

Analisis Bibliometrik Teknologi Blockchain pada Jurnal Akademik

A Bibliometric Analysis on Blockchain Technology Literature in Academic Journals

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Abstrak

Blockchain adalah sistem revolusioner yang menghubungkan jaringan komputer secara terdesentralisasi dan terdistribusi. Blockchain memungkinkan proses transaksi saat ini menjadi peer-to-peer (P2P) tanpa bergantung pada satu server. Setelah dimasukkan, informasi tidak pernah dapat dihapus. Blockchain berisi catatan tertentu dan dapat diverifikasi dari setiap transaksi yang pernah dilakukan. Studi ini mengevaluasi pengembangan publikasi penelitian dalam proses implementasi dan tren masa depan Teknologi Blockchain. Tujuan dari penelitian ini adalah untuk membantu para peneliti dalam menciptakan kerangka teori dan untuk menyediakan sumber referensi awal dalam pemetaan penelitian di bidang ini. Semua publikasi penelitian terkait dengan implementasi dan tren masa depan Teknologi Blockchain dalam database Scopus dianalisis menggunakan beberapa indikator bibliometrik. Penulis, jumlah kutipan, sumber jurnal, penerbit, lembaga, negara, tahun publikasi, kategori, dan kata kunci penulis dianalisis.

Kata kunci: *Blockchain, database, teknologi*

Abstract

A blockchain is a revolutionary system that connects computer networks in a decentralized and distributed manner. Blockchain allows the process of current transactions to be peer-to-peer (P2P) without relying on a single server. Once entered, information can never be erased. The blockchain contains a certain and verifiable record of every single transaction ever made. This study evaluated the development of research publications in the implementation process and future trend of Blockchain Technology. The aim of this study is to assist researchers in creating a theoretical framework and to provide a preliminary source of references in research mapping in this field. All research publications related to the implementation and future trend of Blockchain Technology in the Scopus database were analyzed using several bibliometric indicators. The authorship, number of citations, journal sources, publishers, institutions, and countries, year of publication, categories, and author keywords were examined.

Keywords: *Blockchain, database, technology*

Introduction

Blockchain is a system of recording transactions in many databases that are widespread on many computers. Each database has an identical record. This blockchain system is also called distributed ledger. This decentralized transaction record makes blockchain almost impossible to change unilaterally, without changing the majority of all databases that record the data. The main advantages of Blockchain include decentralization, time-series data,

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collective maintenance, programming and security capabilities, and are therefore very suitable for building programmable monetary systems, financial systems, and even macroscopic social systems (Yuan, dan Wang, 2016; Zheng, et al., 2017; Ouaddah, Abou Elkalam, dan Ait Ouahman, 2016; Zheng, et al., 2018; Pop, et al., 2018).

Based on Gatteschi, et al. (2018), blockchain has undergone three evolutions as follows: Blockchain 1.0, 2.0, and 3.0. Blockchain 1.0 is very much associated with Bitcoin and cryptocurrency. If Blockchain 1.0's focus is money, Blockchain 2.0 is about registering, confirming, and transferring contracts or property. On Blockchain 3.0, the application field is no longer limited to finance and goods transactions, but includes sectors such as government, health, science, education, and more.

The development of blockchain technology has made blockchain-based applications appear. The application covers many fields including financial services, reputation systems and the Internet of Things (IoT), and so on. However, there are still many blockchain technology challenges such as scalability and security issues that must be addressed (Zheng, et al., 2017). In addition, this technology also requires quite expensive hardware, data replication that requires a large enough space and the addition of information that is sometimes slow (Gatteschi, et al. 2018).

Scientific publications on new Blockchain Technology began in 2014 and have great potential to continue to grow. Bibliometric analysis will provide guidance for researchers especially in mapping research-related publications (Abdullah, Waemustafa, & Mat, 2017). Blockchain has many benefits such as decentralization, anonymity, and audit capabilities. There are many blockchain applications ranging from cryptocurrency, financial services, risk management, internet of things (IoT) to public and social services. This analysis helps to provide an overview of the development of research in the area of blockchain technology.

Method

Bibliometric analysis consists of determining qualitative and quantitative changes by applying statistical methods in certain scientific research topics, managing publication profiles on these topics, and detecting trends in a scientific discipline (De Bakker, Groenewegen, & Den Hond, 2005). In addition, this type of analysis provides useful information for researchers who want to evaluate scientific activities (Duque Oliva, Cervera Taulet, & Rodríguez Romero, 2006) because bibliometric analysis acts as a clue to the status of research on a particular subject.

