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Food Supply Chain and Blockchain: Bibliometric Analysis

Gıda Tedarik Zinciri ve Blok Zincir: Bibliyometrik Analiz

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Abstract

Food is a fundamental phenomenon for mankind. Nowadays, the number of people who approach food more selectively is increasing. They want information about the food they consume be accessible. Details such as the production time and producer of the food, whether it is served at a fair pricing and its content are all matters the consumers feel curious about. With the ability to create immutable data, blockchain technology can respond to consumer demands from the agricultural supply chain. Blockchain provides traceability and anti-counterfeiting solutions in the agricultural supply chain. Due to the fact that blockchain technology is becoming more and more popular in the agricultural supply chain, the level of its academic interest is also increasing.

In order to reveal the characteristics of academic interest in the subject, an inquiry was conducted on the topic of food supply chain and blockchain in the Web of Science (WoS) database. The publications obtained at the end of the inquiry were classified under such headings as category, country, and publication type. In addition, bibliometric analysis was performed on the publications obtained. With this research, it is aimed to show the level of academic interest in blockchain technology, which is among the popular technologies recently. The study is important in terms of showing the level of interest shown in blockchain technology, which is expected to increase traceability in food supply chain processes. In countries like Türkiye where there are sudden price movements in products, blockchain technology provides governments with the opportunity to monitor food and identify where the problem occurs. In this way, the way for a more reliable food supply chain is paved by presenting products with full records with rights.

Keywords: Food Supply Chain, Blockchain, Bibliometric Analysis

Öz

Gıda insanlık için vazgeçilmez bir olgudur. Günümüzde gıda konusunda hassasiyet gösteren insanların sayısı artmaktadır. İnsanlar, tükettikleri gıdalara yönelik bilgi sahibi olmak istemektedirler. Gıdanın ne zaman üretildiği, kimin tarafından üretildiği, adil bir fiyatlandırma ile sofraya gelip gelmediği, içeriği gibi ayrıntılar tüketici tarafından merak edilmektedir. Blok zincir teknolojisi değiştirilemez veriler oluşturabilme özelliğiyle tarımsal tedarik zincirinde tüketicinin taleplerine yanıt verebilme özelliğine sahiptir. Blok zincir tarımsal tedarik zincirinde izlenebilirlik ve sahteciliğe karşı çözümler sunmaktadır. Tarım tedarik zincirinde blok zinciri teknolojisinin her geçen gün popüler olmasından dolayı konuya akademik ilginin seviyesi de artmaktadır.

Konuya olan akademik ilginin özelliklerini ortaya koyabilmek adına Web of Science (WoS) veri tabanında gıda tedarik zinciri ve blok zincir konulu sorgulama yapılmıştır. Sorgulama sonunda elde edilen yayınlar kategori, ülke, yayın türü gibi başlıklar altında sınıflandırılmıştır. Ayrıca elde edilen yayınlar üzerinde bibliyometrik analiz yapılmıştır. Araştırmayla son zamanların popüler teknolojileri arasında yer alan blok zinciri teknolojisine olan akademik ilginin seviyesini göstermek amaçlanmaktadır. Çalışma gıda tedarik zinciri süreçlerinde izlenebilirliği arttırması beklenen blokzincir teknolojisine gösterilen ilginin seviyesini göstermesi açısından önem taşımaktadır. Türkiye gibi ürünlerde ani fiyat hareketlerinin olduğu ülkelerde blokzincir teknolojisi hükümetlere gıdayı izleyebilme ve problem noktasını tespit etme olanağı sağlamaktadır. Bu sayede hakla kayıtları eksiksiz tutulmuş ürünler sunularak daha güvenilir gıda tedarik zincirinin önü açılmaktadır.

Anahtar Kelimeler: Gıda Tedarik Zinciri, Blockchain, Bibliyometrik Analiz

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1.INTRODUCTION

It is important to encourage farmers, establish a bond between them and their stakeholders and to establish an integrated supply chain for each type of product (Kumar et al., 2022: 4). Such importance is highlighted because people are more worried about food today. Food safety, reliability and traceability in agriculture are gradually becoming more important. Records with no human intervention are now needed throughout the supply chain since irreplaceable and accountable records are gaining significance (Dadi et al., 2021: 85).

