.

According to Figure 10, the nodes' size and the keywords' frequency have a positive correlation. Meanwhile, the link among the nodes represents the level of co-occurrence of keywords. In other words, the thicker the link among nodes is, the stronger the correlation among the keywords is; otherwise, the weaker the correlation among the keywords is. Based on the distribution of the nodes, keywords with a high frequency of research on blockchain in management and economics include "technology", "blockchain technology", "supply chain", "management", "smart contract", "system", and "framework," etc.; these keywords to some degree map the hot research topics. According to the links among the nodes, we can find that the whole structure of the network is relatively loose, and there are many scattered keyword nodes around. Meanwhile, focusing on the link thickness among the keyword nodes, it can be found that many keywords with large nodes in the co-occurrence network do not show significant correlation and crossover characteristics.

Therefore, there are relatively large research branches on blockchain in management and economics, and the crossover characteristics of hot research keywords are not significant.

In order to further clarify the research hotspots of blockchain in management and economics and expound on the key issues in this field, this study summarized the important index data in the calculation results of CiteSpace, as shown in Table 4.

Table 4. Keywords co-occurrence related index data.

No.	Count	Centrality	Year	Keywords
1	88	0.03	2019	technology
2	76	0.00	2019	blockchain technology
3	73	0.02	2019	supply chain
4	55	0.02	2019	management
5	48	0.10	2016	smart contract
6	47	0.01	2019	system
7	45	0.01	2019	framework
8	43	0.08	2018	challenge
9	40	0.13	2017	internet
10	40	0.02	2019	impact
11	40	0.04	2018	supply chain management
12	31	0.05	2016	bitcoin
13	30	0.06	2019	performance
14	29	0.00	2019	information
15	27	0.08	2019	logistics
16	26	0.06	2017	distributed ledger technology
17	25	0.06	2019	model
18	23	0.08	2017	blockchain
19	20	0.02	2019	big data
20	20	0.11	2019	internet of thing

Table 4 mainly includes keyword frequency, centrality, and year, etc. The keyword frequency data shows that the keyword frequency distribution of research on blockchain in management and economics is relatively uniform. Based on the data on centrality, we can find no evident relevance between frequency and centrality. For example, the keyword "Technology" has a frequency of 88 while its centrality value is only 0.03. Other keywords with similar characteristics include "Blockchain technology" and "Supply chain", etc. The reason may be related to the relatively scattered research hotspots of blockchain in management and economics, so that the correlation among some specific research hotspots is not significant. Meanwhile, nodes with betweenness centrality >0.1 can be regarded as high central nodes [39]. Keyword nodes with centrality >0.1 in Table 4 include "internet" and "internet of thing", so it can be considered that these keywords are essential bonds and bridges in the research on blockchain in management and economics. In addition, according to the index data of keyword year, we can find that many keywords with high frequency appeared in 2019, while the number of keywords with high frequency that appeared before 2019 was relatively few. Further analysis can also find that keywords with high frequency before 2019 are more and place extra emphasis on blockchain technology or blockchain-related technology aspects, such as "smart contract", "internet", and "distributed ledger technology." It can show that the findings on blockchain technology provide core support for expanding and deepening the management and economics research field.

Further analysis of the information revealed by the keywords in Table 4 reveals that the research on blockchain in management and economics includes the specific application fields of blockchain, such as the field of logistics and SCM (information mapped by the keywords "supply chain", "SCM", and "logistics") and the field of electronic currency (information mapped by the keyword "Bitcoin"). Meanwhile, it also includes the research on technical support in this field, such as information mapped by the keywords "technology", "blockchain technology", "smart contract", and "distributed ledger technology". In addition, the research in this field also involves the combination of blockchain and other

technologies, such as the information revealed by the keywords "internet", "big data", and "internet of thing". Furthermore, the research in this field also involves critical elements of essential research support, such as information covered by the keywords "system", "framework", and "model". It indicates that the findings on blockchain in management and economics present diversified characteristics, further confirming that research hotspots in this field are widely distributed.

3.5.2. Keywords Cluster Analysis

Cluster analysis divides the integration of physical or abstract objects into a variety of types consisting of similar research objects according to the consistency of the research object [40], which can recognize primary research areas, emerging trends, and hot issues with evolution [41]. Given this, this study used CiteSpace to conduct cluster analysis, thereby generating knowledge mapping of keywords clustering for the research on blockchain in management and economics, and selected the top 10 largest clusters for analysis, as shown in Figure 11.

