

Scientometric Study on Cloud Computing: An India Perspective

M. Surulinathi¹, A. Gopinath² and N. Prasanna Kumari²

¹Assistant Professor, Department of Library & Information Science, Bharathidasan University, Tiruchirappalli

²Research Scholar, Department of Library & Information Science, Bharathidasan University, Tiruchirappalli

Abstract

This paper deals with the scientometric analysis on Cloud Computing at India level. Totally 332 records were downloaded from the Web of Science database for the study period of 1989 to 2016. This paper deals with the author productivity, authorship pattern, journal wise distribution, institution wise distribution and country wise distribution of publications. Among the world research output (10,419) on cloud computing India ranks 12th place & USA stands in 1st position..

Keywords: Cloud Computing, Authorship Pattern, Scientometric, IT

Introduction

The rapid development of cloud computing in recent years has led to a huge amount of publications containing the attain knowledge of this area of research. Due to the interdisciplinary nature and high significance of cloud computing research, it becomes progressively more difficult or even impossible to understand the overall structure and development of this field without analytical approaches. Scientometric means to empirically study the evolution and state of cloud computing research. This study provides extensive insights into publication patterns, research impact and research productivity. The results of this study provide a better understanding of patterns, trends and other important factors as a basis for directing research activities, sharing knowledge and collaborating in the area of cloud computing research at Indian level.

Objectives of the Study

The main objectives framed for the purpose of the study are:

- To identify the year wise distribution of publications on Cloud Computing.
- To identify the document wise distribution of publications.
- To assess the Institution wise collaboration research concentration.
- To identify the source wise distribution of research output.

To access the author wise distribution of publications, citations and h-index.

Methodology

The study entitled on “Scientometric Study on Cloud Computing at India” is a case study encompassing

records output on Web of Science online database. The growth rate of output in terms of both at absolute level and relative level are analyzed from 1989 to 2016. The author productivity is examined to identify the pattern of research contribution in terms of publications, citations and h-index. Further, an attempt is made to measure the performance of research concentration in the subject domain. The study is mainly exploratory in nature in identifying research output on Cloud Computing.

Analyses and Interpretation

Year wise Distribution of Publications

Table-1 reveals that during the period 1989-2016, a total of 332 publications were published. The highest number of publication is 117 in 2015 followed by 43 papers in 2014 and 35 papers in 2016 and other years have very low number of publications below 40.

Table-1: Year wise distribution of Publications

S. No.	Year	Records	%	TGCS
1.	1991	3	0.9	10
2.	1992	2	0.6	21
3.	1994	2	0.6	16
4.	1995	3	0.9	10
5.	1996	4	1.2	40
6.	1997	5	1.5	88
7.	1998	5	1.5	30
8.	1999	2	0.6	25
9.	2000	1	0.3	13
10.	2001	2	0.6	12
11.	2002	4	1.2	85
12.	2003	4	1.2	84
13.	2004	6	1.8	39
14.	2005	3	0.9	19
15.	2006	6	1.8	120

S. No.	Year	Records	%	TGCS
16.	2007	8	2.4	127
17.	2008	8	2.4	147
18.	2009	8	2.4	59
19.	2010	9	2.7	95
20.	2011	16	4.8	372
21.	2012	19	5.7	189
22.	2013	17	5.1	158
23.	2014	43	13.0	147
24.	2015	117	35.2	60
25.	2016	35	10.5	2
Total		332		

