Juni Khyat ISSN: 2278-4632 (UGC Care Group I Listed Journal) Vol-13, Issue-05, No.04, May : 2023 WORLD LITERATURE ON CLOUD COMPUTING RESEARCH: A SCIENTOMETRIC STUDY

 Mr. S. C. Hosamani Research Scholar, Dept. of Library and Information Science, Karnatak University, Dharwad, Karnataka, India, Email id: sidduch001@gmail.com
 Dr. C. Krishnamurthy Professor, Dept. of Library and Information Science, Karnataka University, Dharwad, Karnataka, India, Email id: jrfkrishna@gmail.com

ABSTRACT:

The present paper examines the quantitative and qualitative growth and development of the literature on cloud computing in terms of publication output as reflected in the Web of Science International Database during the years 2009-2018. The total number of publications received was 14000. The highest number of publications (3010) was published in 2018. The highest number of citations (39050) was received in 2013. The average number of citations per publication are 17.80. The authors concentrate on publication activity in terms of the global share, relative growth rate, doubling time, share of international collaborative publications, citation impact and also attempt to explore the global trends in Cloud computing from different dimensions

KEYWORDS: Scientometrics, Cloud Computing, Web of Science, Relative Growth Rate, Doubling time

INTRODUCTION:

The use of Information Communication Technologies (ICTs) has become an important tool for information access. The scholarly community tries to adopt the new forms of facilities to improve their teaching, learning, and research activities. Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive setup to a variable priced environment. It is the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. **Brodkin (2008)** defines cloud computing is a style of computing in which massively scalable IT-related capabilities are provided as a service to external customers using internet technologies.

Scientometric assessment is an important component of any research and development activity. One of the well-known productivity indicators is the number of publications produced by scientists, institutions, and countries. Such studies will provide some insight into the complex dynamics of research activity and enable researchers, scientists, policymakers, and science administrators to provide adequate facilities and proper guidance in which direction the research has to be conducted (Kademani, et al, 2006). Hence, such an indispensable technique is used to evaluate the quality and quantity of literature published across disciplines within a particular geographical area. In this paper, an attempt is made to analyze the literature published on cloud computing during 2009-2018 from various scientometric dimensions.

OBJECTIVES OF STUDYs

The main objective of the present study is to analyze global research performance on Cloud Computing based on the literature published from 2009 to 2018. The objectives of the study are as follows:

- 1. To determine the year-wise growth rate and Doubling time of publications,
- 2. To find out the Bibliographical forms of publications;
- 3. To study the Language-wise distribution of the publications;
- 4. To recognize highly productive institutions;
- 5. To identify the most prolific authors in terms of publications;
- 6. To recognize the most preferred journals;
- 7. To examine the funding agencies in the field of cloud computing;

Juni Khyat

(UGC Care Group I Listed Journal)

8. To study the global distribution of research publications, and

9. To identify highly cited papers and to rank the journals based on the publication.

METHODS AND MATERIALS

The present study is based on world wide Cloud Computing research output as reflected in the Web of Science (www.isiknowledge.com) database maintained by Clarivate Analytics. The data was retrieved from the WOS database (www.webofknowledge.com) for the period of 10 years (2009-2018). The data was extracted using the search string TS=Cloud Computing AND Time Span=2009-2018. Databases=SCI-EXPANDED this search criteria yielded 14,000 publications. The retrieved publications were loaded in MS-Excel and SPSS for analysis. Later the data were analyzed as per the objectives of the study.

RESULTS AND DISCUSSION:

Relative Growth Rate and Doubling Time of Cloud Computing Research

The analysis of the growth rate in Cloud Computing research publications is one of the prime aspects of the discussion. Table 1 gives the year-wise distribution of publications on cloud computing research. The number of publications increased from year to year, during the period of 2009 to 2018. Out of the total 14000 publications, the maximum number of publications are found in the year 2018, contributing 3010 research papers, which is 21.5% of the total publication. In this regard, a study on the growth rate of publications provides some useful results.

Relative Growth Rate (RGR): is the increase in the number of publications per unit time.