This study uses data from the Scopus database on July 15, 2019. The analysis stage of the results of the research publication begins with a search using the keyword 'financial technology'. This keyword is used to extract documents from the Scopus collection in terms of topics that include four parts (ie, title, abstract, author keywords, and additional keywords) in the limited publication year in the period 2014 to 2020. Based on these keywords, found a total 41,669 publications. However, this publication also contains several documents which are not closely related. As a result, these results are further refined by using the keyword 'blockchain'. Next, the results are refined again by selecting the type of document 'article and conference paper'. In this last stage, the research succeeded in determining a total of 429 research documents that have been published related to blockchain technology as a revolutionary system that connects computer networks in a decentralized and distributed manner.

Result

This study uses several bibliometric indicators as follows:

- The language used in blockchain research
- The field of knowledge in which the author has published research on blockchain

- Trending changes in the number of studies on the blockchain between 2014 and 2020 and the number of author quotes
- Institutions and countries where authors publish research on blockchain
- Journal and publisher where the author has published research on blockchain
- Keywords used by authors who have published research on blockchain.

Language

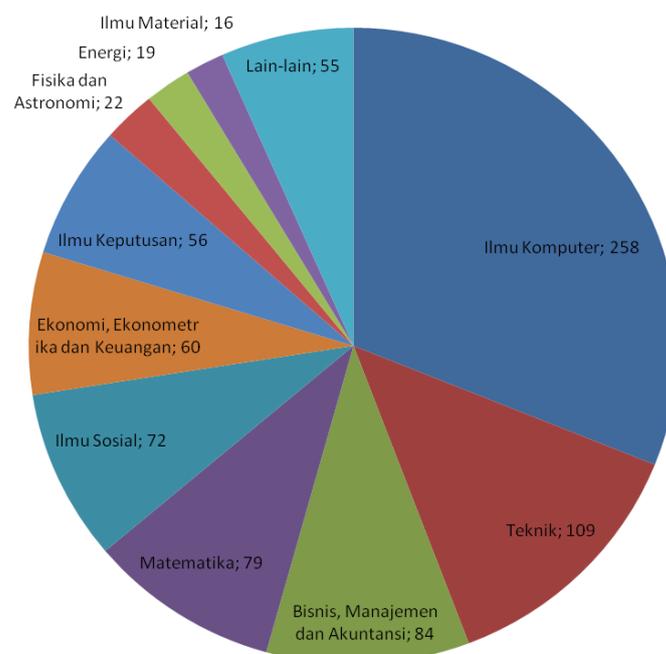
Scimago Journal & Country Rank contains indexed journals published in languages other than English. For example, Jisuanji Xuebao / Chinese Journal of Computers, Yingyong Kexue Xuebao / Journal of Applied Sciences, Ekonomicheskaya Sotsiologiya, Voprosy Ekonomiki, and Wirtschaftsdienst.

Table 1. The language used in blockchain research

Rank	Language	Number of Publications
1	English	415
2	China	5
3	Russian	5
4	German	2

(Source : Scopus)

Table 1 illustrates the number of blockchain publications based on the language used. According to data collected from Scopus, as expected, the most commonly used language is English (415 documents). The second most commonly used language is Chinese (5 documents). These results meet expectations, because English-language journals are the largest in number and are the most frequently used languages that must be mastered by all researchers in the modern global academic community. Some blockchain publications also use not only English but also other languages such as Russian and German.



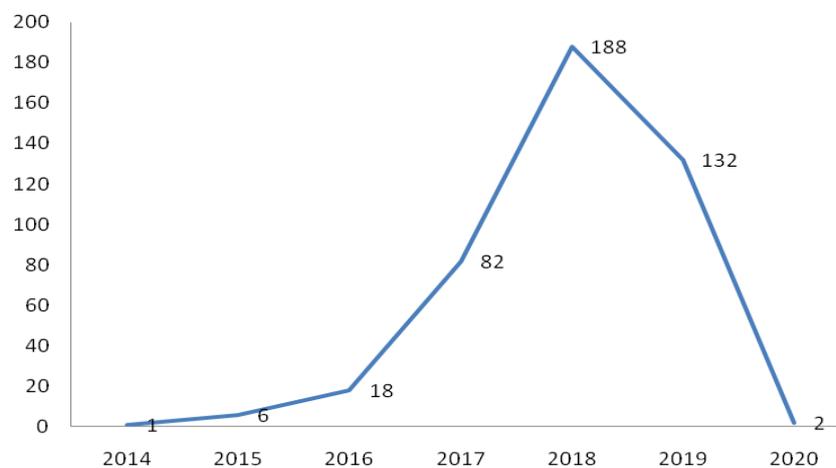
Graphic 1. Documents Based on Research (Source : Scopus)