Today, it is essential that farmers become more competitive and follow sustainable agricultural policies. Some farmers use misleading labels to convince their customers that they perform environmentally friendly harvest procedures. In such practices, where there is no appropriate evidence, the consumer is left alone to rely only on the etiquette. However, blockchain technology provides secure data recording for each product throughout the chain. During the chain, each production unit can create a trust environment by performing operations related to the certificate (dos Santos et al., 2021: 18).

Traceability is one of the important demands of consumers in modern society (Tagarakis et al., 2021: 13). The supply chain industry has gained numerous opportunities such as traceability with the transition to a decentralized model using the blockchain (Shahid et al., 2020: 69241; Oruma et al., 2021: 83604). Blockchain technology has the potential to be used in the agri-food supply chain. The main advantage of the potential use in this area is that green agreements can be adhered to when tracking food from production to consumption. Blockchain allows the food to be tracked and its source to be identified. In addition, it also provides a substructure in reducing intermediaries, monitoring health issues in food, balancing the food chain and increasing competitiveness (Firsova and Abrhám, 2021: 87).

The Food Supply Chain (FSC) is expected to be more flexible and have risk-reducing features (Yadav et al., 2021: 16648). Blockchain management and FSC management can be combined. From the point of view of the FSC, the blockchain provides opportunities to prevent food opportunism (Fu et al., 2020: 677). Blockchain technology is considered as a way to increase the FSC traceability of the product. It is also recognized as a good way to inform stakeholders about food safety, any nutritional information and the food quality throughout the chain (Tharatipyakul and Pongnumkul, 2021: 82925). The blockchain, which holds irreversible and unchangeable data, provides traceability on the FSC. Blockchain technology provides unique security that contributes to the sustainable food industry (Demestichas et al., 2021: 17).

Taken together with technologies such as RFID and IoT; blockchain technology, with important advantages such as security, has a flexible structure. For example, a blockchain-based supply chain application developed for cheese can be easily converted into applications for other dairy products (Cocco et al., 2021: 62913; Varavallo et al., 2022: 20). However, studies on the application of blockchain technology to various sectors are not yet sufficient (Kramer et al., 2021: 18). Although the use of blockchain technology in supply chain practices is new, the predictions that will be made about it are important (Irak and Topcu, 2020: 183).

This study aims to reveal the trend of academic publications on FSC and blockchain. For this purpose, the Web of Science (WoS) database was scanned using the keywords FSC and blockchain. Upon the scanning process, bibliometric analysis was performed on the publications obtained. The aim of the study is to make a contribution to the literature on the field of FSC and blockchain, which is still a new topic.

2.LITERATURE REVIEW

2.1. Food Supply Chain

Competitive advantage is a necessity for companies (Cengiz and Aksoy, 2017: 15). Enterprises that want to be competitive should constantly improve their business processes (Özyelmas Kâhya and Aydın, 2014: 35). Technology is important for organizations to be competitive and they need to design their supply chains in a more innovative way (Sayın, 2020: 1637; Bakoğlu and Yılmaz, 2005: 89; Can and Erciş, 2013: 117).

Facilities providing services in the agricultural sector face many risks. Due to such high risk, industry officials are concerned about any disruptions that may occur in any ring of the supply chain. A problem that may occur in production or delivery will create problems such as loss of income or loss of company reputation (Demir and Kayalı, 2020: 285). Blockchain technology, which can reduce this level of anxiety, allows data to be stored securely and transparently in a decentralized approach without having to rely on any authority (Aslan and Kasapbaşı, 2022:69). Block chain technology offers solutions for the FSC sector on points such as reducing food-borne diseases, increasing quality of products, providing fair pricing and traceability along the value chain, enabling financial solutions for farmers, creating sustainable business, reducing waste, contributing to environmentally friendly agriculture, improving consumer awareness and satisfaction, reducing transaction costs, generating solutions against fraud and providing access to data while protecting the confidentiality (HABTASC, 2022). In the execution of these processes, blockchain has a very important feature such as allowing different stakeholders to access each other's data (November, 2020: 40). Blockchain technology has the opportunity to be used in different sectors with such features (Ünsal and Kocaoğlu, 2018: 62).

Studies on blockchain, artificial intelligence and IoT technologies in agriculture are still under development. There is a need to develop real-time decision support systems, security, confidentiality of enterprises operating throughout the FSC, advanced food-friendly applications and optimization tools (Bhat, 2022: 21-22).