The formula for calculating the mean R

 $R = W_{2} - W_{1}/T_{2} - T_{1}$

Where:

 \mathbf{R} = mean relative growth rate over the specific period of intervals;

 $W_1 = Log W_1$ (natural log of initial number of publication);

 $W_2 = Log W_2$ (natural log of final number of publication);

 $T_2 - T_1$ = the unit difference between the initial and final time

Doubling Time (Dt): The doubling time is the given period required for quantity to double in size or value.

This can be calculated by using the formula.

Doubling time (Dt)= 0.693/R

Here, Dt(P) = average doubling time of publications

Table 1 and Figure 1 indicates that the value of the RGR of publications decreased from 0.88 (2010) to 0.24 (2018). On the other hand, the Doubling time (Dt.) shown a time-increasing trend. The data reveals that Doubling time has increased form 0.79 (2010) to 2.86 (2018).

Table-1: Relative Growth Rate (RGR) and Doubling Time (Dt)

Year	TP	%	Cumulative	Log1	Log2	RGR	Dt.
2009	267	1.91	267	•••	5.59	•••	•••
2010	377	2.69	644	5.59	6.47	0.88	0.79
2011	601	4.29	1245	6.47	7.13	0.66	1.05
2012	827	5.91	2072	7.13	7.64	0.51	1.36
2013	1209	8.64	3281	7.64	8.10	0.46	1.51
2014	1417	10.12	4698	8.10	8.45	0.36	1.93
2015	1734	12.39	6432	8.45	8.77	0.31	2.21
2016	2093	14.95	8525	8.77	9.05	0.28	2.46
2017	2465	17.61	10990	9.05	9.30	0.25	2.73
2018	3010	21.5	14000	9.30	9.55	0.24	2.86



Distribution of cloud computing research form different sources

Table 2 indicates that document-wise output in Cloud Computing research through various communication channels. Journal Articles rank first with 12686 (90.61%) publications, followed by Editorial Material which occupies the second place with 390 (2.79%) publications. Reviews occupy third place with 381 (2.72%) publications. The remaining 543 (3.88%) publications are published in different formats such as Proceedings Papers, Meeting Abstract, Book Review & News Item, etc.

Sl. No.	Document Types	ТР	%	Cumulative	Cumulative %
1	Articles	12686	90.61	12686	90.61
2	Editorial Material	390	2.79	13076	93.40
3	Review	381	2.72	13457	96.12
4	Proceedings Paper	368	2.63	13825	98.75
5	Meeting Abstract	83	0.59	13908	99.34
6	Book Review	25	0.18	13933	99.52
7	News Item	20	0.14	13953	99.66
8	Book Chapter	18	0.13	13971	99.79
9	Letter	9	0.06	13980	99.86
10	Correction	8	0.06	13988	99.91
		5	0.04	13993	99.95
11	Retracted Publication				
12	Reprint	4	0.03	13997	99.98
13	Retraction	2	0.01	13999	99.99
14	Data Paper	1	0.01	14000	100
	Total	14000	100		

Table 2: Distribution of cloud computing research form different sources

Language wise Distribution of Publications

Table 3 examines the research production in the field of cloud computing by language for the present study. Among the languages such as English, Spanish, Portuguese, Chinese, German, French, Polish, Hungarian, Slovenian, and Turkish. The English language has the highest number of 13919 (99.42%) publications followed by Spanish language occupying the second position with 26 (0.19%) publications, and Portuguese gets the third position with 23 (0.16%) publications. The remaining 67 (0.23%) publications are from various other languages such as Chinese, German, French, etc.

Sl. No.	Languages		%	Cumulative	Cum %
		No. of			
		Publications			
1	English	13919	99.42	13919	99.42
2	Spanish	26	0.19	13945	99.61
3	Portuguese	23	0.16	13968	99.77
4	Chinese	12	0.09	13980	99.86
5	German	10	0.07	13990	99.93
6	French	4	0.03	13994	99.96
7	Polish	3	0.02	13997	99.98
8	Hungarian	1	0.01	13998	99.99
9	Slovenian	1	0.01	13999	99.99
10	Turkish	1	0.01	14000	100
	Total	14000	100		