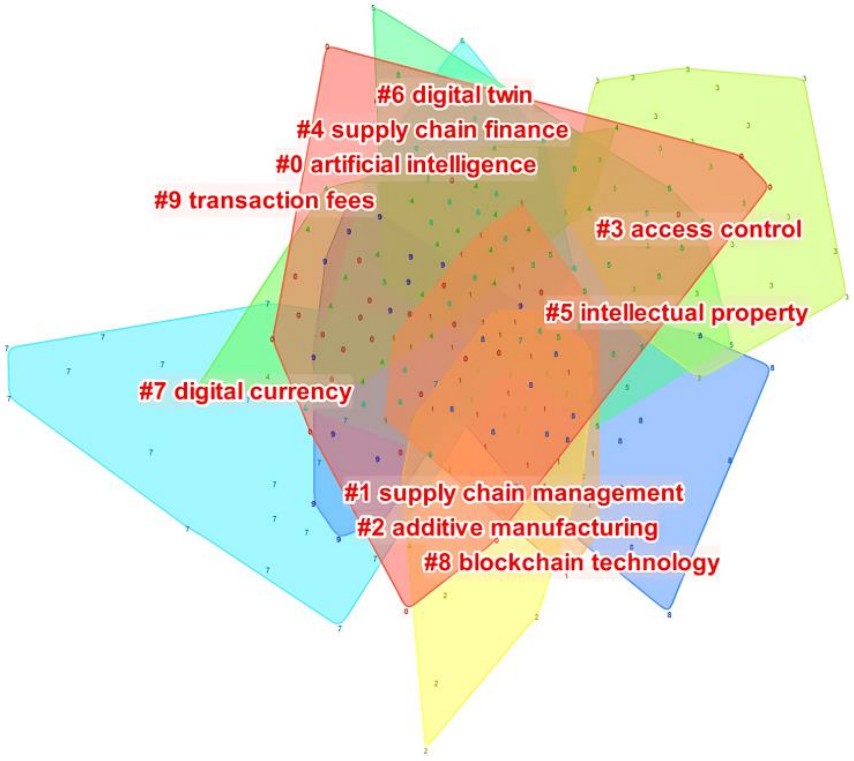


Figure 11. Keywords clustering visualization.

Figure 11 shows the main research clusters on blockchain in management and economics, including #0 artificial intelligence, #1 SCM, #2 additive manufacturing, #3 access control, and #4 supply chain finance, etc. In order to clarify the hot research information on blockchain in management and economics revealed by the cluster in Figure 11, this study further sorted and analyzed the shortlisted literature by screening and studying the literature based on establishing the selection criteria. Specifically, the criteria for selecting the shortlisted pieces of literature in this study are mainly divided into the following two aspects. On the one hand, the selected pieces of literature are all within the research period, and all come from the WoS database, which can effectively correspond to the information carried out by the cluster labels. On the other hand, the selected literature is highly related to the topic revealed by each cluster label, which can better realize the presentation of hot research topics. To sum up, research hotspots in this field mainly include the following six aspects:

- Research on the combination and application of blockchain technology and emerging technologies. Some research covers a cluster of blockchain technology (#8 blockchain technology) and the cluster of emerging technology (#0 artificial intelligence, #2 additive manufacturing, #6 digital twin). The findings of the combination and application of blockchain technology and artificial intelligence cover a relatively wide range of research. For example, some scholars combined blockchain technology with multi-sensor-driven artificial intelligence to explore how to change the circular economy of plastic waste [42]. Some scholars also established a framework to enhance the flow of information, products, and financial resources in humanitarian supply chains based on the combination of artificial intelligence, blockchain, and 3D printing technology [43]. Meanwhile, some scholars applied blockchain and artificial intelligence technology to the field of financial management. For example, they identified and encouraged the management of financial statements through artificial intelligence using eXtensible Business Reporting Language and blockchain [44].

The research related to blockchain technology and additive manufacturing involves the research of essential technologies related to industry 4.0 (such as blockchain technology and additive manufacturing technology). Some scholars analyzed the chances and limitations of these technologies in industry 4.0 [45] and food logistics 4.0 [46]. Moreover, it involves research integrating and combining blockchain technology and additive manufacturing technology. For example, some scholars analyzed the potential of blockchain in additive manufacturing and explored the impact of integrating these two emerging technologies on the supply chain [47]. Some scholars believe blockchain technology contributes to reducing intellectual property and data security obstacles for companies to be used for the business model of additive manufacturing [48].

The research on the combination of blockchain and digital twin technology and its research direction is relatively concentrated. It mainly emphasizes the relevant research of basic supporting elements on platforms, methods, and frameworks, etc. Regarding the establishment of blockchain digital twin platforms, it includes the blockchain-enabled secure digital twin platform [49], the blockchain-based digital twin shared platform [50], and the blockchain-enabled digital twin collaboration platform [51], etc. Meanwhile, some scholars explored the method or framework of blockchain and digital twin research, for example, the blockchain-based data management method for the digital twin of the product [52] and the blockchain-based framework for security sharing on big digital twin data [53]. Furthermore, research related to the technical level of blockchain also involves clustering access control (#3). Among them, fine-grained access control is an essential aspect of research in this field. For example, some scholars established the blockchain-based internet of things system and integrated a chameleon hash algorithm into the blockchain to implement fine-grained access control support for attribute updates [54]. Some scholars also established the blockchain system model that permits flexible authorization of encrypted data, thereby achieving fine-grained access control [55].

- Research on blockchain in SCM (#1). The scope of the hot topic involved in this field is also relatively extensive. On the one hand, it includes the basic supporting elements, such as the conceptual model [56] and framework [57]. On the other hand, it includes the traceability of the food supply chain by blockchain, such as traceability research on blockchain in the mangosteen supply chain [58]. Meanwhile, exploring the specific effects of blockchain in SCM is also an essential aspect of research in this field. For example, some scholars believe that blockchain contributes to promoting supply chain sustainability [59], improves some aspects of supply chain risk [60], and upgrades the integration between supply chain functions, thereby enhancing operational performance [61]. In addition, the research (#1) also involves some specific case studies [62,63], which can also provide certain enlightenment for this field.
- Research on blockchain in supply chain finance (#4). This mainly covers the research on supply chain finance platforms, models, and business processes driven by blockchain technology. Specifically, regarding the research involving blockchain and supply chain

finance platforms, some scholars established a new style of supply chain finance platform and utilized blockchain for conducting all-process management [64]. Some scholars built a business model framework for supply chain financial platforms that support blockchain [65]. Regarding the research involving blockchain and supply chain finance strategies and business processes, some scholars analyzed the tactics for decision-makers to make optimum operation decisions in the blockchain-enabled supply chain finance situation [66]. Some scholars explored the reshaping of finance business processes in the supply chain through the blockchain-driven architecture [67].

