Blockchain Research: A Scientometric Assessment of Global Literature during 2010-18

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ABSTRACT

The paper analyzes global publications in blockchain research on a series of quantitative and qualitative indicators, using Scopus database. Blockchain research published a total of 4629 research publications in 9-year period during 2010-18. The publications registered a fast growth of 150.24 per cent and registered average citation impact per paper of 5.04. The paper profiles most productive countries, organisation, authors and journals on select bibliometric indicators. The top 29 highly-cited papers in this area are also analysed.

Keywords: Blockchain research; Global publications; Bibliometrics; Scientometrics.

1. INTRODUCTION

Blockchain has been evolved as a secured networked data management system with major potential to provide its users with unique features like anonymity, security, privacy, and transparency in data transactions, data storage, data protection, and data authenticity. Blockchain has been hailed as the most secured technology behind the success of Bitcoin and other cryptocurrencies.

Basically, the term bockchain refers to digital information (the block) stored in a public digital ledger (the chain). The public digital ledger is decentralised, distributed across millions of computers linked on a peer to peer network. The most significant feature of Blockchain technology is that the Blockchain is incorruptible. Blockchain technology organises the growing list of records (data) into blocks, and blocks are chained together using cryptography. Each block stores digital signatures (cryptographic hash) of transactions data and hashed data of the previous block which helps it link to previous data. Hashed data residing in blocks is structured into a binary hash tree (Merkle tree). Hash-based architecture in a Merkle tree simplifies transactions data verification, maintains data integrity, and allows Blockchain to scale. By design Blockchain records are temper proof and verifiable across millions of computers connected on a peer to peer network. That Blockchain network has no central authority makes it immune to third party risks. Besides, access to the public ledger is protected by private key and public key. Such network nodes that possess private key are authorised to make new records, and those who possess public key are permitted just access to the database. Blockchain forms a continuous system-driven mechanism of control and checks that prevents data manipulation and errors[1].

Blockchain technology combines three existing technologies – distributed ledger technology, P2P networks, and cryptography - to let network nodes to reach consensus on every new addition to the ledger. Secondly, Blockchain data is time-stamped since every transaction is replicated across several interconnected computers with no central server or administrator[2].

Blockchain technology has been around, but mainly in the context of bitcoin and cryptocurrency since 2008. The bitcoin cryptocurrency, although has not been recognised by several governments, but the financial sector and several other industries have recognised the underlying Blockchain system as incorruptible. Of late, blockchain technology played an important role in constructing a programmable monetary system, financial system, and the macroscopic societal system[3].

In last 2-3 years, Indian government recognised the significance of blockchain in good governance[4], which was reflected in Budget Speech of the Finance Minister[5]. NITI Aayog, the government's current policy-making body, is engaged in formulating a national policy to use blockchain technology in several areas: education, health and agriculture. In the past, India has successfully demonstrated the application of blockchain technology in banking, insurance and land records management[6]. The most common uses of blockchain technology in India, according to a PwC survey, are found in fund transfers, digital identity and payments infrastructure during the last few years. A non-governmental organisation, namely The Blockchain Foundation of India was set up in 2017, which is engaged in community effort with the aim to promote the growth of blockchain-based initiatives in the country[7].

2. LITERATURE REVIEW

Few studies are available on the quantitative and qualitative analyses of Bitcoin and Blockchain research literature. Holub and Johnson[8] analysed 1206 research publications on Bitcoin and other cryptocurrencies across six disciplines. Miau and Yang[9] examined blockchain technology research outputs (801) during 2008-17, focusing mainly on publication growth and author productivity. Blockchain research developments were observed in three stages: (i) the appearance of keywords such as bitcoin and cryptocurrencies in first phase (2008-13); (ii) the bitcoin literature showed rapid growth in second phase (2014-15); and (iii) the blockchain techniques and smart contract gained importance in third phase (2016 onwards). Yli-Huumo, Ko, Choi, Park and Smolander[10] analysed important Blockchain technology publications (41) and discovered underlying research areas and identified challenges and future directions in the subject. More than three fourth of the papers focused on bitcoin system and the rest dealt with other Blockchain applications including e.g. smart contracts and licensing. Dabbagh, Sookhak and Safa[11] examined conference papers, articles, and review papers in blockchain technology, as covered by WoS database, during 2013 to 2018: publications and citations trends, important research areas, influential papers, popular publication channels and major funding bodies. Rousseau[12] performed citation analysis of global Blockchain technology literature. He indicated that this technology has the potential to transform ownership, traceability, incentives and policy making.