Table 3: Language	wise distribution	of Cloud	computing research	h
Lusie et Lungunge		or croud	comparing rescare	-

Highly Productive Organizations/Institutions in the field of Cloud computing research

Table 4 shows the top 25 highly productive Institutions based on their publications, citations, and average citations per publication. According to the Web of Science database, The Chinese Academy of Sciences, Beijing, China contributed the highest number of publications to the field of cloud computing, i.e. 484 publications, followed by Centre National De La Recherche Scientifique (CNRS), Paris, France, has contributed 404 publications, University of California, USA, has 314 publications, and National Aeronautics Space Administration (NASA), Washington, D.C, USA, contributed 239 publications.

In terms of citations received, the University of Melbourne, Victoria, Australia has received the highest number of citations i.e., 15,666 with 85.14 average citations per paper (ACPP), followed by the University of California, USA with 12,571 citations and its average citations per publication is 40.04, and United States Department of Energy (DOE), Washington, D.C, USA received 6475 citations with 39.97 average citations per publication.

SI	Research / Academic Institution		TGCS	ACPP
No.				
1	Chinese Academy of Sciences, Beijing, China	484	10440	21.57
2	Centre National De La Recherche Scientifique (CNRS), Paris,	404	8923	22.09
	France			
3	University of California, USA	314	12571	40.04
4	National Aeronautics Space Administration (NASA),	239	5891	24.65
	Washington, D.C, USA			
5	Beijing University of Posts Telecommunications, Beijing,	233	3522	
	China			15.12
6	Huazhong University of Science Technology, Hubei, China	203	4654	22.93
7	Tsinghua University, Beijing, China	201	4655	23.16
8	Xidian University, Xi'an, China	193	3689	19.11
9	University of Melbourne, Victoria, Australia	184	15666	85.14
10	King Saud University, Riyadh, Saudi Arabia	166	2930	17.65
11	United States Department of Energy (DOE), Washington, D.C,	162	6475	39.97
	USA			
12	State University of New York (SUNY), New York, USA	158	4900	31.01

Table 4: Highly Productive Organizations/Institutions in the field of Cloud Computing

ISSN: 2278-4632 Vol-13, Issue-05, No.04, May : 2023

13	Wuhan University, Hubei, China	150	2725	18.17
14	University of Texas System, Austin, United States	145	2500	17.24
15	Pennsylvania Commonwealth System of Higher Education	143	3155	22.06
	(PCSHE), Pennsylvania, USA			
16	International Business Machines (IBM), New York, USA	140	2508	17.91
17	Shanghai Jiao Tong University, Shanghai, China	130	3053	23.48
18	Universite Paris Saclay, Saint-Aubin, France	125	2990	23.92
19	University of Malaya, Kuala Lumpur, Malaysia	124	4543	36.64
20	Indian Institute of Technology (IIT), Kharagpur, India	123	1671	13.59
21	University of Electronic Science Technology of China,	122	1842	15.1
	Sichuan, China			
22	University System of Georgia , Georgia, USA	122	2981	24.43
23	Sorbonne Universite, Paris, France	121	2784	23.01
24	Cantra national de la Racharche Scientifique (CNRS, Paris	119	3145	26.43
	Erança			
25	University System of Maryland, USA	117	3715	31.75

TP= *Total Publications, TGCS*= *Total Global citation Score, ACPP*= *Average citations per paper* **Most Preferred Journals in cloud computing research**

Table 5 identifies the core journals in the field of cloud computing. Only the top 25 journals are taken into consideration for analysis. Based on average citations per paper (ACPP), The journal IEEE Transactions on Parallel and Distributed Systems from the USA received the highest (i.e.35.5) average citation per paper, followed by IEEE Communications Magazine received from the USA (33.59), Journal of Network and Computer Applications, Netherlands (33.23), Future Generation Computer Systems the International Journal of EScience, Netherlands (31.22), Astrophysical Journal, USA (29.03) IEEE Network, USA (28.84) and Astronomy Astrophysics, Germany (26.76).