Research Area

Graphic 1 illustrates the number of documents published based on the field of research in the Scopus category. The results contained 258 documents in computer science / computer science, 109 documents in engineering / engineering, 84 documents in Business, Management and Accounting / Business, Management and Accounting, 79 documents in mathematics / mathematics and also other fields whose numbers were not significant. This number compares and distinguishes a large number of differences between the numbers of documents in computer science with the number in other research fields. These results imply that blockchain is a very relevant topic in the field of computer science.

Trending Changes in The Number of Studies and The Number of Author Quotes

Graphic 2 shows the amount of scientific research per year on Scopus about the blockchain concept. Analysis shows that early blockchain technology research discussed a lot about the development trends of bitcoin as a virtual currency (Dumitrescu, and Fircă, 2014; Möser and Böhme, 2015; Valenta and Rowan, 2015; Meiklejohn and Orlandi, 2015; Andrychowicz, Dziembowski, Malinowski, and Mazurek, 2015). Bitcoin itself is basically a cryptocurrency or virtual currency that runs on blockchain technology. According to Scopus, research on blockchain began to appear since 2014 (Dumitrescu, and Fircă, 2014). However, the number of documents issued per year before 2016 is very low (less than 20 per year). Graphic 2 illustrates the number of publications between 2014 and 2020.



Graphic 2. Documents Based on Year (Source : Scopus)

In general, Graphic shows that interest in this field of knowledge has increased over the past 7 years. Since 2014, the number of publications has gradually increased and reached its peak in 2018. The number of documents in 2018 was 188 studies. This positive trend illustrates that blockchain is still relevant and has quite a lot of research gaps in the future because this technology is still developing in industry 4.0. For example, the research gap covers several issues, Muhamad Amin et al., (2020) said that the application of blockchain technology for data storage and verification has evolved from financial applications to other fields such as asset management and event monitoring on the Internet-of-Things (IoT). In monitoring events, the scheme proposed in his research is able to reduce the number of data blocks produced in the blockchain network, thereby minimizing the need for intensive storage and verification. Liu and Zou (2019) also agreed that WEB blockchain technology is not only used in finance

and other fields, but also has great potential for applications in the fields of production, education, and research. Blockchain is expected to play an important role in shaping the mechanism of trust in "Internet +" production, research and innovation and promoting education. New blockchain technology applications are developing and will continue to grow going forward. So that the potential for the application of these technologies is still very likely to be explored.

Based on 429 document publications related to blockchain research between the period 2014 to 2020, it can be seen that the authors generally published around 2 writings on blockchain. Table 4.2 shows a list of the top 20 authors based on 66 authors who published more than 2 papers. The results found that the top six authors have published more than three articles relating to blockchain research. Table 2 illustrates that Blums, I, Calvaresi, D., Qiu, M., Schumacher, M., Weigand, H., Zheng, Z., are the highest ranking authors with 3 publications. The other authors publish 2 publications.

Table 2. 20 Authors with the most publications and the number of publications from 2014 to 2020

No	Penulis	Jumlah Publikasi
1	Blums, I.	3
2	Calvaresi, D.	3
3	Qiu, M.	3
4	Schumacher, M.	3
5	Weigand, H.	3
6	Zheng, Z.	3
7	Aich, S.	2
8	Allen, D.W.E.	2
9	Anghel, I.	2
10	Arner, D.W.	2
11	Bertoncini, M.	2
12	Brühl, V.	2
13	Buckley, R.P.	2
14	Burkaltseva, D.D.	2
15	Butler, T.	2
16	Chakraborty, S.	2
17	Chen, X.	2
18	Cioara, T.	2
19	Clark, J.	2
20	Cocco, L.	2

(Source : Scopus)

Table 3 compares the top ten authors and article titles from each author. Research by Zheng, Z., Xie, S., Dai, H., Chen, X., Wang, H., entitled "An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends" in 2017 with 203 citations in place first, followed by Yuan, and Wang (2016), entitled "Blockchain: The state of the art and future trends" with 182 citations and Mengelkamp, et al. (2018), obtained 131 quotations with the publication title "Designing microgrid energy markets: A case study: The Brooklyn Microgrid".