3. OBJECTIVES

The study undertakes a quantitative and qualitative assessment of global publications on blockchain research, using Scopus international database during 2010- 18. The specific objectives are: (i) to understand the growth and distribution of world literature; (ii) to identify and present the profile of leading productive countries, organisations and authors on the subject; (iii) to examine the distribution of publication across leading subject areas; (iv) to identify significant keywords; (v) to identify the preferred mode of communications of research and (vi) to understand the characteristics of its highly-cited publications.

4. METHODOLOGY

The Blockchain global research publications were sourced from Scopus database (http://www.scopus.com) using significant keywords (as search terms) and limiting the search period to 2010-2018. The "TITLE-ABS-KEY" field tag (as shown in the search string below) was used to search literature using keywords ["Blockchain" OR "Bitcoin" OR "Ethereum" OR "Hyperledger" OR "Cryptocurrency" OR "Smart contract"]. The search output was latter restricted to the period 2010-2018. For generating output of top countries in blockchain research,

the search string further used country name (in "country tag"). In the records generated using the above search strategy, many records related to keywords: "polymers" and "colloids" were noticed. Accordingly, the search strategy was modified by adding the keywords: "Not polymer" and "Not colloid". On further using various tags in Scopus database, the data on publication distribution by subject, collaborating countries, authors, organisations and journals were obtained. Citations data was obtained from the date of publication till 30 March 2019.

((TITLE-ABS-KEY ("Blockchain" OR "Bitcoin" OR "Ethereum" OR "Hyperledger" OR "Cryptocurrency" OR "Smart contract") AND PUBYEAR > 2009 AND PUBYEAR < 2019) AND NOT (TITLE-ABS-KEY ("Polymer " OR "Colloid") AND PUBYEAR > 2009 AND PUBYEAR < 2019))

5. DATA ANALYSIS & RESULTS
5.1 Growth Study

During the period 2010-18, blockchain research has accumulated a total of 4629 global publications and registered average annual growth rate of 150.24 per cent. It, however, registered 2262.23 per cent cumulative growth, increasing from

Table 1. Blockchain research - Annual and cumulative world publications growth during 2010-18.

Publication Period	World		
	TP	TC	CPP
2010	3	2	0.67
2011	5	114	22.80
2012	10	409	40.90
2013	37	1849	49.97
2014	133	2358	17.73
2015	223	3102	13.91
2016	328	5173	15.77
2017	1041	6443	6.19
2018	2849	3876	1.36
2010-14	188	4732	25.17
2015-18	4441	18594	4.19
2010-18	4629	23326	5.04

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper
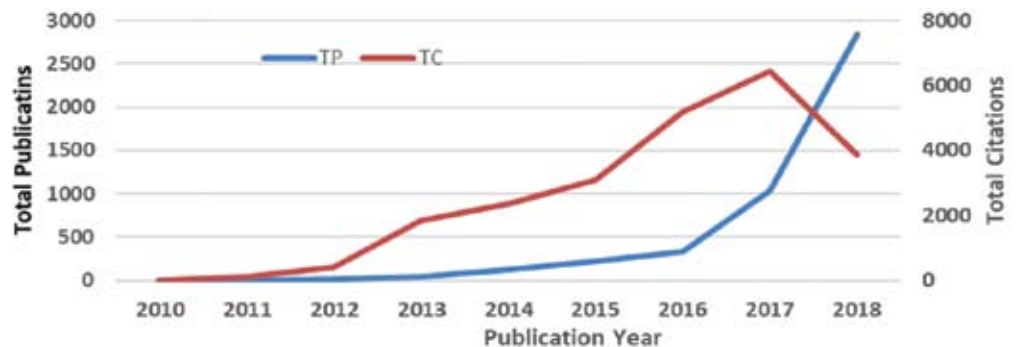
Figure 1. Blockchain research: Publication growth 2010-2018.

4441 to 4629 publications between 2010-14 and 2015-18. This high growth trend highlights that the subject witnessed fastest growth during 2015-18. The citation impact of blockchain research computed on 9-year citation window 2010-18 was 5.04 citations per paper (CPP). On a cumulative citation window, its citation impact dropped from 25.17 CPP during 2010-14 to 4.19 CPP during 2015-18 (Table 1, Fig. 1).

51.76 per cent (2396) of the total publications in the field appeared as conference papers, followed by 28.99 per cent (1342) articles in research journals, 8.53 per cent (395) as conference reviews, 2.87 per cent (133) as articles in press, 2.72 per cent (126) as book chapters, 1.94 per cent (90) as reviews and 1.02 per cent (47) as notes. Other type of publications contributed less than 1 per cent share each include books (0.69 %), editorials (0.56 %), short surveys (0.41 %), letters (0.35 %), erratum (0.13 %) and retracted (0.02 %).

