



Global Trends in Blockchain Technology Research: A Bibliometric Analysis

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Abstract

Blockchain technology has emerged as the most impactful tool of the decade. The term 'Blockchain Technology' can be traced way back to 2008. The magnitude and attention of Blockchain Technology are increasing enormously in the scientific community, which makes it necessary to analyze a bibliometric study on it. Our paper aims to study scientific production only around the term "Blockchain Technology", excluding other blockchain technology applications. Thus, we restricted our search to papers indexed in the Web of Science database provided by Clarivate. Ten years (2013-2022) were selected for the publication period with the keyword 'Blockchain Technology', Microsoft Excel, Bibexcel, and Hiscite were used for the analysis of data. The results revealed some valuable insights, including yearly publications, productive authors, source journals, geographic distribution, linguistic analysis, relative growth, citation trends, etc. The findings of this paper conclude that institutions from China have contributed the highest number of research articles on 'Blockchain Technology' during the last ten years.

Keywords: Blockchain technology, Bibliometrics, Scientometric, Blockchain applications, Bitcoin, Cryptocurrency.

Introduction

A buoyant and emergent discipline called Bibliometric studies is given the most importance in the assessment of scientific productions and results. In the 1960s' Eugene Garfield established Institute for Scientific Information (ISI) and initiated the metrification of researchers, journals, research papers, and organizations. In contrast, research papers are indexed and compiled in an extensive database, which can be used to measure various aspects of publications like citations, topic, number of authors, keywords, collaborations, etc. A hierarchy is followed for citing and reciting authors for indexing articles. Authors cite or refer to a paper that is related to their idea or has some connection to its core concept. This citation can be used to obtain information about authors and the aggregate impact factor. Institutions gather this information in order to define the global research strategy of research councils and universities. Bibliometric studies are not limited to the institutional level. Because new emerging trends help a researcher to understand the extent of a topic beyond his organization, hence traditional literature surveys are altogether different from modern literature

survey as modern analysis use a big database such as the Web of Science. Web of Science is a citation indexing service by Clarivate covering indexing from 1898. More than 59 million records have been indexed unto date. Hundreds of services are provided by the firm including journal citation reports (e.g., impact factor: upto 5 years, Eigen factor, etc.) (**Clarivate Analytics, 2022**). During the last ten years, there has been an expansion and an increase in the number of journals as per discipline and in periodicity. In addition, disciplines have traditions regarding publications like some prefer “Hyper-authorship” such as biomedicine (**Cronin, 2001**). Hyper-Authorship means massive collaboration in a single paper, whether some authors are added who have minimal or least involvement, so it becomes important to check the intrinsic characteristics of topics in a discipline for a meaningful classification.

Blockchain research has soared in the current decade as a disruptive paradigm. This Technology is based on the concept of decentralized consensus-based validation. The first application was introduced by **Nakamoto (2008)** as means of payment which later established a financial system of the crypto-currency market commonly known as “Bitcoin”. Most researchers are trying to understand how Blockchain Technology works since it got huge response from mass media and increasingly become an investment and speculative device (**Zyskind et al., 2015; Zheng et al., 2018**). In fact Economic researchers focus Bitcoin as substitute to national currency (**Yermack, 2013; Bohme et al., 2015**).

The use of Blockchain in libraries can seem a futuristic approach but it is a technology that should be followed as it is gaining more attention from companies all over the world. Blockchain system store information in blocks that record all the transactions ever done through the network and require several nodes to agree on the transaction in order to process it. Blockchain technology could revolutionize the ways that institutions store personal information like student details, registration information, grades and lesson plans that previous teachers have used, which could easily be transferred between schools as students move or graduate into new institutions.

Literature Review

In Terms of Library and Information Science “Bibliometrics” is defined as a research field that uses quantities method of Bibliographic description or material (**Pritchard, 1969; Broadus, 1987**). Bibliometric analysis has become quite popular in classifying bibliographies and developing representative summaries of results. A wide variety of issues can be studied by many bibliometric methods.