Table 3. Top Ten Writers with the Highest Quotes

No	Authors	Publication Title	Publication Year	Numbers of Quotation
1	Zheng, Z., Xie, S., Dai, H., Chen, X., Wang, H.	An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends	2017	203
2	Yuan, Y., Wang, F.-Y.	Blockchain: The state of the art and future trends	2016	182
3	Mengelkamp, E., Gärtner, J., Rock, K., (...), Orsini, L., Weinhardt, C.	Designing microgrid energy markets: A case study: The Brooklyn Microgrid	2018	131
4	Mettler, M.	Blockchain technology in healthcare: The revolution starts here	2016	100
5	Ouaddah, A., Abou Elkalam, A., Ait Ouahman, A.	FairAccess: a new Blockchain-based access control framework for the Internet of Things	2016	73
6	Zheng, Z., Xie, S., Dai, H.-N., Chen, X., Wang, H.	Blockchain challenges and opportunities: A survey	2018	65
7	Yermack, D.	Corporate governance and blockchains	2017	63
8	Pop, C., Cioara, T., Antal, M., (...), Salomie, I., Bertocini, M.	Blockchain based decentralized management of demand response programs in smart energy grids	2018	56
9	Guo, Y., Liang, C.	Blockchain application and outlook in the banking industry	2016	55
10	Aste, T., Tasca, P., Di Matteo, T.	Blockchain Technologies: The Foreseeable Impact on Society and Industry	2017	53

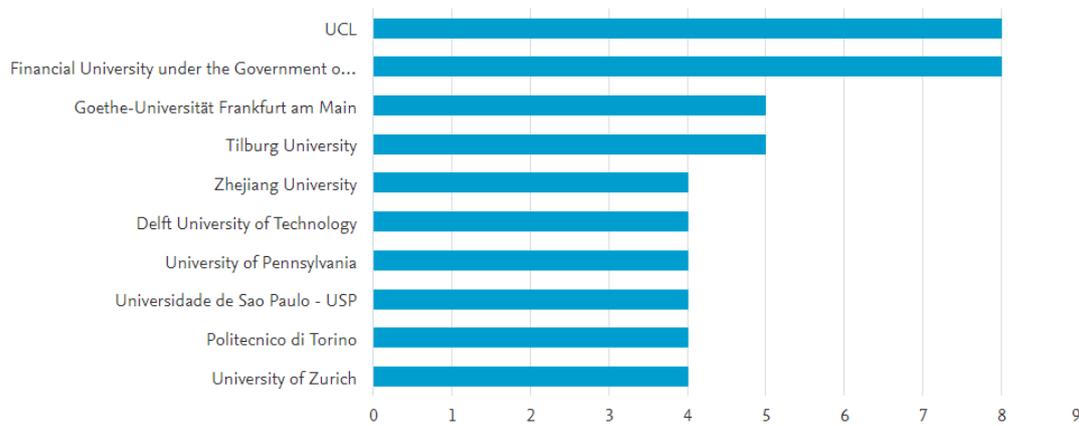
(Source : Scopus)

These results are consistent with Baltussen, and Kindler (2004), and Dubin, Häfner, and Arndt (1993) who conduct research claiming that the publication of articles in journals such as reviewed papers will have a higher tendency to be quoted so that they will receive a higher number of citations high.