## 5.2 Most Productive Countries in Blockchain Research

This study finds that 102 countries had participated in blockchain research during 2010-18, but the distribution of global research by country of publication was highly skewed. Sixty-one countries contributed 1 to 20 papers, 22 contributed 21-50 papers, 5 contributed 51 to 100 papers, 12 contributed 101-374 papers, and 5 contributed the highest 701 to 959 papers.

It was observed that 72.09% publications share and 85.42% citations share during the period came from only top 10 participating countries out of 102. The top 10 countries global publication share varied widely from 3.20% to 20.72%. The USA and China lead the list of top 10 countries with their dominant publication shares (20.72 % and 15.29 % respectively), followed by U.K (8.08 %), Germany (6.35 %) and six other countries (from 3.20 % to 4.15 %) during 2010-18 (Table 2, Fig. 2).

Table 2. Scientometric profile of 10 leading countries in global blockchain research during 2010-18

Country Name	Number of Papers			Share of Papers			2010-18				
	2010-14	2015-18	2010-18	2010-14	2014-18	2010-18	TC	CPP	ICP	ICP (Per cent)	RCI
USA	50	909	959	26.60	20.47	20.72	8293	8.65	335	34.93	1.72
China	3	705	708	1.60	15.87	15.29	2597	3.67	218	30.79	0.73
U.K.	10	364	374	5.32	8.20	8.08	2648	7.08	165	44.12	1.40
Germany	23	271	294	12.23	6.10	6.35	1889	6.43	108	36.73	1.27
Italy	7	185	192	3.72	4.17	4.15	1019	5.31	75	39.06	1.05
India	6	183	189	3.19	4.12	4.08	364	1.93	52	27.51	0.38
France	3	158	161	1.60	3.56	3.48	1139	7.07	88	54.66	1.40
Australia	4	155	159	2.13	3.49	3.43	1320	8.30	84	52.83	1.65
South Korea	1	152	153	0.53	3.42	3.31	469	3.07	27	17.65	0.61
Russian Federation	1	147	148	0.53	3.31	3.20	188	1.27	28	18.92	0.25
Total	108	3229	3337	57.45	72.71	72.09	19926	5.97	1180	35.36	1.18
World Total	188	4441	4629				23326	5.04			
	57.45	72.71	72.09				85.42				

*TC=Total citations; CPP=Citations Per Paper; ICP=International Collaborative Papers; RCI=Relative Citation Index
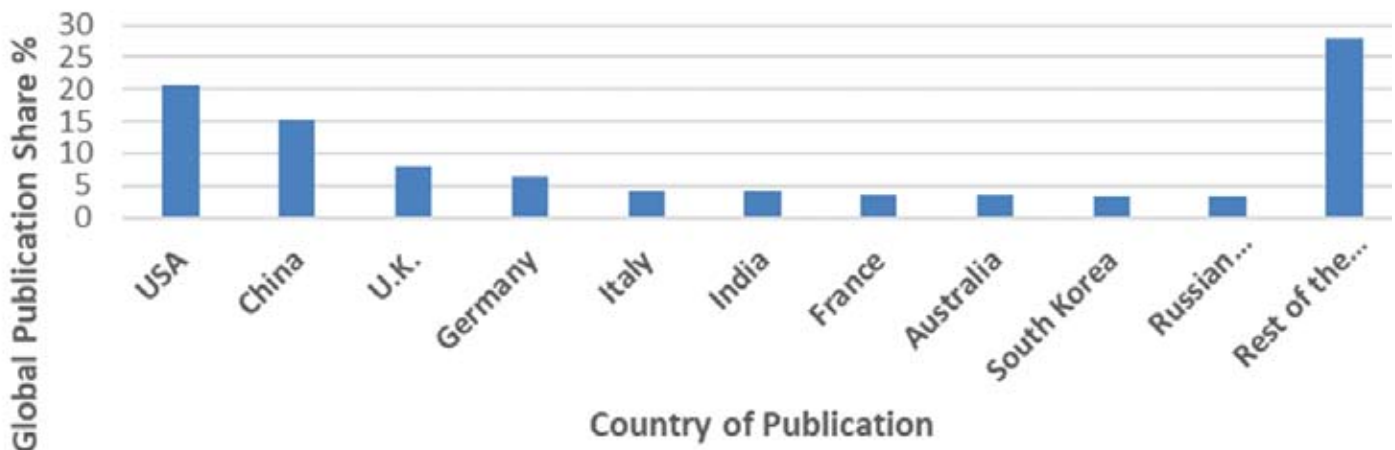
Figure 2. Distribution of blockchain research by country of publication 2010-2018

Above the group average citations impact and relative citation index (5.97 CPP and 1.18 respectively) were registered by 5 countries: USA (8.65 and 1.72), Australia (8.30 and 1.65), U.K. (7.08 and 1.40), France (7.07 and 1.40 each) and Germany (6.43 and 1.27). India, however, depicted the lowest relative citation index score of 0.38.