2.2. Agri Food Supply Chain and Bibliometric Analysis

Morella et al. (2021) used bibliometric analysis in their studies of Industry 4.0 practices in the agricultural food supply chain (FSC). Researchers have shown that publications focused on the FSC and Industry 4.0 have recently increased. In addition, CPS, IoT, Big Data and blockchain are emerging as the most cited topic types. These technologies are important for FSC and sustainability.

Barbosa (2021) examined the data on the subject between 2008 and 2019 by bibliometric method in order to decisively examine the evolution of FSC research. Among the new research themes related to the topic of FSC, it seems that the topic blockchain and IoT stands out.

Niknejad et al. (2021) used bibliometric analysis on 171 publications to show trends towards blockchain technology in the food and agriculture industry. The study covers the period from 2016 to 2019. It is apparent that the interest in the subject became apparent in 2016.

3.METHOD

On 29.3.2022, the WoS database was scanned using the keywords “food supply chain” (Topic) and “blockchain” (Topic)". Upon the scanning process, bibliometric analysis was performed on the publications obtained. VOSviewer software was used for visualization.

Query link: https://www.webofscience.com/wos/woscc/summary/292f4494-7d03-447b-b0d9-eb538fe19df6-2d24f6fa/relevance/1

4.DATA

The course of agricultural products from production to consumption is called FSC. There are many factors in agriculture, from logistics to fluctuating prices. In order to improve agriculture, a lot of useful information is collected and more information is processed with cheaper information processing techniques. This process increases predictive studies and optimization techniques. Blockchain is a revolutionary technology in keeping records of products in terms of FSC. When combined with IoT and data analytics, blockchain contributes essentially to the FSC sector. People want to get accurate and unchangeable information about food, and at this point, the solution is blockchain (AFSC). Such an important issue is now also of interest to the academic community. In this section, there are the orientations of the academic community on the topic of FSC.

4.1. Citation

When FSC and blockchain-oriented publications were questioned, 153 publications appeared in the WoS database. The resulting publications have an H-Index value of 31. Figure 1 shows the citation statistics of the related publications.

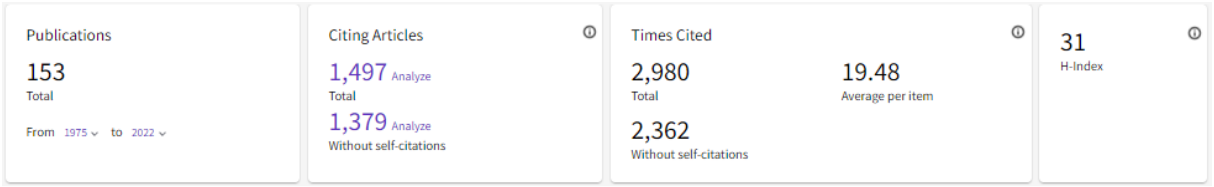

Figure 1. *Citation statistics of FSC and blockchain-oriented publications. Source WoS*

Figure 2 shows the citation statistics of FSC and blockchain-oriented publications by year. Interest in the topic became apparent in 2016, and the increase in interest is observed every year.

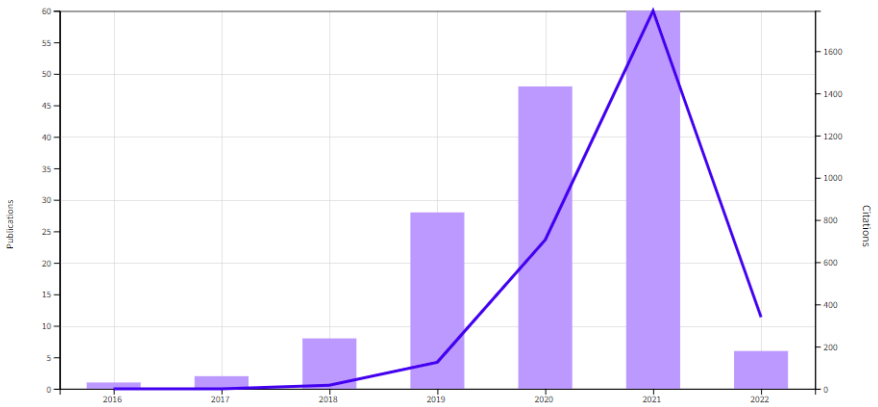

Figure 2*. Citation statistics of FSC and blockchain-oriented publications.Source WoS*

4.2. Tables

In Table 1, there are 35 published "Computer Science Information Systems" fields in the first place under the field "Web of Science Categories". In the second place is the field of "Telecommunications" with 29 publications. In the third place is the "Engineering Electrical Electronic" field with 26 publications. When examining this table, it should be taken into account that some publications are evaluated in more than one category according to the WoS policy.