The Journal IEEE Communications published from the USA has the highest impact factor (11.05), followed by IEEE Network published from USA with impact factor (8.808), IEEE Transactions on Services Computing, USA (7.42), Future Generation Computer Systems the International Journal of EScience, Netherlands (6.125), Astrophysical Journal, USA (5.745), Journal of Network and Computer Applications, Netherlands (5.570) and Astronomy Astrophysics, Germany (5.636).

SI	Source / Journal	Country	TP	TGCS	ACPP	Impact
No.						factor
1	Future Generation Computer Systems the International Journal of EScience	Netherlands	606	18922	31.22	6.125
2	IEEE Access	USA	395	4901	12.42	3.745
3	Journal of Super computing	USA	288	3692	12.82	2.600
4	Concurrency and Computation Practice Experience	USA	286	2595	9.07	1.447
5	Astronomy Astrophysics	Germany	244	6530	26.76	5.636
6	IEEE Transactions on Parallel And Distributed Systems	USA	232	8235	35.5	2.6
7	Cluster Computing the Journal of Networks Software Tools and Applications	USA	205	1906	9.3	1.514

 Table 5: Most Preferred Journals in cloud computing research

8	Journal of Network and Computer Applications	Netherlands	192	14091	33.23	5.570
9	Monthly Notices of the Royal Astronomical Society	United Kingdom	179	4078	22.78	5.356
10	Astrophysical Journal	USA	159	4616	29.03	5.745
11	IEEE Transactions on Cloud Computing	USA	153	1550	10.13	4.714
12	IEEE Transactions on Services Computing	USA	144	2926	20.32	7.42
13	Journal of Grid Computing	Germany	121	2028	16.76	1.556
14	Journal of Internet Technology	TAIWAN	119	622	5.23	0.99
15	Sensors	Switzerland	117	925	7.91	3.275
16	IEEE Communications Magazine	USA	116	3897	33.59	11.05
17	KSII Transactions on Internet and Information Systems	South Korea	109	267	2.45	0.648
18	Journal of Systems and Software	Netherlands	108	1391	12.88	1.352
19	Journal of Geophysical Research Atmospheres	USA	107	2034	19.01	3.82
20	Security and Communication Networks	USA	106	603	5.69	1.288
21	Computers Electrical Engineering	Netherlands	101	1039	10.29	2.663
22	IEEE Network	USA	101	2913	28.84	8.808
23	Journal of Parallel and Distributed Computing	Netherlands	100	2125	21.25	2.296
24	Computer Networks	Netherlands	99	1738	17.56	3.111
25	China Communications	China	96	518	5.4	2.024

TP= *Total Publications*, *TGCS*= *Total Global citation Score*, *ACPP*= *Average citations per paper*

Highly Productive Authors in the field of cloud computing

Table 6 analyses the highly productive authors in the field of Cloud Computing. The author Buyya, Rajkumar of Victoria University, Melbourne, Victoria, Australia ranks first with 142 publications and 14622 citations, (ACPP 102.97 and h-index 45), followed by Li, Jing of University of Denver, Colorado, U.S.A has published 131 papers with 3817 citations, (ACPP 29.14 and h-index 31), Zhang, Yinghui of Xian Jiaotong University, Shaanxi, China has 85 papers with 1984 citations, (23.34 ACPP and 27 h-index), Li Y of the University of Maryland, Baltimore, USA has published 71 papers with 1758 citations, (24.76 ACPP and 16 h-index) and Zomaya, Albert Y of University of Sydney, NSW, Australia has published 66 papers with 1609 citations (24.38 ACPP and 22 h-index).

Sl.						H-
No	Author	Affiliation			ACPP	Index
			No. of.	No. of.		
			Publications	Citations		
	Buyya,	Victoria University, Melbourne,				
1	Rajkumar	Victoria, Australia	142	14622	102.97	45
		University of Denver, Colorado,				
2	Li, Jing	U.S.A	131	3817	29.14	31
	Zhang,	Xi'an Jiaotong University, Shaanxi,				
3	Yinghui	China	85	1984	23.34	24
4	Li Y	University of Maryland, Baltimore,	71	1758	24.76	16