- Research on blockchain in intellectual property (#5). The research in this field emphasizes the application of blockchain in intellectual property protection. For example, some scholars analyzed the ability of blockchain to enhance the security of intellectual property management and protection in additive manufacturing [68]. Some scholars established a blockchain service architecture to improve the traceability of original achievement information and protection effectiveness, including patent and copyright [69].
- Research on blockchain in digital currency (#7). This research mainly focuses on cryptocurrency. For example, some scholars analyzed cryptocurrency's blockchain technology [70]. Some scholars explored the latest trend of blockchain application in the cryptocurrency market and new projects [71]. For many new cryptocurrency projects, blockchain capacitates transparent, credible, quick, efficient, and safe transactions [72].
- Research on blockchain in transaction fees (#9). This research focuses more on bitcoin's transaction fees. Some scholars explored bitcoin transaction fees through the game theory [73]. Some scholars also analyzed how bitcoin fees affect the transaction confirmation process based on the queuing theory [74]. Focusing on the segmentation field of transaction fees research, some scholars analyzed the stability of bitcoin transaction fees [75]. Moreover, some scholars explored the elements of economic determining factors of transaction fees in the Ethereum blockchain [76].

In summary, the research on blockchain in management and economics primarily includes blockchain application research in the specific field. Meanwhile, the research on blockchain in management and economics also covers the level of interdisciplinary research, such as the research emphasizing the technical aspects of the combination of blockchain and emerging technologies and research involving access control technology. Therefore, the research hotspots of blockchain in management and economics are widely distributed, which is also mutually corroborated with the view revealed by the co-occurrence of the keywords above. Moreover, the research hotspots in this field also show relatively prominent interdisciplinary characteristics.

3.6. Analysis of Evolution Trends

The timeline analysis emphasizes the connections among clusters and the time range of articles within a cluster [77], effectively showing emerging trends, and tracks research topics over time [78]. Given this, CiteSpace software was used for timeline analysis to generate a timeline visualization knowledge map of the research in this field, as shown in Figure 12.

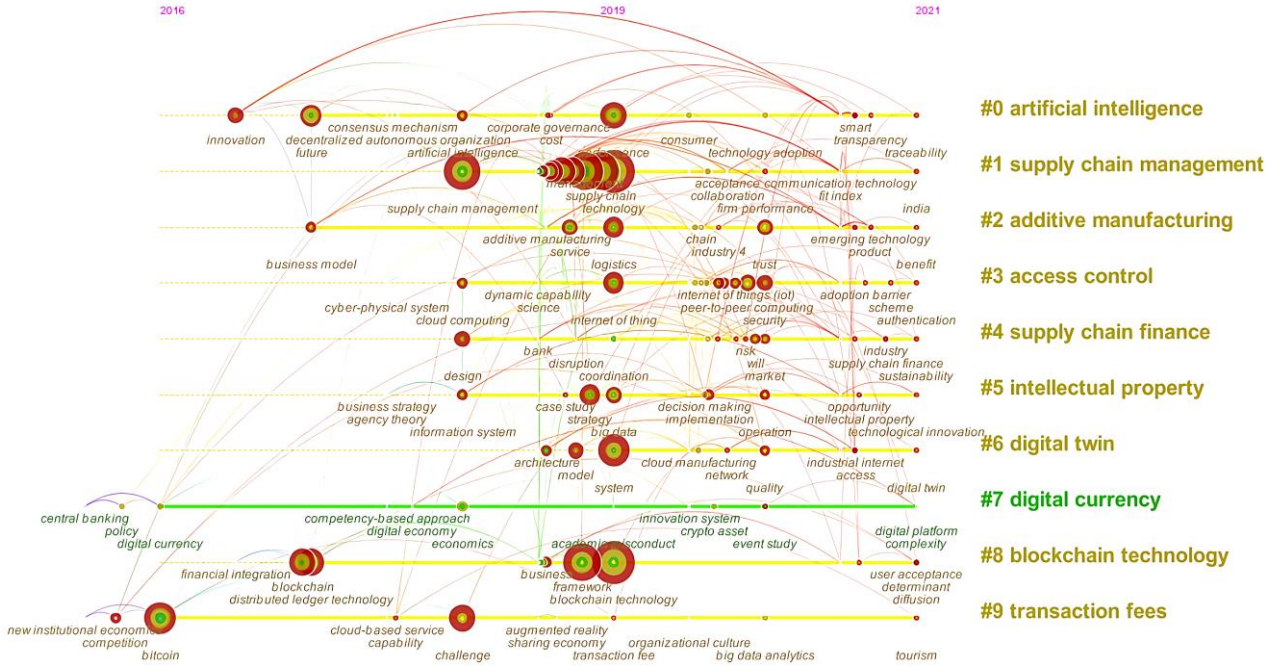


Figure 12. Timeline view visualization.

Figure 12 includes clustering axes, clustering labels, keyword nodes, links, and years, etc. Among them, each cluster axis covers keyword nodes and node-link information, and the right side of the cluster axis corresponds to the cluster label to which the cluster axis belongs. Moreover, the year at the top of Figure 12 corresponds to the time when the keyword nodes first appear on each cluster axis.

From the time dimension of the keyword nodes appearing on the clustering axis, it can be seen that the clusters of digital currency (#7) and transaction fees (#9) appear the earliest. For instance, "central banking" first appeared in the cluster of digital currency in 2016, and "new institutional economics" first appeared in the cluster of transaction fees in 2016. In comparison, the cluster of digital twin (#6) appeared relatively late, and the keyword "architecture" appeared for the first time in 2019. Further analysis shows that the keywords in most of the clusters in Figure 12 first appeared relatively early, and the time distribution of the first appearance of keywords with more clusters is around 2017 and 2018.