Cobo et al (2011) analyses the thematic evaluation of fuzzy sets theory of bibliometrics in studying keyword analysis while **Bonilla et al (2015)** studies the development of academic research in economics (from 1992 & 2013) of

Latin America. In the discipline of Computer & Industrial Engineering **Cancino et al (2017)** analyzed bibliometric publication from 1979 and 2015. While **Andrikopoulos et al (2016)** performed an economic analysis of bibliometrics by reviewing 1st 40 years of econometrics journals, collaboration patterns, and research in International econometrics. **Wei (2019)** also followed the same bibliometric analysis in the Journal of Economy. **Costa et al (2019)** performed a bibliometric analysis in the field of science on behavioural economics and behavioural finance. In support to their research **Claveau and Gingras (2016)** combined different tools of bibliometry and analyzed research on the history of economics. They further analyzed that combining different methods of bibliometrics yields dynamic network analysis. In a different way, **Korom (2019)** analyzed the interdisciplinary perspectives by examining the Thematic Overlap approaches between the Sociological and Economic fields.

In the year 2009, an anonymous individual with the pseudo name “Nakamoto” published a decentralized currency at the time of the global financial crisis which was non-government-controlled, the crisis was considered the most serious economic downturn in 2009 (**Almunia et al., 2009**). The slowdown was so bad that people lost trust in banking matters, at that time Nakamoto’s idea was adopted rapidly and timely by the public. Without any financial system, Bitcoin allows people to transfer money in a peer-to-peer encrypted manner. Bitcoin become tantamount to cryptocurrency, as this type of currency is anonymous and transactions are hidden from financial authorities (**Coinmarket, 2022**). **Miau and Yang (2018)**, consider Block Chain Technology as a broad research area while researchers focus on its one application “Bitcoin” which is a small fragment of this technology. **Zeng et al, (2018)** analyzed bibliographic methods on Blockchain related applications, the investigation reveal a thorough analysis of application pertinent to Blockchain Technology.

Dabbagh et al (2019) analyzed 995 papers dealing with bibliometric analysis on Blockchain Technology. Their analyses reveal that the interests of researchers have shifted from Bitcoin to Blockchain Technology in past two years. **Yli-Huumo et al (2016)** presents bibliometric analysis on 41 research articles excluding explicit papers dealing with legal economic business and regulation perspective of Blockchain. As described by **Petersen et al (2008)** they conducted their study using systematic mapping process prior to Yli-Huumo.

Consequently, our paper may be a contribution in expanding literature related to blockchain technology which provides a thorough trend regarding publication of research articles consisting of key word “Blockchain Technology” from 2013-2022 and further identifies the top institutions, journals and researchers in the said field.

Objectives

The objectives of the present study are:

- a) To measure the year wise distribution of publication Growth of Literature.
- b) To find out the Relative Growth Rate and Double time of Publication.
- c) To identify document type, language and geographical Distribution of Articles
- d) To know the most preferred journals in the field of Blockchain Technology
- e) To identify the foremost prolific authors throughout the time period
- f) To examine the nature of authorship patterns and degree of collaboration

Methodology

The data for the present study were downloaded from the Clarivate-Analytics- Web of Science one of the largest citation and abstracting databases in May 2023. The period analysis was limited to the publication years from 2013-2022 with the topic search “Blockchain Technology”. All records were analyzed by using Microsoft Excel, Bibexcel and Hiscite. The data downloaded were enhanced with different parameters like year-wise number of articles, productive authors, source journals, document type, geographic distribution, linguistic analysis, relative growth and doubling time and authorship pattern along with a degree of collaboration. The data was subsequently examined, observed, analyzed and tabulated for making observations. The data were subjected to analysis as per the objectives of the study.

Table 1: Details about Sample Data

S. No.	Details about Sample	Observed values
1	Duration	2013-2022
2	Collection Span	10 years
3	Total no. of Records	592
4	Total no. of Authors	2946
5	Document Types	5
6	Languages	10
7	Contributing Countries	66
8	Total Source Titles	422
9	Average Citation per item	21.25
10	H-index	55

Data Analysis and Interpretation

Evaluate the Annual Output of Publications

Table 2 indicates the growing trend in the growth of publication in Blockchain Technology research year after year. There is a continuous increase in the

number of publications during the time span of 2013-2022. The percentage share of the research contribution comes to 5.73% (2013) and 16.72% (2022). According to Table 2, 2022 has the highest number of research documents 99 (16.72%) with 2 total local citation scores and 265 total global citation scores, and is leading among the 10 years output and standing in first rank position. The year 2021 has 78 (13.17%) research documents and ranks second with 2 total local citation scores and 667 total global citation scores. It is followed by the year 2019, with 77 publications with 1385 total global citation scores. The least number of publications was produced in 2013, 34 (5.73%) with a 1556 global citation score. It is evident that the increase in the number of publications may not impact total local citation scores and global citation scores.