Institutions and Country

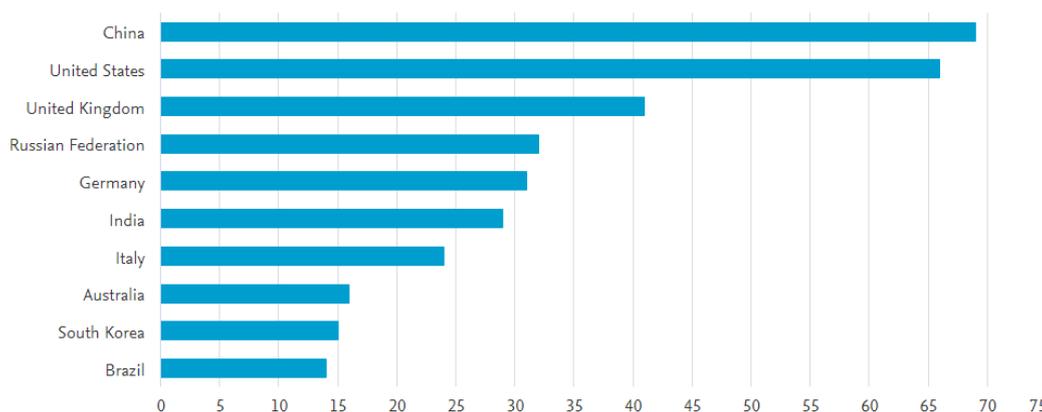
Graphic 3 shows the top ten institutions that contributed papers on the adoption of the blockchain. In general, the analysis found 160 different universities and institutions that contributed research papers in this field. Based on the number of publications, Graphic 3 shows that the highest contribution of 8 papers came from UCL and Financial University under the Government of the Russian Federation. The ranking was then followed by Goethe-Universität Frankfurt Frankfurt am Main and Tilburg University, which have contributed 5 papers. Differences in expenditure and research support by universities or institutions is one reason for the difference in the number of paper publications between these universities or institutions.

Man, Weinkauff, Tsang, and Sin (2004) learn that different universities or institutions will have different reward systems for calculating publication results. Therefore, many research publications published in high-impact journals are supported by institutions that provide a system of rewards for human resources. In general, universities that have more research publications mean that universities are better in terms of research assistance, financial support, or best practice systems to encourage more publications.



Graphic 3. Documents Berdasarkan Afiliasi (Source : Scopus)

Graphic 4 shows that the number of publications since 2014 in China was 69 Documents. Second place is US with 66 publications. The UK, Russia and Germany have each published more than 30 publications. The remaining 53 countries are not shown in the Figure because they have less than 14 publications. The big difference in the number of Docs is because most SJR journals come from China and the United States. Indonesia is included in countries not shown on Graphic 4. In Indonesia there are 3 scientific articles that have been published on Scopus. The first research is about the Blockchain Approach for Future Renewable Energy Transactions and the second research is about the rice donation system in the internet-based orphanage, raspberry-pi, and blockchain. The latest research from Indonesia is Data Protection in Financial Technology Services: Indonesian Legal Perspective.



Graphic 4. Documents Based on Country or Territory (Source : Scopus)

Journals and Publishers

Analysis of the journals that publish research on blockchain technology is not only to decide which journals to publish, but also to understand the focus of each related journal. Table

4 shows the top 5 journals that have published most of the Documents on blockchain technology.

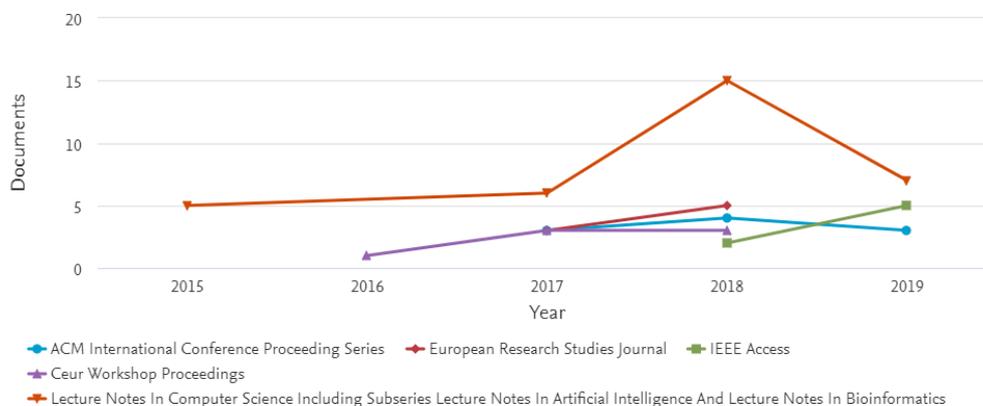
Table 4 shows that Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics have published 33 Documents. This journal has published more blockchain research than any other journal. Second place is the ACM International Conference Proceeding Series with 10 publications. The European Research Studies Journal is ranked third with 8 research publications and is followed by the Ceur Workshop Proceedings and IEEE Access, which together have 7 publications.