Table 1. Web of Science Categories

Web of Science Categories	**Record Count**	**153% of**
Computer Science Information Systems	35	22.876
Telecommunications	29	18.954
Engineering Electrical Electronic	26	16.993
Food Science Technology	23	15.033
Computer Science Theory Methods	19	12.418
Computer Science Interdisciplinary Applications	18	11.765
Environmental Sciences	18	11.765
Green Sustainable Science Technology	16	10.458
Management	14	9.150
Engineering Industrial	13	8.497
Showing 10 out of 49 entries		

Examining Table 2, we see that the interest in food supply chain and blockchain-oriented publications is new. Publications on the topic have an upward trend since 2019.

Table 2. Publication Years

Publication Years	**Record Count**	**153% of**
2022	6	3.922
2021	60	39.216
2020	48	31.373
2019	28	18.301
2018	8	5.229
2017	2	1.307
2016	1	0.654

Considering Table 3, there are 93 articles-type publications in the first place in food supply chain and blockchain-oriented publications. This is followed by 36 publications of the proceedings papers type. The third place is occupied by 26 publications of the review articles type.

Table 3. Document Types

Document Types	Record Count	153% of
Articles	93	60.784
Proceedings Papers	36	23.529
Review Articles	26	16.993
Early Access	12	7.843
Book Chapters	1	0.654

Table 4 shows the category of affiliations. The first two ranks were listed as “University of Cagliari” and “Universiti Malaya”.

Table 4. Affiliations

Affiliations	Record Count	153% of
University of Cagliari	6	3.922
Universiti Malaya	4	2.614
Beijing Technology Business University	3	1.961
Indian Institute of Management IIM System	3	1.961
Iqra Natl Univ	3	1.961
National Institute of Industrial Engineering NITIE	3	1.961
National Tsing Hua University	3	1.961
University of Lincoln	3	1.961
University of Texas System	3	1.961
Vienna University of Economics Business	3	1.961
Showing 10 out of 49 entries		

Looking at the topic of Publication Titles, the first place is occupied by 10 publications “IEEE Access”. In the second place is “Sustainability" with 7 publications. In the third place is the “Journal of Cleaner Production” with 6 publications.

Table 5. Publication Titles

Publication Titles	Record Count	153% of
IEEE Access	10	6.536
Sustainability	7	4.575
Journal of Cleaner Production	6	3.922
Trends in Food Science Technology	4	2.614
British Food Journal	3	1.961

Frontiers in Blockchain	3	1.961
International Journal of Production Research	3	1.961
Applied Sciences Basel	2	1.307
Communication in Computer And Information Science	2	1.307
Computer Industrial Engineering	2	1.307
Showing 10 out of 49 entries		

Table 6 shows the ranking of Funding Agencies. The first place is occupied by 13 publications of the "National Natural Science Foundation of China NSFC". It is seen that organizations such as the "European Commission" and the "National Science Foundation NSF" are also showing interest in the issue.

Table 6. Funding Agencies

Funding Agencies	**Record Count**	**153% of**
National Natural Science Foundation of China NSFC	13	8.497
European Commission	3	1.961
National Science Foundation NSF	3	1.961
Regione Sardegna	3	1.961
Chinese Ministry of Education Project of Humanities and Social Science	2	1.307
Engineering Physical Sciences Research Council EPSRC	2	1.307
Ministry of Science and Technology Taiwan	2	1.307
National Key R D Program of China	2	1.307
National Key Research and Development Program of China	2	1.307
National Research Foundation of Korea	2	1.307
Showing 10 out of 124 entries		
80 record(s) (52.288%) do not contain data in the field being analyzed		

Table 7 gives a ranking of the countries that publish on the topic. The first place is occupied by China with 32 publications, the second place is occupied by India with 24 publications, and the third place is occupied by USA with 20 publications.