Table 2: Annual Distribution of Publications and Citations

Year	No. of Publications	Cumulative Articles	%age	TLCS	TGCS
2013	34	34	5.73	5	1556
2014	45	79	7.60	10	2038
2015	37	116	6.25	11	1596
2016	45	161	7.60	7	1104
2017	48	209	8.10	14	1882
2018	59	268	9.96	11	1124
2019	77	345	13.00	3	1385
2020	70	415	11.82	2	919
2021	78	493	13.17	2	667
2022	99	592	16.72	2	265
Total	592				

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Relative Growth rate and Doubling Time

It is very clear that the relative growth rate of the total literature output published has been progressively improved. The growth rate is 0.56 in 2014, which increased to 1.85 in 2021. The mean relative growth rate is 1.44 during the period 2013-2022. Generally, the relative growth rate of publications of all sources has shown an increasing trend. The mean doubling time is 0.55 during the period 2013-2022. In general, the doubling time of scholarly publications of all sources in this study has also shown a decreasing trend.

Document Type

There are six document types that constitute the research publications produced in the field of Blockchain Technology. The data shown in Table 4 can be seen in 5 document formats. Nearly (83.8%) of the publications were published as journal articles, followed by (12.7%) Review papers and (2%) published as Proceeding papers. It is clearly seen that editorial material,

review book chapters, and article book chapters are published in less than one percent share. It is evident that Blockchain technology has got their research published predominantly by journal articles.

Table 3: Relative Growth Rate and Doubling Time

Year	No. of Pub.	Cum. Pub.	w1	w2	Mean	w2-w1	DT	Mean
2013	34	34	3.52	3.52	1.44	0	0	0.55
2014	45	79	3.80	4.36		0.56	1.2	
2015	37	116	3.61	4.75		1.14	0.6	
2016	45	161	3.80	5.08		1.28	0.5	
2017	48	209	3.81	5.34		1.53	0.5	
2018	59	268	4.07	5.59		1.52	0.5	
2019	77	345	4.34	5.84		1.5	0.5	
2020	70	415	4.24	6.02		1.78	0.4	
2021	78	493	4.35	6.20		1.85	0.4	
2022	99	592	4.59	6.38		1.79	0.4	
Total	592							

Pub. = No. of publications; Cum. Pub = Cumulative Publications

Table 4: Publication Distribution by Document Type

Rank	Document Type	No. of Pub.	Percentage	TLCS	TGCS
1	Article	496	83.8	57	8179
2	Review	75	12.7	10	4092
3	Proceeding Paper	12	2	0	149
4	Editorial Material	4	0.7	0	53
5	Review; Book Chapter	3	0.5	0	61
6	Article; Book Chapter	2	0.3	0	2
7	Total	592	100.00		

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Geographical Contribution

The literature on Blockchain Technology was produced by 66 countries all over the world, but there are some productive countries that have produced comparatively more research output in the world. Table 5 presents the geographical analysis of publications revealed during the time period of study. It was found that the contribution of the USA 144 (24.3%) with 14 total local score citations and 3779 total global citation scores ranks first in the list followed by China 137 (23.1%) with 9 total local score citations and 2056 total global score citations and Germany 56(9.5%) 5 total local citation score and 1172 total global citation score. The rest of the countries like Italy, England, France, South Korea, Japan, Australia, and Spain contributed less than (7%) to the total share. So far as citations are concerned, the USA was the highest number of publications is also having the highest total local score citations and total global score citations.