5.3 Subject-Wise Distribution of Papers

The subject areas (as defined by Scopus database) were used as criteria for understanding the distribution of research in global blockchain research during 2010-18. This study finds that computer science which intersected with Blockchain research accounted for the largest global publications share (72.28 %), and economics, econometrics & finance (9.40 %) for the least share. The dynamics of research across select subject areas was compared on 'activity index' in reference to global average activity in the given subject (global average value as 100). During the period between 2010-14 and 2015-18, the select subject areas that witnessed increase in publication activity are: computer science, engineering and decision science. In all other subjects, their publication activity witnessed marginal to moderate decline (Table 3, Fig. 3).

Economics, econometrics & finance registered the highest citation impact per paper (8.09) in contrast to decision science registering the least impact (2.78) during 2010-18 (Table 3).
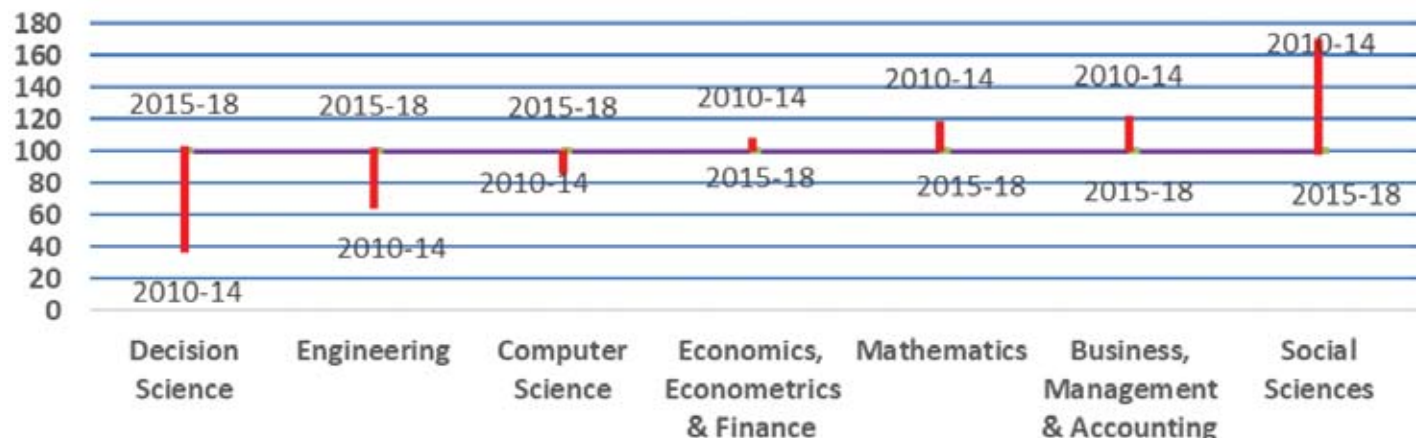
5.4 Significant Keywords

Blockchain, electronic money, Bitcoin, smart contract, and internet of things are the key significant keywords in searching Blockchain literature from Scopus database. In all 34 keywords were identified to understand growth trends in Blockchain research. Table 4 lists these keywords in the order of frequency of their occurrence. A longitudinal analysis of these keywords across three arbitrarily select periods: 2010-14, 2015-16 and 2017-18 reveal that the keywords are temporal in nature, gradually increasing in the frequency of their occurrence overtime. Thematically, these keywords also highlight how focus of research in the domain of Blockchain research kept on changing from one select period to another.

- During 2010-14, the focus was on keywords such as Bitcoin (65), Security of Data (29), Electronic Money (27), Cryptography (26), Peer to Peer Networks (18), Virtual Currency (12) and Anonymity (12);

Table 3. Blockchain research - Subject-wise breakup of global publications during 2010-18

Subject*	Number of Papers (TP)			Activity Index		Total Citations	CPP	% TP
	2010-14	2015-18	2010-18	2010-14	2015-18	2010-18		
Computer Science	117	3229	3346	86.10	100.59	15915	4.76	72.28
Engineering	34	1287	1321	63.37	101.55	5994	4.54	28.54
Mathematics	49	970	1019	118.40	99.22	4470	4.39	22.01
Business, Management & Accounting	25	483	508	121.17	99.10	2020	3.98	10.97
Decision Science	7	470	477	36.13	102.70	1328	2.78	10.30
Social Sciences	33	444	477	170.34	97.02	1634	3.43	10.30
Economics, Econometrics & Finance	19	416	435	107.55	99.68	3520	8.09	9.40
World Output	188	4441	4629					

*CPP=Citation per Paper

Figure 3. Blockchain research: Activity index by subjects- 2010-2018.