Table 6: Highly Productive Authors in the field of cloud computing

		USA				
	Zomaya,	The University of Sydney, NSW,				
5	Albert Y	Australia	66	1609	24.38	22
6	Zhang, Jun	Southeast University, Jiangsu, China	65	2050	31.54	18
	Gani,	Taylor's University, Taylor's				
7	Abdullah	University	64	2908	45.44	28
		Newcastle University. Type and				-
8	Ranjan, Rajiv	Wear, United Kingdom	63	3120	49.52	21
9	Wang, Jian	Wuhan University, Hubei, China	63	1642	26.06	16
	U,	China University of Petroleum,				
10	Liu, Xin	Oingdao and Dongving, China	61	1179	19.33	17
	Khan, Samee	North Dakota State University.				
11	U	Fargo, USA	58	2831	48.81	27
	Yang,	University of Science and				
12	Laurence T	Technology of China, Anhui, China	56	1222	21.82	20
13	Li, Keqin	Hunan University, Hunan, China	54	923	17.09	19
	· •	National University of Defense				
14	Chen, Junjie	Technology, Hunan, China	52	1443	27.75	25
15	Jin, Hai	Huazhong University of Science and		838	16.12	14
	,	Technology, Hubei, China	52			
		Beijing Jiaotong University, Beijing,				
16	Liu, Yun	China	52	597	11.48	15
17	Wang, Chao	Wuhan University, Hubei, China	52	2358	45.35	22
		Luleå University of Technology,				
18	Vasilakos,	Luleå, Sweden		2750	53.92	31
	Athanasios V		51			
19	Chen, Min	Huazhong University of Science and		2445	48.9	24
		Technology, Hubei, China	50			
20	Liu, Lei	Jilin University, Jilin, China	50	707	14.4	12
	Park, Jong					
21	Hyuk			350	7	9
	-	Seoul National University of Science	50			
		and Technology, Seoul, South Korea				
22	Yang, Yang	Tsinghua University School of		855	17.45	14
		Economics and Management,	49			
		Beijing, China				
	Chen,					
23	Xiaofeng	Xidian University, Xi'an, China	48	1819	37.9	21
24	Li, Huan	Peking University, Beijing, China	48	1098	22.88	13
		The University of Texas at San				
25	Choo, Kim-	Antonio, Texas, USA		1028	21.87	18
	Kwang		47			
	Raymond					

Global Distribution of Publications

Table 7 shows the analysis of country wise publications in the field of cloud computing during the period of 10 years (2009-2018) The share of international publications in the field of cloud computing research output were among the different collaborative countries the Peoples R China ranks first with 3,863 papers with 67,177 citations, (15.84 ACP and 97 H-Index), followed by the USA which ranked second with 3,795 papers with 94,247 citations, (24.83 ACP and 118 H-Index), England ranked third with 953 publications with 19575 citations, Australia with 919 and Canada

with 778 papers ranked fourth and fifth respectively followed by other countries, as shown in the table7.

SI No	Country	TD	TCCS		, U Indov
51. 190		11	IGCS	ACII	II-IIIuex
	Peoples R	20.62		1504	- -
1	China	3863	67177	15.84	97
2	USA	3795	94247	24.83	118
3	England	953	19575	20.54	66
4	Australia	919	31744	35.54	75
5	Canada	778	16755	21.54	61
6	Germany	768	17329	22.56	66
7	Spain	750	13131	17.51	50
8	South Korea	749	8290	11.07	41
9	India	740	8745	11.82	39
10	France	719	13906	19.34	56
11	Italy	698	12455	17.84	51
12	Taiwan	637	7627	11.97	40
13	Japan	382	5129	13.43	35
14	Brazil	305	5777	18.94	30
15	Saudi Arabia	300	4807	16.02	33
16	Netherlands	237	5943	25.08	40
17	Singapore	229	6963	30.41	40
18	Iran	224	3106	13.87	31
19	Malaysia	214	6358	29.71	40
20	Switzerland	213	5579	26.19	36
21	Greece	209	5613	26.86	36
22	Sweden	196	8266	42.17	36
23	Pakistan	190	2575	13.55	28
24	Austria	171	6378	37.3	33
25	Poland	163	2071	12.71	24

Table 7:	Global	Distribution	of Publications
I and /.	Uluual	Distribution	of I upincations