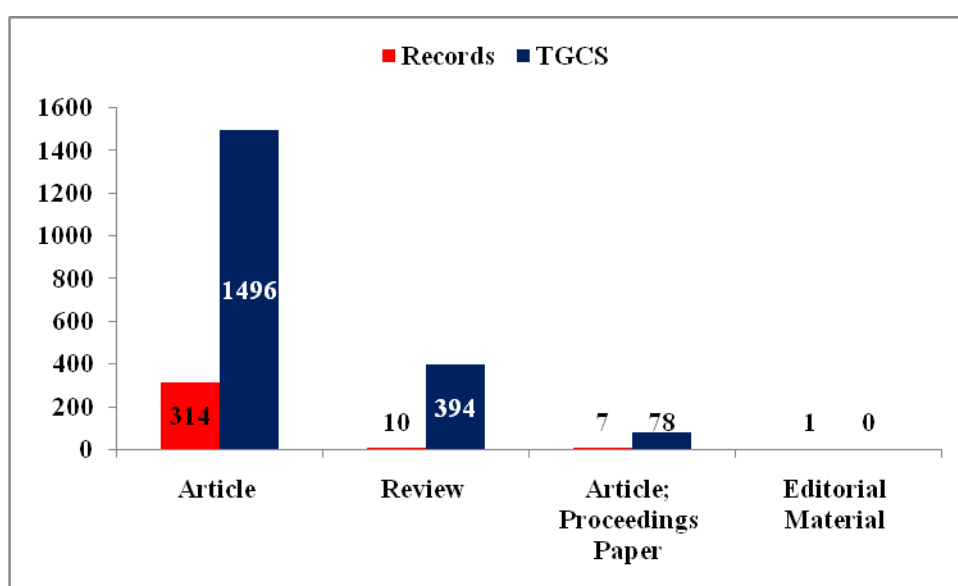
Document wise Distribution of Publications

The highest numbers of publications were 314 (94.6%) as journal article; followed by Review 10 (3.0%); Article; Proceedings Paper 7 (2.1%) and other publication such as editorial material with only one publication.

Table-2: Document wise distribution of Publications

S. No.	Document Type	Records	TGCS
1.	Article	314	1496
2.	Review	10	394
3.	Article, Proceedings etc.	7	78
4.	Editorial Material	1	0

Figure-1: Document wise analysis of Publications with TGCS



Institution wise Collaboration

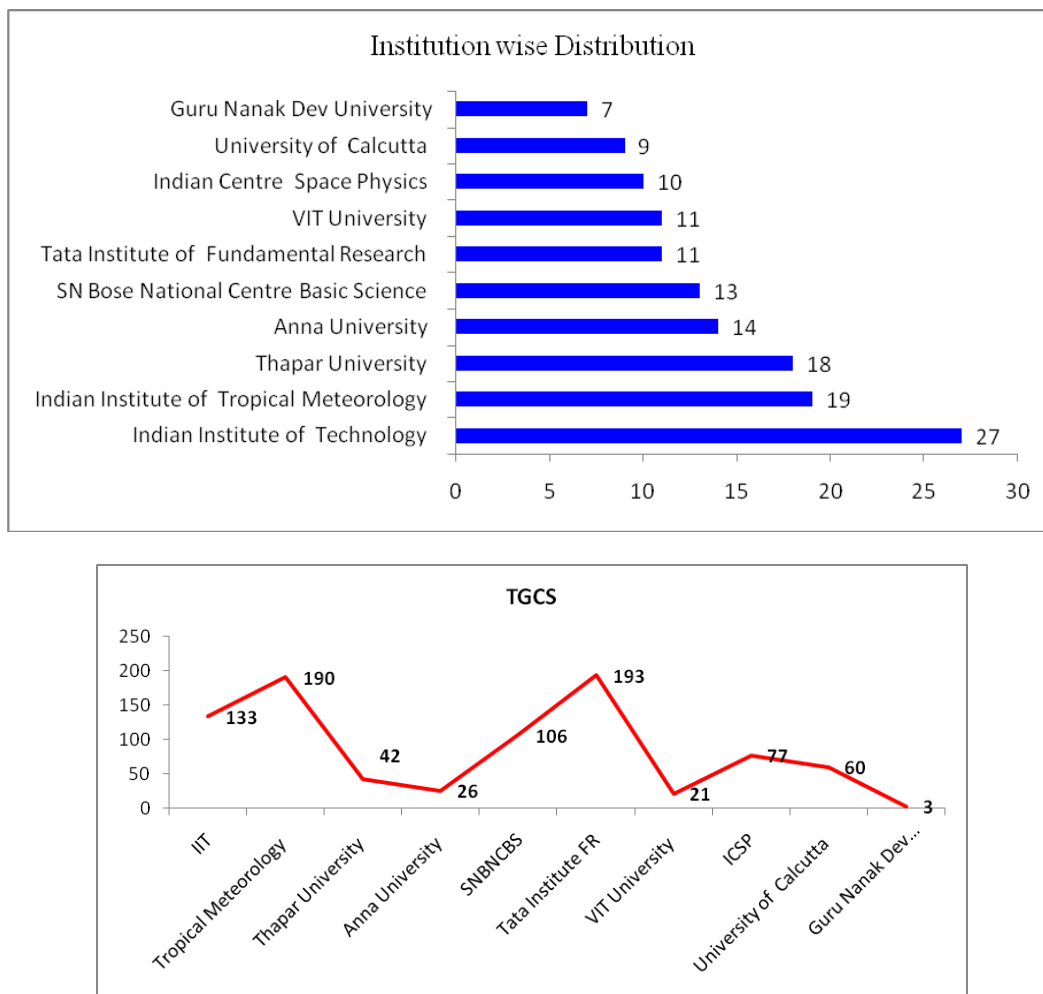
Table-3 indicates Institution-wise research productivity. Among 358 institutions, it is noted that Indian Institute of Technology, Delhi ranks first in order by contributing 27 (8.1%) of total research output of 332 with 133 TGCS. Indian Institute of Tropical Meteorology, Pune holds the second place with 19 (5.7%) in order and Thapar University, Punjab which shares third position with 18 (5.4%) followed by Anna University, SN Bose National Centre Basic Science, Tata Institute of Fundamental Research and so on. Tata Institute of Fundamental Research has only 11 publications but it has highest TGCS value 193.