Table 4. Significant keywords in global Blockchain research during 2010-18

Significant Keyword	Number of Papers				Significant Keyword	Number of Papers			
	2010-14	2015-16	2017-18	2010-18		2010-14	2015-16	2017-18	2010-18
Blockchain	4	154	2376	2504	Big Data	0	12	154	166
Electronic Money	27	212	754	993	Block-chain Technology	0	4	113	117
Bitcoin	65	190	659	914	Proof of Work	3	19	88	110
Smart Contract	2	23	518	543	Access Control	1	6	102	109
Cryptocurrency	11	79	326	416	Distributed Ledger	0	1	104	105
Internet of Things	2	12	396	410	Miners	5	16	60	81
Cryptography	26	65	269	367	Trusted Third Party	3	9	67	80
Network Security	11	28	301	340	Virtual Currency	12	23	33	68
Data Privacy	4	27	276	307	Trusted Computing	0	5	62	67
Distributed Computer Systems	3	38	239	287	Consensus Protocols	0	3	62	65
Peer to Peer Networks	18	37	197	252	Consensus Algorithms	0	10	37	47
Digital Storage	1	18	223	242	Transparency	1	3	43	47
Commerce	11	27	176	215	Digital Currency	3	14	28	45
Security	3	9	173	186	Anonymity	12	9	23	44
Ethereum	0	13	165	178	Mining	0	8	36	44
Authentication	2	14	156	172	Distributed Consensus	1	3	36	40
Security of Data	29	20	119	168	Proof of Concept	1	2	31	34

- During 2015-16, the focus was on keywords such as Electronic Currency (212), Bitcoin (190) Blockchain (154), Big Data (154), Blockchain Technology (154), Distributed Ledger (104), Access Control (102), Cryptocurrency (79) and Cryptography (65); and
- During 2017-18, the focus was on keywords such as Blockchain (2376), Electronic Currency (754), Bitcoin (659), Smart Contract (518), Internet of Things (396), Cryptocurrency (326), Network Security (301), Data Privacy (276), Cryptography (269), Distributed Computer System (239) and Digital Storage (223).

5.5 Contribution and Impact of Top 30 Most Productive Global Organisations

517 organisations took part in global blockchain research during 2010-18, but showed uneven distribution: 273 contributed 1-5 papers each, 134 organisations 6-10 papers each, 78 organisations 11-20 papers each, 31 organisations 21-50 papers each and 1 organisation 53 papers.

The 30 most productive organisations produced 22 to 53 papers each, and they together contributed 900 papers (19.44 % share) and received 8648 citations (37.07 % share) during 2010-18.

- Eleven organisations showed higher productivity over group average (30 papers) : University College of London, U.K (53 papers), Eidenossische Technische Hochschule, Switzerland (50 papers), Beijing University of Posts & Telecommunications, China (48 papers), Beihang University, China (38 papers), University of New South Wales, Australia (36 papers), University of Illinois at Urbana-Champaign, USA, Peking University, China, National University of Singapore, etc. (Table 5)
- Seven organisations depicted higher citation impact and relative citation index over group average of 9.61 citations per paper and 1.91 respectively: University of Maryland, USA (39.27 and 7.79), Cornell University, USA (30.06 and 5.97), Eidenossische Technische Hochschule, Switzerland (20.94 and 4.15), Massachusetts Institute of Technology, USA (20.75 and 4.12), Carnegie Mellon University, USA (16.04 and 3.18), University of New South Wales, Australia (15.33 and 3.04), Commonwealth Scientific & Industrial Organisation, Australia (14.43 and 2.86), National University of Singapore (14.09 and 2.80), etc. (Table 5).