TP= *Total Publications, TGCS*= *Total Global citation Score, ACPP*= *Average citations per paper* **Top funding agencies contributing to research in Cloud computing**

Table 8 examines the top 25 funding agencies which are financially assisting research activities in the field of cloud computing, it is evident from the table that the National Natural Science Foundation of China has funded the highest contribution of 2618 publications constituting (33.56%) of the total publications. followed by National Science Foundation (NSF), Virginia, USA, funded for 958 publications (12.28%), Fundamental Research Funds for the Central Universities, China, funded for 449 publications (5.75%), National Basic Research Program, China, funded for 392 publications (5.02%), Furthermore, European Union (EU), Brussels, Belgium, funded for 386 publications (7.95%), National Aeronautics and Space Administration (NASA), Washington, D.C., USA, funded for 294 publications (3.77%), and National High Technology Research and Development Program, China, funded for 218 publications (2.79%). It can be inferred from the above analysis that Agencies from China and the USA are the most supportive for research activities in the field of Cloud Computing.

Table 8.	Ton fi	ınding	agencies	contributing	to research	in Cloud	d computing
Lable 0.	TOPIC	munig	agencies	contributing	to research	III CIUU	a computing.

Sl. No.	Funding Agencies	ТР	%
1	National Natural Science Foundation of China (NSFC), China	2618	33.56
2	National Science Foundation (NSF), Virginia, USA	958	12.28

3	Fundamental Research Funds for the Central Universities, China	449	5.75
4	National Basic Research Program, China	392	5.02
5	European Union (EU), Brussels, Belgium	386	4.95
6	National Aeronautics Space Administration (NASA), Washington, D.C., USA	294	3.77
7	National High Technology Research and Development Program, China	218	2.79
8	Natural Sciences and Engineering Research Council, Canada	217	2.78
9	United States Department of Energy (DOE), Washington, D.C., USA	202	2.59
10	China Postdoctoral Science Foundation, China	178	2.28
11	Australian Research Council, Australia	170	2.18
12	United States Department of Health Human Services, Washington, D.C., USA	168	2.15
13	National Institutes of Health (NIH), USA	166	2.13
14	National Science Council, Taiwan	158	2.03
15	European Commission Joint Research Centre, Ispra, Italy	135	1.73
16	German Research Foundation (DFG), Bonn, Germany	120	1.54
	Ministry of Education Culture Sports Science and Technology Japan Mext,		
17	Japan	119	1.53
18	French National Research Agency (ANR), Paris, France	118	1.51
	Engineering Physical Sciences Research Council (EPSRC), Swindon, United		
19	Kingdom	116	1.49
20		113	1.45
	National Council For Scientific And Technological Development (CNPQ),		
	Brasilia, Brazil		
21	National Key Research and Development Program, China	106	1.36
22		103	1.32
	Specialized Research Fund For The Doctoral Program of Higher Education		
	(SRFDP), China		
23	Ministry Of Science And Innovation Spain (MICINN), Madrid, Spain	102	1.31
24	Natural Science Foundation of Jiangsu Province, China	100	1.28
25	Program For New Century Excellent Talents In University (NCET), China	96	1.23
	Total	7802	100

Highly Cited Papers in the Field of Cloud Computing Research

Table 9 shows the top 10 highly cited papers from the globe in the field of Cloud Computing published from the year of 2009 to 2018. The top 10 highly cited papers are identified which have received 837 to 3665 citations and the ACPP is 3225.7.

The top 10 highly cited papers were published in 7 journals. 3 papers in Future Generation Computer Systems-The International Journal of E-science, 1 paper each by Communication of the Acm, Bioinformatics, Software-Practice & Experience, Journal of Network and Computer Applications, Acm Sigcomm Computer Communication Review, Mobile Networks & Applications. Around 32257 Citations were received by these top 10 cited papers. Most of the papers are having multiple authors (Two or more authors).