From the dimension of the attention degree of keywords on the clustering axis, it shows that the cluster of SCM (#1) has the highest degree of attention. Compared with other clusters, this cluster has the most high-frequency keywords. In particular, a series of keywords with high frequency appeared on the cluster axis in 2019, such as "technology", "supply chain", and "management", which also confirms that SCM is a significant hotspot in blockchain in management and economics. Meanwhile, clusters such as blockchain technology (#8) and artificial intelligence (#1) also have relatively close attention.

Based on the perspective of the starting time of the attention degree of keywords on the cluster axis, it can be found that the time distribution of increasing attention in each cluster is different. In other words, there are differences in the time distribution of the relatively high-frequency keywords that start to appear in each cluster. For example, artificial intelligence (#0), SCM (#1), additive manufacturing (#2), and access control (#3) began to receive relatively close attention in 2017, 2018, 2019, and 2019, respectively, which indicates that the clusters corresponding to these years have begun to be concerned and recognized by scholars.

From the perspective of the attention duration of keywords on the cluster axis, it can also be found that the attention duration of each cluster is not the same. Specifically, for clusters involving emerging technologies and access control technologies combined

with blockchain, the keyword frequency distribution on the cluster axis is relatively balanced. There are still many relatively prominent keyword nodes near the end of the study (2020–2021), such as artificial intelligence (#0), supply chain additive manufacturing (#2), access control (#3), and digital twin (#6). Meanwhile, clusters with similar evolution rules are also involved in specific application fields of blockchain, such as supply chain finance (#4) and intellectual property (#5), which indicates that these clusters have a long duration of attention. In comparison, after the appearance of keyword nodes with relatively high frequency in some clusters, the number of relatively prominent keyword nodes of subsequent appearance is small. There is a relatively noticeable difference in frequency between the subsequent appearance keywords and the previous appearance keywords. For example, after the appearance of high-frequency keyword nodes in the cluster of SCM (#1) in 2018 and 2019, the cluster has a relatively small number of relatively prominent keyword nodes in 2020–2021. The keywords of this stage are significantly different from the keywords of the previous appearance in terms of frequency. Meanwhile, the clusters with similar evolution rules also include blockchain technology (#8) and transaction fees (#9), which indicate that the attention degree of these clusters shows an evolution trend of "from hot to cold" as a whole. Especially for the cluster of digital currency (#7), the frequency of keywords on the cluster axis is relatively low. Meanwhile, the number of relatively prominent keyword nodes in this cluster near the end of the study is also relatively few. Therefore, the evolution trend of this cluster's "cooling" attention degree is more prominent.

From the dimension of iconic keywords that appear on the cluster axis, it can be seen that some clusters have iconic keyword nodes in the evolution process. On the one hand, keyword nodes with high frequency appear in the evolution process of some clusters, such as the keyword node "performance" in the cluster of artificial intelligence (#0) and the keyword nodes "technology", "supply chain", "management", and "SCM" in the cluster of SCM (#1). On the other hand, the frequency of keyword nodes in some clusters is relatively high and has many links with other keyword nodes in the evolution process. For example, the keyword node "innovation" appears in a cluster of artificial intelligence (#0), and the keyword node "integration" appears in a cluster of SCM (#1). In general, the iconic keywords that appear in the clusters that conform to the above characteristics have significant supporting effects in the evolution of each cluster. Therefore, the iconic keywords are worth attending to in the research process.

To sum up, the time distribution of the first appearance of keywords in different clusters is not the same during the study period. The time of the first appearance of the keyword nodes in most clusters is relatively early. The attention degree of keywords demonstrates that different clusters present similar evolution trends and have some differences. Moreover, the iconic keyword nodes that appear on the cluster axis have great significance in supporting the deepening of the clustering evolution and are worth further exploration.

4. Conclusions

This study systematically analyzed the research status, hotspots, and evolution trends of blockchain in management and economics using the bibliometric knowledge mapping visualization and statistical analysis methods. The major conclusions are as follows:

(1) The research on blockchain in management and economics covers the initial development phase (2016–2018) and the blowout growth phase (2019–2021), and the publications have demonstrated a trend of continuous growth on the whole. The United States and China occupy the leading positions in this field. In particular, China's research development is more prominent, its research findings in the past three years (research period) are the largest, and the growth rate is evident. In addition, the main force of publications in this field is primarily concentrated in developed countries, and its geographical distribution is mainly located in Asia, North America, Europe, and Australia.

(2) There are some cooperative groups with close cooperation relations on blockchain in management and economics, including countries/regions' and authors. However, the degree of cooperation between countries/regions and authors must be further strength-

ened based on the overall perspective. Meanwhile, high-impact research organizations and authors have emerged in this field. The Hong Kong Polytechnic University and Copenhagen Business School, etc. have significant influence. The author Choi TM. is the core research scholar.

(3) Journals with a high number of publications on blockchain in management and economics have a certain concentration of papers, and journals with a high co-citation frequency have a high scientific research reputation. The *International Journal of Production Research* and *International Journal of Production Economics*, among others, are the authoritative journals in this field. Moreover, the categories of journals with a high number of publications and high co-citations also jointly reveal the interdisciplinary nature of this field.

(4) The research contents of high co-cited and high-cited references of blockchain in management and economics reveal that SCM is a hot topic in this field. Meanwhile, classic pieces of literature with high co-cited and high-cited attributes have also emerged in this field, such as "Blockchain technology and its relationships to sustainable supply chain management" and "Understanding the blockchain technology adoption in supply chains-Indian context".