Table 7. Countries/Regions

Countries/Regions	**Record Count**	**153% of**
People R China	32	20.915

India	24	15.686
USA	20	13.072
England	15	9.804
Italy	15	9.804
Canada	8	5.229
Spain	8	5.229
Greece	7	4.575
Saudi Arabia	7	4.575
Australia	6	3.922
Showing 10 out of 51 entries		

5.BIBLIOMETRIC ANALYSIS

Bibliometric analysis was performed on the publications obtained as a result of the query carried out using the keyword “food supply chain” (Topic) and “blockchain” (Topic)” from the WoS database. After removing words that had nothing to do with the subject, such as “literature”, from words that were repeated at least 10 times in the analysis, 60 words were obtained. These words were clustered using the ”full cointing" method. The “Association Strength” model was chosen as the “Normalization” method in clustering. The value of ‘'Resolution“ was determined as 1.00 and the value of ”minimum cluster size" as 1. As a result of the clustering, 5 different groups were obtained. The first group consisted of 19, the second group 15, the third group 13, the fourth group 8 and the fifth group consisted of 5 elements.

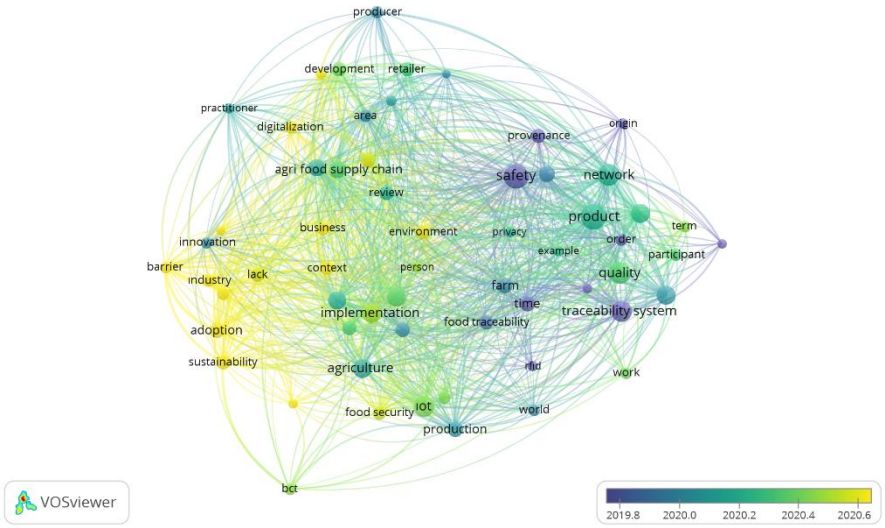

Figure 3. *Overlay visualization of Food Supply Chain and Blockchain-oriented publications.*

When examining the output of the overlay visualization of the food supply chain and Blockchain-oriented publications given in Figure 3, keywords like Safety, Network, product traceability, agriculture and implementation stand out. In publications on Food Supply Chain and Blockchain, the keywords shown in Figure 3 are often used and research is being formed around these words.