Table 5.   Scientometric profile of 17 leading global organisations (including top 10 most productive and 10 most cited) during 2010-18

Name of the Organisation	TP	TC	CPP	HI	ICP	% ICP	RCI
University College of London, U.K	53	278	5.25	9	24	45.28	1.04
Eidenossische Technische Hochschule (ETH), Switzerland	50	1047	20.94	15	32	64.00	4.15
Beijing University of Posts & Telecommunications, China	48	154	3.21	7	11	22.92	0.64
Beihang University, China	38	113	2.97	7	12	31.58	0.59
University of New South Wales, Australia	36	552	15.33	11	23	63.89	3.04
University of Illinois at Urbana-Champaign, USA	33	83	2.52	5	8	24.24	0.50
Peking University, China	33	103	3.12	6	18	54.55	0.62
National University of Singapore	33	465	14.09	9	17	51.52	2.80
University of Chinese Academy of Sciences, China	33	100	3.03	5	10	30.30	0.60
National University of Defense Technology, China	32	405	12.66	7	3	9.38	2.51
Cornell University, USA	31	932	30.06	12	5	16.13	5.97
Commonwealth Scientific & Industrial Organization, Australia	28	404	14.43	9	16	57.14	2.86
Massachusetts Institute of Technology, USA	24	498	20.75	8	9	37.5	4.12
Carnegie Mellon University, USA	23	369	16.04	7	8	34.78	3.18
University of Maryland, USA	22	864	39.27	11	6	27.27	7.79
Stanford University, USA	22	289	13.14	7	9	40.91	2.61
Institute of Automation, CAS, China	22	286	13	5	4	18.18	2.58

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index.

5.6 Contribution and Impact of Top 30 Most Productive Authors

613 authors took part in global blockchain research during 2010-18, but showed uneven distribution: 488 contributed 1-5 papers each, 102 authors 6-10 papers each and 23 authors 11-20 papers each.

The 30 productive authors produced 10 to 20 papers, and they together contributed 386 papers (8.34 % share) and generated 6805 citations (29.17 % share) during 2010-18.

- Sixteen authors showed higher productivity over group average (12.87 papers): F.Y. Yang (19 papers), A. Miller (19 papers), E. Shi (17 papers), A. Kiayias and X. Xu (16 papers each), Y. Yuan (15 papers), E. Bouri, M. Marchesi, W. Shi and I. Weber (14 papers each), L. Chen, Z. Gao, G.O. Karame, D. Roubaud, R. State and L. Xu (13 papers each) (Table 6)
- Thirteen authors depicted higher citation impact and relative citation index over group average of 17.63 and 3.50, respectively: E. Shi (45.18 and 8.96), A. Miller (41.0 and 8.13), C. Decker (40.8 and 8.10), G.O. Karame (40.15 and 7.97), R. Wattenhofer (37.09 and 7.36), P. Saxena (35.7 and 7.08), J. Clark (32.9 and 6.53), J. Bonneau (28.18 and 5.59), A. Zohar (27.55 and 5.47), D. Roubaud(20.77 and 4.12), E. Bouri (19.0 and 3.77), Y. Yuan (18.4 and 3,65) and A. Kiayias (18.06 and 3.58) (Table 6).

5.7 Channels of Research Communication

Conference proceedings and journals medium contributed the major share (44.72 % and 33.98 %) to the global output in blockchain research, followed by book series (16.57 %), books (2.87 %) and trade publications (1.86 %) during 2010-18.

289 journals took part in global blockchain research during 2010-18, but showed uneven distribution: 244 journals published 1-5 papers each, 22 journals 6-10 papers each, 17 journals 11-20 papers each, 5 journals 21-50 papers each and 1 journals 68 papers.

The output in journals varied from 13 to 68 papers by top 15 journals and their total contribution constituted 22.79 per cent share of total output in journals during 2010-18. The combined output of top 15 journals marginally increased from 20.0 per cent to 22.38 per cent between 2010-14 and 2015-18. IEEE Access emerged as the topmost productive journal (with 68 papers), followed by Finance Research Letters (38 papers), Economist, U.K. (37 papers), Economic Letters (28 papers), International Journal of Engineering & Technology, UAE (24 papers each), IEEE Internet of Things Journal (21 papers), etc. during 2010-18 (Table 7).

5.8 Highly Cited Papers

29 out of 4629 global papers on blockchain research registered comparatively higher citations: 102 to 285 citations per paper (referred here as highly-cited papers). These 29 papers together contributed 4406 citations, averaging

Table 6. Scientific profile of leading 18 authors (including 10 top most productive and 10 most cited) during 2010-18