(5) The research in this field has diversified characteristics, and its research hotspots are also widely distributed. Among them, the research hotspots mainly involve related research on the combination and application of blockchain and emerging technologies and blockchain in SCM, supply chain finance, intellectual property, digital currency, and transaction costs. Moreover, the research hotspot also shows the prominent interdisciplinary characteristics of the research in this field.

(6) The keywords of most clusters of blockchain in management and economics first appeared relatively early. Moreover, the degree of attention among the clusters shows the evolution rule of the intersection of commonality and individuality. In other words, there are not only similar evolution trends among clusters but also certain differences. Some iconic keywords should be focused on and further explored.

Although we conducted a systematic analysis of the research on blockchain in management and economics, which has a certain contribution to revealing the overall situation of this field, this study also has some limitations:

(1) This study chose the literature in the WoS single database as the data source. Although WoS is the largest and most widely used international database for the analysis of research findings [79], it is difficult to cover all the research findings of blockchain in management and economics. Therefore, it will inevitably have a certain impact on the comprehensiveness of the research results. Meanwhile, similar limitations have also been reported in the research findings of a bibliometric analysis on other topics, such as the literature [31,79–81]. Future research can be combined with the literature in databases such as Scopus and PubMed to expand further and improve the research findings of bibliometric analysis of the blockchain in management and economics.

(2) This study focused on the systems perspective to analyze the research on blockchain in management and economics. However, it is challenging to reveal the comprehensive research situation on subfields of this field. For example, this study explored the research hotspots of blockchain in supply chain management. However, it is difficult to explore the distribution of the number of publications, countries/regions' and authors' cooperation, and other specific conditions in this subfield. Therefore, future research can concentrate on the subfields of blockchain in management and economics, further enriching and deepening the bibliometrics-related research findings of blockchain in management and economics.

Author Contributions: Conceptualization, Y.Y., L.H. and L.W.; methodology, Y.Y. and L.H.; software, Y.Y. and G.Q.; formal analysis, Y.Y. and G.Q.; writing—original draft preparation, Y.Y.; writing—review and editing, Y.Y., G.Q., L.H. and L.W.; visualization, Y.Y. and G.Q.; supervision, Y.Y.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Annual Fund Project of Social Science Research of Colleges and Universities in Hebei Province (No. BJ2020068), the National Natural Science Foundation of China (No. 71963025), and the Key Research Project in Humanity and Social Science of Hebei Education Department (No. ZD202211).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Lu, H.; Huang, K.; Azimi, M.; Guo, L. Blockchain technology in the oil and gas industry: A review of applications, opportunities, challenges, and risks. *IEEE Access* **2019**, *7*, 41426–41444. [CrossRef]
2. Antonucci, F.; Figorilli, S.; Costa, C.; Pallottino, F.; Raso, L.; Menesatti, P. A review on blockchain applications in the agri-food sector. *J. Sci. Food. Agric.* **2019**, *99*, 6129–6138. [CrossRef] [PubMed]
3. Dutta, P.; Choi, T.M.; Somani, S.; Butala, R. Blockchain technology in supply chain operations: Applications, challenges and research opportunities. *Transport Res. Part E Logist. Transp. Rev.* **2020**, *142*, 102067. [CrossRef] [PubMed]
4. Zhao, G.; Liu, S.; Lopez, C.; Lu, H.; Elgueta, S.; Chen, H.; Boshkoska, B.M. Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions. *Comput. Ind.* **2019**, *109*, 83–99. [CrossRef]
5. McGhin, T.; Choo, K.K.R.; Liu, C.Z.; He, D. Blockchain in healthcare applications: Research challenges and opportunities. *J. Netw. Comput. Appl.* **2019**, *135*, 62–75. [CrossRef]
6. Wang, Q.; Li, R.; Zhan, L. Blockchain technology in the energy sector: From basic research to real world applications. *Comput. Sci. Rev.* **2021**, *39*, 100362. [CrossRef]
7. Alkhudary, R.; Brusset, X.; Fenies, P. Blockchain in general management and economics: A systematic literature review. *Eur. Bus. Rev.* **2020**, *32*, 765–783. [CrossRef]
8. Dede, S.; Köseoğlu, M.C.; Yercan, H.F. Learning from early adopters of blockchain technology: A systematic review of supply chain case studies. *Technol. Innov. Manag. Rev.* **2021**, *11*, 19–31. [CrossRef]
9. Gurtu, A.; Johny, J. Potential of blockchain technology in supply chain management: A literature review. *Int. J. Phys. Distrib. Logist. Manag.* **2019**, *49*, 881–900. [CrossRef]
10. Li, K.; Lee, J.Y.; Gharehgozli, A. Blockchain in food supply chains: A literature review and synthesis analysis of platforms, benefits and challenges. *Int. J. Prod. Res.* **2021**, 1–20. [CrossRef]
11. Vu, N.; Ghadge, A.; Bourlakis, M. Blockchain adoption in food supply chains: A review and implementation framework. *Prod. Plan. Control* **2021**, 1–18. [CrossRef]
12. Gan, Q.; Lau, R.Y.K.; Hong, J. A critical review of blockchain applications to banking and finance: A qualitative thematic analysis approach. *Technol. Anal. Strateg. Manag.* **2021**, 1–17. [CrossRef]
13. Osmani, M.; El-Haddadeh, R.; Hindi, N.; Janssen, M.; Weerakkody, V. Blockchain for next generation services in banking and finance: Cost, benefit, risk and opportunity analysis. *J. Enterp. Inf. Manag.* **2020**, *34*, 884–899. [CrossRef]
14. Veloutsou, C.; Mafe, C.R. Brands as relationship builders in the virtual world: A bibliometric analysis. *Electron. Commer. Res. Appl.* **2020**, *39*, 100901. [CrossRef]
15. Ji, B.; Zhao, Y.; Vymazal, J.; Mander, Ü.; Lust, R.; Tang, C. Mapping the field of constructed wetland-microbial fuel cell: A review and bibliometric analysis. *Chemosphere* **2021**, *262*, 128366. [CrossRef]
16. Donthu, N.; Kumar, S.; Mukherjee, D.; Pandey, N.; Lim, W.M. How to conduct a bibliometric analysis: An overview and guidelines. *J. Bus. Res.* **2021**, *133*, 285–296. [CrossRef]
17. Liang, C.; Luo, A.; Zhong, Z. Knowledge mapping of medication literacy study: A visualized analysis using CiteSpace. *SAGE Open Med.* **2018**, *6*, 2050312118800199. [CrossRef]
18. Cheng, P.; Tang, H.; Dong, Y.; Liu, K.; Jiang, P.; Liu, Y. Knowledge mapping of research on land use change and food security: A visual analysis using CiteSpace and VOSviewer. *Int. J. Environ. Res. Public Health* **2021**, *18*, 13065. [CrossRef]
19. Xu, S.; Zhang, X.; Feng, L.; Yang, W. Disruption risks in supply chain management: A literature review based on bibliometric analysis. *Int. J. Prod. Res.* **2020**, *58*, 3508–3526. [CrossRef]
20. Ren, R.; Hu, W.; Dong, J.; Sun, B.; Chen, Y.; Chen, Z. A systematic literature review of green and sustainable logistics: Bibliometric analysis, research trend and knowledge taxonomy. *Int. J. Environ. Res. Public Health* **2020**, *17*, 261. [CrossRef]