The authors Armbrust, Michael; Fox, Armando; Griffith, Rean; et al. (authors) received the highest citations i.e. 3665 for their paper on 'A View of Cloud Computing' published in the journal *Communications of the Acm*, in the ear 2010 followed by authors Pronk et al. have received citations i.e. 3182 for their paper on 'GROMACS 4.5: a high-throughput and highly parallel open source molecular simulation toolkit' published in the journal *Bioinformatics*, in the year 2013, Gubbi, Jayavardhana; Buyya, Rajkumar; Marusic, Slaven; et al. received citations i.e. 3121 for their paper on Internet of Things (IoT): A vision, architectural elements, and future directions published in the journal *Future Generation Computer Systems-The International Journal of Escience*, in the year

ISSN: 2278-4632 Vol-13, Issue-05, No.04, May : 2023

2013, Buyya, Rajkumar; Yeo, Chee Shin; Venugopal, Srikumar; et al received citations i.e. 2294 for their paper on Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility published in the journal *Future Generation Computer Systems-The International Journal of Escience*, in the year 2009. This shows that more research is being conducted on newly developing subjects.

Sl.		Title	Authors	Bibliographic Details
No.	No. of. Citations Received			
1	3665	A View of Cloud Computing	Armbrust, Michael; Fox, Armando; Griffith, Rean; et al.	<i>Communications of the Acm,</i> Apr 2010, Vol: 53 No: 4, p.50-58
2	3182	GROMACS 4.5: a high- throughput and highly parallel open source molecular simulation toolkit	Pronk, Sander; Pall, Szilard; Schulz, Roland; et al.	<i>Bioinformatics</i> , Apr 2013, Vol.29 No.7, p. 845-854
3	3121	Internet of Things (IoT): A vision, architectural elements, and future directions	Gubbi, Jayavardhana; Buyya, Rajkumar; Marusic, Slaven; et al.	Future Generation Computer Systems-The International Journal of Escience, Sep 2013, Vol.29 No. 7, p.1645-1660
4	2294	Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility	Buyya, Rajkumar; Yeo, Chee Shin; Venugopal, Srikumar; et al.	Future Generation Computer Systems-The International Journal of Escience, Jun 2009, Vol.25 No. 6, p. 599- 616
5	1750	CloudSim: a toolkit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms	Calheiros, Rodrigo N.; Ranjan, Rajiv; Beloglazov, Anton; et al.	Software-Practice & Experience, Jan 2011, Vol. 41 No. 1, p. 23-50
6	1449	Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications	Al-Fuqaha, Ala; Guizani, Mohsen; Mohammadi, Mehdi;.al	<i>IEEE Communications</i> <i>Surveys and Tutorials</i> , Dec 2015, Vol.17 No. 4, p.2347-2376
7	1083	Energy-aware resource allocation heuristics for efficient management of data centers for Cloud computing	Beloglazov, Anton; Abawajy, Jemal; Buyya, Rajkumar	Future Generation Computer Systems-The International Journal of Escience, May 2012, Vol.28 No.5, p.755- 768
8	948	A survey on security issues in service delivery models	Subashini, S.: Kavitha, V.	Journal of Network and Computer Applications, Jan

Table 9: Highly Cited Papers in the Field of Cloud Computing Research

		of cloud computing		2011 Vol 34 No. 1, p. 1, 11
		or croud computing		2011, V01.34 100. 1, p.1-11
				Acm Sigcomm Computer
9	918	A Break in the Clouds: Towards	Vaquero, Luis	Communication Review, Jan
		a Cloud Definition	M.; Rodero-Merino,	2009, Vol. 39 No. 1, p.50-55
			Luis; Caceres, Juan; et	-
			al.	
10	837	Big Data: A Survey		Mobile Networks &
		-	Chen, Min; Mao,	Applications, Apr 2014,
			Shiwen; Liu, Yunhao	Vol.19 No.2, p.171-209

RESULTS AND CONCLUSION:

The following important results are revealed based on the analysis:

- 1. The highest number of research citation score was found in the year 2013 i.e.39050 and the lowest number of citations in the year 2018 i.e 14756 respectively. The Relative Growth Rate is found to be 0.88 which is the highest in the year 2010 among all the years between 2009-2018 and the doubling time is highest in the year 2018 (2.86).
- 2. It is observed that most of the publications are published by journals in the form of articles i.e.12686 Constituting more than 90% and others include publications such as reviews, Proceedings Papers, Meeting Abstracts, Book Reviews, News Items, Book Chapters and the lowest number of publications are in the form Letters, corrections and Retracted publications.
- 3. It is found that the Chinese Academy of Sciences, Beijing, China has the highest number of publications (484) contributed on cloud computing.
- 4. The highest number of publications i.e.142 are contributed by Buyya with 14622 citations and ranks first, and out of the top 25 authors, the lowest number of publications are contributed by Park, Jong Hynk i.e.49 publications with 350 citations.
- 5. The highest number of publications i.e.0606 is contributed by the Journal "Future Generation Computer Systems the International Journal of EScience," Netherlands based on the global citation score (18922) during the period of the study (2009-2018).
- 6. It is observed that Peoples R China has the highest number of publications i.e.3795 with 67717 citations followed by the USA has 3795 publications with 94247 citations and England has 953 publications with 19575 citations.
- 7. It is identified that the National Natural Science Foundation of China (NSFC) has made the highest funding for the contribution of 2618 publications constituting (33.56%) of the total publications. Followed by National Science Foundation (NSF), Virginia, USA, i.e.958 publications with 12.28%.
- 8. It is observed that "A View of Cloud Computing" is a highly cited paper with 3665 citations followed by GROMACS 4.5: a high-throughput and highly parallel open source molecular simulation toolkit with 3182 citations.

Scientometrics has become one of the useful tool for the assessment of the growth of research in specific subjects. It helps to study the qualitative and quantitative aspects of research and development trends in scientific literature based on various statistical methods. Research is the most important aspects of development in any subject. It is the most important tool for the advancement of knowledge, scientific discoveries, technological achievements, and scholarly publications.

The present study analyses the growth of literature in cloud computing by researchers in the world during the period of 2009 to 2018 based on the data extracted from the Web of Science (WOS). Research in cloud computing is gradually increasing and there is an upward trend in the world. However, there is some fluctuation in the trends of publications. Global computing research

funding agencies including the Government should provide sufficient funding and other infrastructure facilities for the advancement of cloud computing research. Cloud computing is the delivery of different services through the internet, including Email, Data storage, backup & recovery, and analyzing data, Audio, and video streaming, creating and testing apps, etc. and cloud computing is widely useful in the advanced technological world. This Study can be helpful in the direction of forecasting the trends of global research in cloud computing and its allied fields. Further, it can help the government and other research agencies to frame policies, on the issues of cloud computing in the future.

REFERENCES:

- 1. Brodkin, J. (2008). Gartner: Seven cloud-computing security risks. Infoworld, 2008, 1-3.
- 2. Gupta, B. M., & Bala, A. (2011). Mapping of asthma research in India: A scientometric analysis of publications output during 1999-2008. *Lung India: Official Organ of Indian Chest Society*, 28(4), 239.
- 3. Hosamani, S. C., & Krishnamurthy, C. (2020). Scientometric Analysis of Indian Physics Literature During 2004-2018. *Library Philosophy & Practice*.
- 4. Hosamani, S. C., & Krishnamurthy, C. (2020). Scientometric Analysis of Indian Physics Literature During 2004-2018. *Library Philosophy & Practice*, (e-journal). 4677. https://digitalcommons.unl.edu/libphilprac/4677.
- 5. Kademani, B. S., Vijai, K., Anil, S., & Anil, K. (2006). Scientometric dimensions of nuclear science and technology research in India: A study based on INIS (1970-2002) database. *Malaysian Journal of Library & Information Science*, 11(1), 23-48.
- 6. Mahapatra, M. (1985, July). On the validity of the theory of exponential growth of scientific literature. In *Proceedings of the 15th IASLIC conference, Bangalore* (Vol. 6170).
- 7. Ravichandrarao, I. K. (2010). Growth of literature and measures of scientific productivity: scientometric models.
- 8. Seetharam, G., & Ravichandra Rao, I. (1999). Growth of food science and technology literature: A comparison of CFTRI, India and the world. *Scientometrics*, 44(1), 59-79.
- 9. www.isiknowledge.com (2018).