Author name	Author affiliation	TP	TC	CPP	HI	ICP	% ICP	RCI
F.Y. Yang	Institute of Automation, CAS, China	20	286	14.30	5	3	15.00	2.84
A.Miller	University of Maryland, USA	19	779	41.00	8	3	15.79	8.13
E. Shi	Cornell University, USA	17	768	45.18	10	1	5.88	8.96
A. Kiayias	University of Athens, Greece	16	289	18.06	6	11	68.75	3.58
X. Xu	CSIRO, Eveleigh, NSW, Australia	16	266	16.63	7	11	68.75	3.30
Y. Yuan	Institute of Automation, CAS, China	15	276	18.40	5	2	13.33	3.65
E. Bouri	Holy Spirit University of Kaslik, Lebanon	14	266	19.00	8	14	100.00	3.77
M. Marchesi	University of Cagliari, Italy	14	79	5.64	5	1	7.14	1.12
W. Shi	University of Houston, TX, USA	14	33	2.36	3	1	7.14	0.47
I.Weber	CSIRO, Eveleigh, NSW, Australia	14	188	13.43	7	7	50.00	2.66
G.O.Karame	NEC Laboratories Europe, Germany	13	522	40.15	10	10	76.92	7.97
D. Roubaud	Montpellier Business School, France	13	270	20.77	8	13	100	4.12
R.Wattenhofer	Eidenossische Technische Hochschule (ETH), Zurich	11	408	37.09	9	5	45.45	7.36
J.Bonneau	Princeton University, USA	11	310	28.18	6	2	18.18	5.59
A.Zohar	Microsoft Research, USA	11	303	27.55	7	3	27.27	5.47
C. Decker	Eidenossische Technische Hochschule (ETH), Zurich	10	408	40.8	7	5	50	8.1
P. Saxena	National University of Singapore	10	357	35.7	6	2	20	7.08
J. Clark	Concordia University, Canada	10	329	32.9	6	7	70	6.53

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index.

151.93 citations per paper. 11 papers depict sole institution participation (zero collaboration) among 29 highly-cited papers, as against 8 involving national collaboration and 10 international collaboration. USA participated in the largest number of highly- cited papers (10), followed by Switzerland (5 papers), Germany, Israel and U.K. (3 papers each), China (2 papers), etc. The 100 authors from 59 organisations took part in 29 highly-cited papers Amongst 29 highly-cited papers, only 7 were published in research journals :Economic Letters (2 papers) and IEEE Communications Survey & Tutorials, Journal of Economic Perspective, PLOS One, Scientific Reports and Zidonghua Xuebao/Acta Automatica Sinica.(1 paper each).

6. CONCLUSIONS

The paper presents a scientometric profile of global Blockchain research, using selected quantitative and qualitative indicators during 2010-18. The research area showed 150.24 per cent growth per annum, depicted citation impact per paper of 5.04 and contributed 0.62 per cent share of its total output as highly-cited papers. The global research in the subject witnessed the uneven participation of 102 countries, with 10 countries alone cumulatively 72.09 per cent global publications share. The USA and China contributed 20.72 per cent and 15.29 per cent share respectively, followed distantly by eight others in the list of top 10 most productive countries which contributed 3.20 per cent to 8.08 per cent share to the world output during the period. The USA registered the highest CPP and RCI (8.65 and 1.72) followed by Australia (8.30 and 1.65), U.K. (7.08 and 1.40), France (7.07 and 1.40 each) and Germany (6.43 and 1.27). Computer science, among various subjects, is the most sought after subject area in Blockchain research accounting for the highest 72.78 per cent publications share.

19.44 per cent global publications share and 37.07 per cent global citations share came from top 30 top (out of 517) participating organisations. University College of London, U.K is the most productive organisation (with 53 papers) and IEEE Access is the most productive journal (with 41 papers) in global blockchain research. The 29 highly-cited papers in global blockchain research registered 102 to 285 citations per paper since their publication during 2010-18.

Conclusion: Blockchain is fast gaining importance in banking and financial sectors for its usefulness as a secured

Table 7.   Top 15 most productive journals on Blockchain research during 2010-18

Journal name	Number of Papers		
	2010-14	2015-18	2010-18
IEEE Access	0	68	68
Finance Research Letters	0	38	38
Economist, U.K.	5	32	37
Economic Letters	0	28	28
International Journal of Engineering & Technology, UAE	0	24	24
IEEE Internet of Things Journal	0	21	21
Technology Review	3	16	19
Future Generation Computer System	0	17	17
PLOS One	2	13	15
Sensors Switzerland	0	15	15
Communication of the ACM	2	12	14
Jisuanji Yanjiu Yu Fazhan. Computer Research & Development	0	14	14
Zhongguo Dianji Gongcheng. Proceeding of the Chinese Society of Electrical Engineering	0	14	14
Nature	0	13	13
Physica A. Statistical Mechanics and Its Applications	0	13	13
Total of 15 Journals	12	338	350
Total of World	60	1510	1570
Share of 15 journals in World journal output	20.00	22.38	22.29