21. Lu, X.; Peng, W.; Huang, X.; Fu, Q.; Zhang, Q. Homestead management in China from the "separation of two rights" to the "separation of three rights": Visualization and analysis of hot topics and trends by mapping knowledge domains of academic papers in China national knowledge infrastructure (CNKI). *Land. Use. Policy* **2020**, *97*, 104670. [CrossRef]
22. Yang, Y.; Lv, K.; Xue, J.; Huang, X. A bibliometric analysis and visualization of fractional order research in China over two decades (2001–2020). *J. Math.* **2021**, *2021*, 7996776. [CrossRef]
23. Rejeb, A.; Keogh, J.G.; Zailani, S.; Treiblmaier, H.; Rejeb, K. Blockchain technology in the food industry: A review of potentials, challenges and future research directions. *Logistics* **2020**, *4*, 27. [CrossRef]
24. Berneis, M.; Bartsch, D.; Winkler, H. Applications of blockchain technology in logistics and supply chain management insights from a systematic literature review. *Logistics* **2021**, *5*, 43. [CrossRef]
25. Mohammad Saif, A.N.; Islam, M.A. Blockchain in human resource management: A systematic review and bibliometric analysis. *Technol. Anal. Strateg. Manag.* **2022**, 1–16. [CrossRef]
26. Pal, A.; Tiwari, C.K.; Behl, A. Blockchain technology in financial services: A comprehensive review of the literature. *J. Glob. Oper. Strateg. Sourc.* **2021**, *14*, 61–80. [CrossRef]
27. Shen, Y.; Mao, S.; Chen, F.; Zhao, S.; Su, W.; Fu, L.; Zare, N.; Karimi, F. Electrochemical detection of Sudan red series azo dyes: Bibliometrics based analysis. *Food Chem. Toxicol.* **2022**, *163*, 112960. [CrossRef]
28. Zou, L.X.; Sun, L. Global diabetic kidney disease research from 2000 to 2017: A bibliometric analysis. *Medicine* **2019**, *98*, e14394. [CrossRef]
29. Yu, S.; Cui, B.; Xie, C.; Man, Y.; Fu, J. Bibliometric review of biodiversity offsetting during 1992–2019. *Chin. Geogr. Sci.* **2022**, *32*, 189–203. [CrossRef]
30. Yang, Y.; Qu, G.; Hua, L. Research Status, Hotspots, and Evolution Trend of Decision-Making in Marine Management Using VOSviewer and CiteSpace. *Math. Probl. Eng.* **2022**, *2022*, 8283417. [CrossRef]
31. Wang, Z.; Ma, D.; Pang, R.; Xie, F.; Zhang, J.; Sun, D. Research progress and development trend of social media big data (smbd): Knowledge mapping analysis based on citespace. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 632. [CrossRef]
32. Peng, X.; Dai, J. A bibliometric analysis of neutrosophic set: Two decades review from 1998 to 2017. *Artif. Intell. Rev.* **2020**, *53*, 199–255. [CrossRef]
33. Liao, H.; Tang, M.; Luo, L.; Li, C.; Chiclana, F.; Zeng, X.J. A bibliometric analysis and visualization of medical big data research. *Sustainability* **2018**, *10*, 166. [CrossRef]
34. Wu, C.; Yuan, Y.; Tang, Y.; Tian, B. Application of terrestrial laser scanning (TLS) in the architecture, engineering and construction (AEC) industry. *Sensors* **2021**, *22*, 265. [CrossRef]
35. Nakamoto, S. Bitcoin: A Peer-to-Peer Electronic Cash System. 2008. Available online: https://bitcoin.org/bitcoin.pdf. (accessed on 4 May 2022).
36. Godsiff, P. Bitcoin: Bubble or Blockchain. In *Agent and Multi-Agent Systems: Technologies and Applications*; Jezic, G., Howlett, R., Jain, L., Eds.; Springer: Cham, Switzerland, 2015; Volume 38, pp. 191–203.
37. Wang, X.; Xu, Z.; Škare, M. A bibliometric analysis of Economic Research-Ekonomska Istraživanja (2007–2019). *Econ. Res.-Ekon. Istraživanja* **2020**, *33*, 865–886. [CrossRef]
38. Dai, Z.; Zhang, Q.; Zhu, X.; Zhao, L. A comparative study of Chinese and foreign research on the internet of things in education: Bibliometric analysis and visualization. *IEEE Access* **2021**, *9*, 130127–130140. [CrossRef]
39. Torres-Pruñonosa, J.; Plaza-Navas, M.A.; Díez-Martín, F.; Beltran-Cangrós, A. The intellectual structure of social and sustainable public procurement research: A co-citation analysis. *Sustainability* **2021**, *13*, 774. [CrossRef]
40. Sun, Q.; Wang, B.; Xu, S.; Cong, X.; Pu, Y.; Zhang, J. Research development and trends of benzene-induced leukemia from 1990 to 2019-a bibliometric analysis. *Environ. Sci. Pollut. Res.* **2022**, *29*, 9626–9639. [CrossRef]
41. Liu, K.; Guan, X.; Li, C.; Zhao, K.; Yang, X.; Fu, R.; Yu, F. Global perspectives and future research directions for the phytoremediation of heavy metal-contaminated soil: A knowledge mapping analysis from 2001 to 2020. *Front. Environ. Sci. Eng.* **2022**, *16*, 73. [CrossRef]
42. Chidepatil, A.; Bindra, P.; Kulkarni, D.; Qazi, M.; Kshirsagar, M.; Sankaran, K. From trash to cash: How blockchain and multi-sensor-driven artificial intelligence can transform circular economy of plastic waste? *Adm. Sci.* **2020**, *10*, 23. [CrossRef]
43. Rodríguez-Espíndola, O.; Chowdhury, S.; Beltagui, A.; Albores, P. The potential of emergent disruptive technologies for humanitarian supply chains: The integration of blockchain, artificial intelligence and 3Dprinting. *Int. J. Prod. Res.* **2020**, *58*, 4610–4630. [CrossRef]
44. Mosteanu, N.R.; Faccia, A. Digital systems and new challenges of financial management–Fintech, XBRL, blockchain and cryptocurrencies. *Qual.-Access Success* **2020**, *21*, 159–166.
45. Olsen, T.L.; Tomlin, B. Industry 4.0: Opportunities and challenges for operations management. *Manuf. Serv. Oper. Manag.* **2020**, *22*, 113–122. [CrossRef]
46. Jagtap, S.; Bader, F.; Garcia-Garcia, G.; Trollman, H.; Fadiji, T.; Salonitis, K. Food logistics 4.0: Opportunities and challenges. *Logistics* **2021**, *5*, 2. [CrossRef]
47. Kurpjuweit, S.; Schmidt, C.G.; Klöckner, M.; Wagner, S.M. Blockchain in additive manufacturing and its impact on supply chains. *J. Bus. Logist.* **2021**, *42*, 46–70. [CrossRef]
48. Klöckner, M.; Kurpjuweit, S.; Velu, C.; Wagner, S.M. Does blockchain for 3D printing offer opportunities for business model innovation? *Res. Technol. Manag.* **2020**, *63*, 18–27. [CrossRef]