Table 4. The Top 5 Journals and Publishers and the Number of Publications published from 2014 to 2020

No	Journal & Publisher	Number of Publications
1	Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	33
2	ACM International Conference Proceeding Series	10
3	European Research Studies Journal Q2 Publisher: University of Piraeus, International Strategic Management Association	8
4	Ceur Workshop Proceedings	7
5	IEEE Access Q1 Publisher : Institute of Electrical and Electronics Engineers Inc.	7

(Source : Scopus)

Graphic 5 describes publications produced annually from 2014 to 2020 by the top 5 journals. Journal rank can be measured by comparing journals with others according to the journal's quartile. The journals in the fourth quartile are the most irrelevant, but the journals in the first quartile are the most relevant. The journal in the fourth quartile is the journal with the lowest impact factor.



Graphic 5. Documents Per Year (Source : Scopus)

An author needs to consider and choose a high-impact factor journal for publishing their research. According to Garfield (2006) journal impact factors are one of the most important steps that shows the significance of journals in related fields to publish research. In addition, the fact that most of these papers were published and appeared in high-impact factor journals in English (Bayley, Brooks, Tong, & Hariharan, 2014).

Author Keywords

Table 5 shows a list of the five keywords most frequently used by authors in the publication of their papers and other keywords related to research searches on blockchain. The results show that the keyword most frequently used by writers in this area is 'Blockchain'. This keyword is used 264 times. The second author's most frequently used keyword is 'Electronic Money' (93 times), followed by 'Bitcoin' (92 times). the appearance of the keywords 'Finance' and 'Smart Contracts' are the same 70 and 41 times, respectively. Five different keywords were also found from the author's publications Documents. These keywords are 'Block-chain' (38 times), 'Cryptocurrency' (34 times), Internet of Things (31 times), 'Big Data' (28 times), and 'Cryptography' (25 times).

Table 5. Top Keywords

No	Keywords	Number of Usage
1	Blockchain	264
2	Electronic Money	93
3	Bitcoin	92
4	Finance	70
5	Smart Contracts	41
Kata Kunci Lain		
1	Block-chain	38
2	Cryptocurrency	34
3	Internet Of Things	31
4	Big Data	28
5	Cryptography	25

(Source : Scopus)

The resulting keywords are analyzed and it can be concluded that the research trends in this topic have covered various fields of knowledge and diverse literature. This shows that blockchain technology research still has some areas to explore. Fu and Ho (2012) say that quantitative analysis of the frequency of keywords used by the writer can provide a pretty good picture to see future research trends.

Conclusion

This study analyzes the development of research publications regarding blockchain technology. Several papers that have correlations with blockchain are analyzed using bibliometric analysis. The results describe the language used in blockchain publications, the field of knowledge in which researchers publish papers, trends in the number of publications from year to year and author quotes, institutions and countries where the authors have published the most relevant research, journals and publishers that authors choose to publish their papers, and keywords that are often used by authors who have published research on blockchain. This analysis helps authors who have an interest in blockchain technology, and provides information on which journals to look at and which writers have the most research on blockchain.

Bibliometric analysis of 429 Docs blockchain technology has been collected from the Scopus database and shows that the most popular language for publication is English (415 Documents). The field of knowledge of most of the Documents published is computer science / computer science (258 Documents). The number of publications began to increase from year to year, reaching 188 Documents published in 2018. The highest citation in blockchain research was for publications written by Zheng, Z., Xie, S., Dai, H., Chen, X., Wang, H., in 2017 (203 quotes). The most prolific authors in blockchain publications are Blums, I, Calvaresi, D., Qiu, M., Schumacher, M., Weigand, H., Zheng, Z., (3 Documents). The most productive institutions are UCL and Financial University under the Government of the Russian Federation with 8 Documents published. The country that published the most blockchain research was China (69 Documents). The most widely published journal of blockchain research is Lecture Notes in Computer Science Including Subseries of Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics (33 Documents), Blockchain is the keyword most often used in research searches on blockchain technology.

Some of the findings revealed in this publication can help other researchers who want to write about blockchain. However, it is hoped that future research will also include articles not only belonging to Scopus. In addition, it is also hoped that the results of this analysis can make the public pay more attention to the field of publication regarding blockchain technology.

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