Table 5: Top Ten Publishing Countries

Rank	Country	No. of Pub.	Percentage	TLCS	TGCS
1	USA	144	24.3	14	3779
2	China	137	23.1	9	2056
3	Germany	56	9.5	5	1172
4	Italy	38	6.4	4	523
5	England	36	6.1	1	1136
6	France	28	4.7	10	1002
7	South Korea	27	4.6	3	442
8	Japan	25	4.2	13	615
9	Australia	23	3.9	4	1111
10	Spain	21	3.5	2	511
	Other Countries	57	9.62		
	Total	592	100.00		

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Language used for communicating the research output

The language-wise distribution of research output in the field of Blockchain Technology revealed that English is the most productive language out of the ten languages in which the research literature on Blockchain Technology has been communicated during these ten years with 574 (96.95%) publications with 67 total local citations score and 12520 total global citation score. On the contrary, other languages such as Chinese, Spanish, Portuguese, Croatian, Italian, Japanese, Polish, Russian and Turkish which constitute their share in one digit a quite little ratio to the overall share of the research literature in the field.

Table 6: Distribution of Language

Language	No. of Pub.	Percentage	TLCS	TGCS
English	574	96.95	67	12520
Chinese	5	0.84	0	11
Spanish	5	0.84	0	1
Portuguese	2	0.33	0	3
Croatian	1	0.16	0	1
Italian	1	0.16	0	0
Japanese	1	0.16	0	0
Polish	1	0.16	0	0
Russian	1	0.16	0	0
Turkish	1	0.16	0	0
Total	592	100.00		

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Distribution of publications among Source Titles

The current literature was published in 422 source titles and the analysis has been shown only for the top 10 source titles that are used for publishing the literature on Blockchain Technology. As evident from Table 7 'Macromolecules' is the highly ranked journal contributing (2.70%) of the total share with 16 records during the time span of ten years with 5 total local citation scores and 364 total global citation scores, having an impact factor 5.914, followed by 'Polymer Chemistry' that is producing 10 number of research publications constituting (1.68%) of the total share with 5 total local citation score and 578 total global citation score, with 4.92 impact factor more total global citation score than the journal ranked at first rank.

Table 7: Top Ten Source Titles

Source Titles	No. of Papers	Percentage	TLCS	TGCS	Impact Factor
Macromolecules	16	2.70	5	364	5.914
Polymer Chemistry	10	1.68	5	578	4.927
PLOS ONE	9	1.52	0	125	2.766
Polymer	9	1.52	5	454	3.483
Macromolecular Rapid Communications	8	1.35	1	189	4.265
Langmuir	7	1.18	5	177	3.789
European Polymer Journal	6	1.01	0	79	3.741
Journal of American Chemical Society	6	1.01	3	163	14.357
ACS Macro Letters	5	0.84	1	62	6.131
Journal of Polymer Science	5	0.84	7	139	2.588

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Productive Authors

A total of 2946 authors contributed their research in the field of Blockchain Technology. It can be seen that out of the ten authors of Blockchain Technology research in the Web of Science. Li, Y and Wang, C both emerged as the topmost prolific author with 5 (0.08%) publications. The following authors Junkers, T., Li, C., Seki, T and Zhang, T ranked at second position 4(0.7%) publications as shown in Table 8. The rest of the authors contribute less than (0.5%) of its total share.

Authorship pattern along with degree of collaboration

The degree of collaboration (DC) is clear as the ratio of the number of collaborative research papers to the total number of research papers in a discipline during a definite period. The formula recommended by

Subramanyam is used. It is expressed as where,

$$C = N_m/N_m + N_s$$

C- is the degree of collaboration in a discipline;

N_m is the number of multi-authored research papers in the discipline published during a year;

N_s is the number of single-authored papers in the discipline published during the same year.

Using this formula, the Degree of Collaboration (DC) is determined for the present study. Table 9 reveals that the highest value of the degree of collaboration 0.98 was observed in the year 2017 and the lowest value of 0.91 in 2014 and 2022. There were fluctuations in the degree of collaboration during the study period.