49. Liu, X.; Jiang, Y.; Wang, Z.; Zhong, R.Y.; Cheung, H.H.; Huang, G.Q. imseStudio: Blockchain-enabled secure digital twin platform for service manufacturing. *Int. J. Prod. Res.* **2021**, 1–20. [CrossRef]
50. Li, M.; Li, Z.; Huang, X.; Qu, T. Blockchain-based digital twin sharing platform for reconfigurable socialized manufacturing resource integration. *Int. J. Prod. Econ.* **2021**, *240*, 108223. [CrossRef]
51. Li, M.; Fu, Y.; Chen, Q.; Qu, T. Blockchain-enabled digital twin collaboration platform for heterogeneous socialized manufacturing resource management. *Int. J. Prod. Res.* **2021**, 1–21. [CrossRef]
52. Huang, S.; Wang, G.; Yan, Y.; Fang, X. Blockchain-based data management for digital twin of product. *J. Manuf. Syst.* **2020**, *54*, 361–371. [CrossRef]
53. Shen, W.; Hu, T.; Zhang, C.; Ma, S. Secure sharing of big digital twin data for smart manufacturing based on blockchain. *J. Manuf. Syst.* **2021**, *61*, 338–350. [CrossRef]
54. Yu, G.; Zha, X.; Wang, X.; Ni, W.; Yu, K.; Yu, P.; Zhang, J.A.; Liu, R.P.; Guo, Y.J. Enabling attribute revocation for fine-grained access control in blockchain-IoT systems. *IEEE Trans. Eng. Manag.* **2020**, *67*, 1213–1230. [CrossRef]
55. Agyekum, K.O.B.O.; Xia, Q.; Sifah, E.B.; Cobblah, C.N.A.; Xia, H.; Gao, J. A proxy re-encryption approach to secure data sharing in the internet of things based on blockchain. *IEEE. Syst. J.* **2021**, *16*, 1685–1696. [CrossRef]
56. Nayak, G.; Dhaigude, A.S. A conceptual model of sustainable supply chain management in small and medium enterprises using blockchain technology. *Cogent Econ. Financ.* **2019**, *7*, 1667184. [CrossRef]
57. Batwa, A.; Norrman, A. A framework for exploring blockchain technology in supply chain management. *Oper. Supply Chain. Manag. Int. J.* **2020**, *13*, 294–306. [CrossRef]
58. Vikaliana, R.; Rasi, R.Z.R.M.; Pujawan, I.N. Traceability system on mangosteen supply chain management using blockchain technology: A model design. *Stud. Appl. Econ.* **2021**, *39*. [CrossRef]
59. Saberi, S.; Kouhizadeh, M.; Sarkis, J.; Shen, L. Blockchain technology and its relationships to sustainable supply chain management. *Int. J. Prod. Res.* **2019**, *57*, 2117–2135. [CrossRef]
60. Vishnubhotla, A.K.; Pati, R.K.; Padhi, S.S. Can projects on blockchain reduce risks in supply chain management? An oil company case study. *IIM Kozhikode Soc. Manag. Rev.* **2020**, *9*, 189–201. [CrossRef]
61. Aslam, J.; Saleem, A.; Khan, N.T.; Kim, Y.B. Factors influencing blockchain adoption in supply chain management practices: A study based on the oil industry. *J. Innov. Knowl.* **2021**, *6*, 124–134. [CrossRef]
62. Sivula, A.; Shamsuzzoha, A.; Helo, P. Requirements for blockchain technology in supply chain management: An exploratory case study. *Oper. Supply Chain. Manag.* **2021**, *14*, 39–50. [CrossRef]
63. Sundarakani, B.; Ajaykumar, A.; Gunasekaran, A. Big data driven supply chain design and applications for blockchain: An action research using case study approach. *Omega* **2021**, *102*, 102452. [CrossRef]
64. Du, M.; Chen, Q.; Xiao, J.; Yang, H.; Ma, X. Supply chain finance innovation using blockchain. *IEEE Trans. Eng. Manag.* **2020**, *67*, 1045–1058. [CrossRef]