networked data management system that stakeholders can harness and use to generate unique services like middleman-free direct payments, temper proof data security, improving speed of delivery, and such other secured applications. During 2010-18, a total of 102 countries precipitated in global research on this topic and registered 150.24 per cent annual average growth rate. However, the distribution of research by country of publication was highly skewed. Nearly 3/4th of total output in the subject came from top 10 countries. USA and China lead the world in blockchain research among top 10 countries. The top 10 countries together accounted for 36 per cent bulk share of total output in the subject. USA and China are also the affiliating host countries of 10 and 8 most productive global organisations and authors in the subject. Despite registering a fast rate of growth, the body of the literature in the subject continued to remain small till date, limited to just 4629 publications. Certainly, blockchain research is still in its nascent stage of growth and development. That only 10 of 102 world countries are by far known to be the major drivers of research in subject is a matter of great concern. India is the 6th most productive country in the world in blockchain research. If India is to become world leader in the subject, significant investments are required in the country. In addition, India will be required to identify major sub-areas of national interest in the subject, identity target institutions where research in such sub-areas could be undertaken, and in addition establish new national programs in this area as well as set up an institutional framework with mandate to monitor and coordinate research across national and international organisations

REFERENCES
1.   Monitor Deloitte. Blockchain and media: A new game changer for the media industry. Blockchain Institute. 2017. https://www2.deloitte. com/content/dam/Deloitte/de/ Documents/technology-media-telecommunications/ PoV_ Blockchain_Media_interaktiv.pdf (Accessed on 7 August 2018)
2.   Das, Bitanshu. Blockchain technology – The immutable database revolution. 17 November 2015.http://analyticsindiamag. com/Blockchain-technology-the-immutable-database-revolution/ (Accessed on 7 August 2018).
3.   Yuan, Y. & Wang, F.Y. Blockchain: The state of the art and future trends. Zidonghua Xuebao/ Acta Automatica Sinica 1 April 2016, 42(4), 481-94 .http://en.cnki. com.cn/Article_en/CJFDTOTAL-MOTO201604001. htm.
4.   Deloitte & ASSOCHAM. Blockchain technology in India: Opportunities and challenges. April 2017. https:// www2.deloitte.com/content/dam/Deloitte/in/Documents/ strategy/ in-strategy-innovation-Blockchain-technology-india-opportunities-challenges-noexp.pdf (Accessed on 7 August 2018)
5.   Mehdiratta, Megha. Implementing Blockchain in India. 19 June 2018. https://www.investindia.gov.in/team-india-blogs/implementing-Blockchain-india (Accessed on 7 August 2018).
6.   Karnik, Madhura. Blockchain technology is the coolest thing in Indian finance right now but nobody really gets it. 25 April 2017. https://qz.com/india/966629/Blockchain-technology-is-the-coolest-thing-in-indian-finance-right-now-but-nobody-really-gets-it/ (Accessed on 7 August 2018).
7.   Bhushan, Kul. Blockchain: Benefits of this emerging technology beyond cryptocurrencies. 4 March 2018. https:// www.hindustantimes.com/tech/Blockchain-benefits-of-this-emerging-technology-beyond-cryptocurrencies/

story-KmLMhsBgFhVHgppDMDuyXN.html (Accessed on 7 August 2018).

8. Holub, Mark & Johnson, Jackie. Bitcoin research across disciplines. *Inf. Soc. : An Int J.*, 2018, **34**(2), 114-126.
    doi: 10.1080/01972243.2017.14140949.

9. Miau, Scott & Yang, Jiann-Min Yang. Bibliometrics-based evaluation of the Blockchain research trend: 2008 – March 2017. Technology Analysis & Strategic Management 2018, **30**(9), 1027-45.
    doi: 10.1080/09537325.2018.1434138.

10. Yli-Huumo, J.; Ko, D.; Choi, S.; Park, S. & Smolander, K. Where is current research on Blockchain technology? A systematic review. *PLOS One*, October 2016, **11**(10), Article number e0163477.
    doi: 10.1371/journal.pone.0163477.

11. Dabbagh, Mohammad; Sookhak, Mehdi; Safa, Nader Sohrabi. The evolution of Blockchain: A bibliometric study. IEEE Access, 2019, **7**, 1-10.
    doi: 10.1109/ACCESS.2019.2895646.

12. Rousseau, Ronald. Blockchain technology: A bibliometric analysis. ISSI Newsletter, 2018, **14**(1), #53, 10-22. file:///C:/Users/river2/Downloads/BlockchaintechnologyISSI%20(1).pdf

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