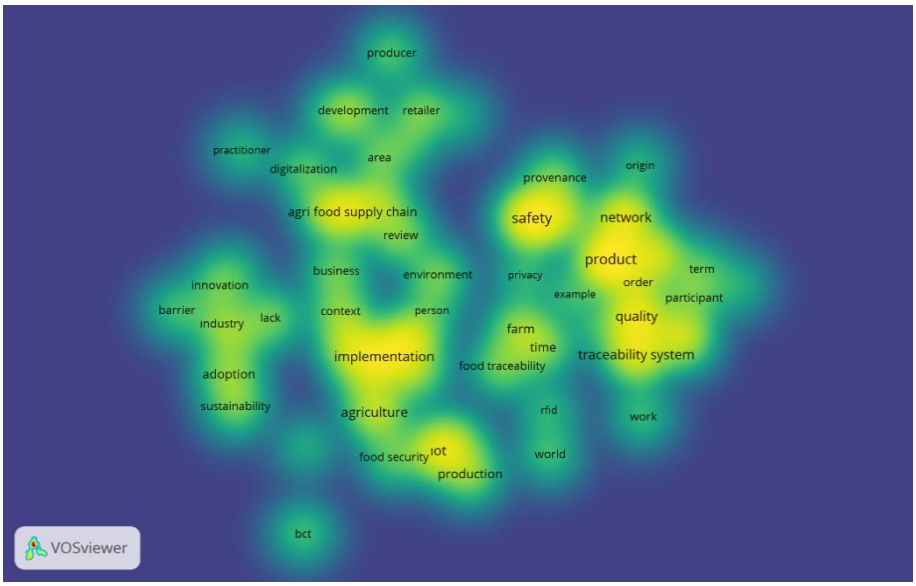

Figure 4. *Density visualization of Food Supply Chain and blockchain-oriented publications.*

When the density visualization output of Food Supply Chain and Blockchain-oriented publications given in Figure 4 is examined, the frequency of use of keywords related to the subject is observed. Keywords such as safety and product have a greater intensity of use than the others. The words that stand out in the intensity graph are repeated more in the studies than other words.

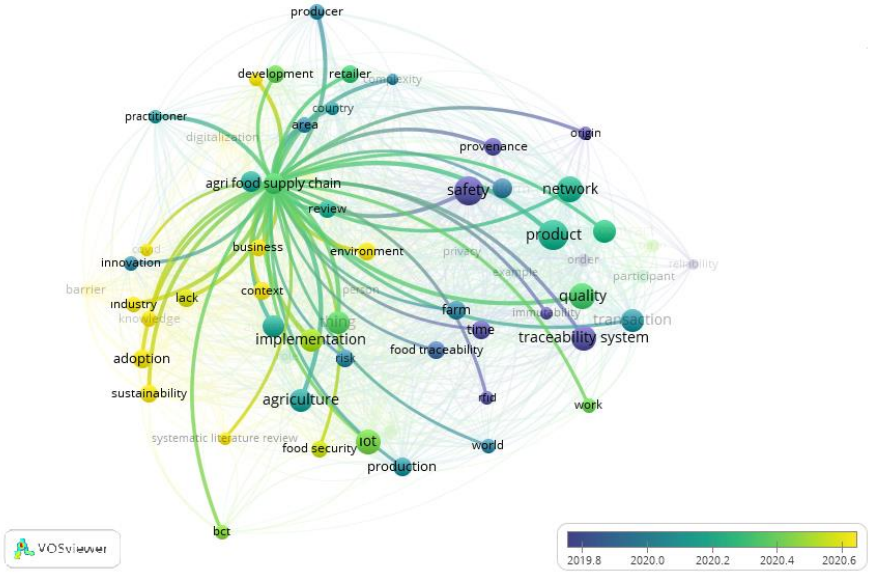

Figure 5. *Links to the keyword" agri food supply chain".*

Figure 5 shows the connection of the keyword" Agri food supply chain" with other words. Examining the links, we see that the keyword "Agri food supply chain" has strong links with different words from different sets.

6.CONCLUSION

Blockchain technology enables stakeholders and consumers to access the right information during the FSC process (Ronaghi, 2021:406). The blockchain can create data that cannot be changed so that

stakeholders can trust each other for intelligent agricultural management. The blockchain combined with IoT technologies has started to revolutionize the field of agriculture (Harshitha et al., 2021: 225). The advantages of blockchain technology for food safety should be taken into account by researchers.

In the scope of the study, When the "Web of Science Categories" category of publications on the topic of "food supply chain and blockchain" is examined, it is seen that the "Computer Science Information Systems" category is in the first place. An increase has been observed in the number of publications on the subject since 2019. The largest number of article types are preferred in publications related to the topic. The first place in the field of affiliations is occupied by the "University of Cagliari". The "National Natural Science Foundation of China NSFC" takes the first place in the field of Funding Agencies. The first place in publications on the topic is occupied by China.

It is seen that the researchers who published on the topic of "Agri food supply chain" concentrated on the keywords given in Figure 1, Figure 2 and Figure 3. At this point, new researchers who are interested in the subject area can focus on topics containing keywords shown in figures.

The aim of this study is to contribute to the literature in the field of FSC and blockchain. The literature in this area is just developing and has a limited number of studies. The fact that the study data was taken only from the WoS database is the limitation of the study. The scope of the study can be expanded by obtaining data from databases such as Scopus.

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