65. Ning, L.; Yuan, Y. How blockchain impacts the supply chain finance platform business model reconfiguration. *Int. J. Logist. Res. Appl.* **2021**, 1–21. [CrossRef]
66. Liu, L.; Li, Y.; Jiang, T. Optimal strategies for financing a three-level supply chain through blockchain platform finance. *Int. J. Prod. Res.* **2021**, 1–18. [CrossRef]
67. Chen, J.; Chen, S.; Liu, Q.; Shen, M. Applying blockchain technology to reshape the service models of supply chain finance for SMEs in China. *Singap. Econ. Rev.* **2021**, 1–18. [CrossRef]
68. Sekerin, V.D.; Slepov, V.A.; Gayduk, V.I.; Bank, S.V.; Kravets, E.V. Blockchain technology development as tool for enhancing security in management and protection of intellectual property rights in additive manufacturing. *Rev. Geintec-Gest. Inov. E Tecnol.* **2021**, *11*, 1184–1200. [CrossRef]
69. Zhu, P.; Hu, J.; Li, X.; Zhu, Q. Using blockchain technology to enhance the traceability of original achievements. *IEEE Trans. Eng. Manag.* **2021**, 1–15. [CrossRef]
70. Smith, C.; Kumar, A. Crypto-currencies-an introduction to not-so-funny moneys. *J. Econ. Surv.* **2018**, *32*, 1531–1559. [CrossRef]
71. Rana, R.L.; Giungato, P.; Tarabella, A.; Tricase, C. Blockchain applications and sustainability issues. *Amfiteatru Econ.* **2019**, *21*, 861–870.
72. Bezovski, Z.; Davcev, L.; Mitreva, M. Current adoption state of cryptocurrencies as an electronic payment method. *Manag. Reseach Pract.* **2021**, *13*, 44–50.
73. Easley, D.; O'Hara, M.; Basu, S. From mining to markets: The evolution of bitcoin transaction fees. *J. Financ. Econ.* **2019**, *134*, 91–109. [CrossRef]
74. Kasahara, S.; Kawahara, J. Effect of bitcoin fee on transaction-confirmation process. *arXiv* **2016**, arXiv:1604.00103.
75. Ilk, N.; Shang, G.; Fan, S.; Zhao, J.L. Stability of transaction fees in bitcoin: A supply and demand perspective. *MIS Q.* **2021**, *45*, 563–592. [CrossRef]
76. Karaivanov, A.; Donmez, A. Transaction fee economics in the ethereum blockchain. *Econ. Inq.* **2021**, *60*, 265–292.
77. Wang, J.; Wang, S.; Zou, D.; Chen, H.; Zhong, R.; Li, H.; Zhou, W.; Yan, K. Social network and bibliometric analysis of unmanned aerial vehicle remote sensing applications from 2010 to 2021. *Remote Sens.* **2021**, *13*, 2912. [CrossRef]
78. Meng, S.; Xiong, D. Review and exploration of China subtropical climate change research based on scientometric analysis. *Trop. Conserv. Sci.* **2018**, *11*, 1940082918806795. [CrossRef]

79. Guo, Y.-M.; Huang, Z.-L.; Guo, J.; Guo, X.-R.; Li, H.; Liu, M.-Y.; Ezzeddine, S.; Nkeli, M.J. A bibliometric analysis and visualization of blockchain. *Future Gener. Comput. Syst.* **2021**, *116*, 316–332. [CrossRef]
80. Wang, X.; Xu, Z.; Su, S.F.; Zhou, W. A comprehensive bibliometric analysis of uncertain group decision making from 1980 to 2019. *Inf. Sci.* **2021**, *547*, 328–353. [CrossRef]
81. Zhu, B.; Fan, H.; Xie, B.; Su, R.; Zhou, C.; He, J. Mapping the scientific research on healthcare workers' occupational health: A bibliometric and social network analysis. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2625. [CrossRef]