Table 8: Productive Authors

Rank	Authors	No. of Pub.	Percentage	TLCS	TGCS	H-index
1	Li, Y	5	0.8	0	8	18
1	Wang, C	5	0.8	0	70	5
2	Junkers, T	4	0.7	8	150	39
2	Li, C	4	0.7	0	70	34
2	Seki, T	4	0.7	4	140	23
2	Zhang, L	4	0.7	1	180	24
2	Zhang, K	4	0.7	0	40	19
3	Auriemma, F	3	0.5	1	7	47
3	Barner-Kowollick, C	3	0.5	0	19	88
3	Chen, Z	3	0.5	0	77	58
	Other Authors	553	93.41			
	Total	592	100.00			

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Table 9: Authorship pattern along with the degree of collaboration

Year	Single Authored	Multi Authored	Degree of Collaboration
2013	2	32	0.94
2014	4	41	0.91
2015	1	36	0.97
2016	3	42	0.93
2017	1	47	0.98
2018	3	56	0.95
2019	7	70	0.91
2020	4	66	0.94
2021	3	75	0.96
2022	9	90	0.91
Total	37	555	0.94

Top Contributing Institution

There were a total of 886 research institutes that have produced their research contribution in the field of Blockchain Technology. The list of the top ten institutes is shown in Table 10. It is found that the Chinese Academy of Science with 11 publications with 391 total global citations is at the top and that contributes 1.85% of the total share. The Shanghai Jiao Tong University with 8 (1.35%) publications with 131 total global citation scores got the second spot, Sichuan University, University of Science and Technology, China and the University of Washington with 7 (1.18%) publications in 3rd spot respectively. The study also tried to analyze the total local citation score and total global citation score of these research institutes and it was revealed that the University of Melbourne with 556 has the highest total global citation score followed by National Centre for Scientific Research with 427 total global citation score presented in the table below. It is clearly evident that China is the top most productive institutions contains the top four spots in Blockchain Technology research output worldwide.

Table 10: Productive Institutions

Rank	Institutions	Country	No. of Pub.	%age	TLCS	TGCS
1	Chinese Academy of Science	China	11	1.85	3	391
2	Shanghai Jiao Tong University	China	8	1.35	0	131
3	Sichuan University	China	7	1.18	0	111
3	University of Science and Technology, China	China	7	1.18	3	323
3	University of Washington	USA	7	1.18	2	336
4	University of Ghent	Belgium	6	1.02	0	66
4	University of Sao Paulo	Brazil	6	1.01	7	130
5	Arizona State University	USA	5	0.8	1	40
5	National Centre for Scientific Research	France	5	0.8	7	427
5	University of Nagoya	Japan	5	0.84	4	150
5	University of Melbourne	Australia	5	0.84	1	556
5	University of Minnesota	USA	5	0.84	1	185
5	University of Pisa	Italy	5	0.84	0	68
5	Xi An Jiao Tong University	China	5	0.84	0	34
5	University of Zhejiang	China	5	0.84	0	86
	Other Institutions		500	84.45		

TLCS: Total Local Citation Score; TGCS: Total Global Citation Score

Conclusion

Blockchain technology is opening new opportunities for libraries. Apart from its applications in financial services, blockchain-based systems may be implemented in other field related to libraries like library verification of credentials, digital preservations, library record keeping and inter-library loan system. The analysis revealed that a total of 592 records is available in the Web of Science database in Blockchain Technology publications from 2013-2022. The findings revealed that there is an increasing trend in the growth of Blockchain research publications. The highest number of publications is observed in the year 2022(16.2%) followed by 2021(13.17%) and 2020(11.82%) respectively. A total of 2946 authors contributed to the blockchain research and author-wise analysis reveals that Li, Wang and Junkers were acknowledged as the top most prolific authors based on the total number of papers published. A document type analysis depicts that the majority of the blockchain research got published (83.8%) in the form of articles followed by reviews (12.7%) and proceeding papers (2%) respectively. The mean value of RGR is 1.44, and the mean doubling time is 1.44. Linguistic analysis reveals that the most communicated language is English, though some publications are also in Chinese, Spanish and Portuguese. The majority of the scholarly contributions published from the USA (24.3%) secures at 1st rank followed by China with (23.1%) publications at 2nd spot and Germany with (9.5%) publications at 3rd spot respectively. The Macromolecules source title published a total of 16 publications with a 5.9 impact factor followed by Polymer Chemistry with 10 publications with a 4.9 impact factor and PLOS ONE with 9 publications having a 2.7 impact factor. The top leading institution in Blockchain Technology is the Chinese Academy of Science with 11 publications followed by Shanghai Jiao Tong University with 8 publications and Sichuan University with a total of 7 publications. All the top three institutions the majority of the research papers contributed to the blockchain technology are from China.

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