The publications of other Institutions are as follows:

Table-3: Institution wise distribution of Publications

S.No.	Institution	Records	TGCS
1.	Indian Institute of Technology	27	133
2.	Indian Institute of Tropical Meteorology	19	190
3.	Thapar University	18	42
4.	Anna University	14	26
5.	SN Bose National Centre Basic Science	13	106
6.	Tata Institute of Fundamental Research	11	193
7.	VIT University	11	21
8.	Indian Centre Space Physics	10	77
9.	University of Calcutta	9	60
10.	Guru Nanak Dev Uni.	7	3

Figure-2: Institution wise analysis of Publications with TGCS



Subject wise Distribution of Publications

Based on the subject wise distribution the “Computer Science” has the highest number of publications with 148 (44.58%) followed by “Engineering” with 50

(15.06%) ranks second place and “Astronomy Astrophysics” with 46 (13.85%) with third place respectively.

Table-4: Subject wise distribution of Publications

Research Areas	Records	% of 332
Computer Science	148	44.58
Engineering	50	15.06
Astronomy Astrophysics	46	13.85
Meteorology Atmospheric Sciences	41	12.39
Telecommunications	25	7.53
Chemistry	20	6.04
Geology	19	5.73
Environmental Sciences Ecology	17	5.12
Science Technology other Topics	14	4.22
Remote Sensing	14	4.22

Journal wise Distribution of Publications

This study finds that the literature on Cloud computing research proliferated more than 173 scholarly journals for the study period covered by Web of Science database. “International Journal of Grid and Distributed

Computing”; “Astrophysical Journal” were published major chunk of the research literature among the journals. It is also found that the Astrophysical Journal has got highest TGCS (80) with 10 publications and followed by other journals.

Table-5: Journal wise distribution of Publications

S. No.	Journal	Records	TGCS
1.	International Journal of Grid and Distributed Computing	21	1
2.	Astrophysical Journal	10	80
3.	Monthly Notices of The Royal Astronomical Society	8	65
4.	International Journal of Computer Science and Network Security	7	0
5.	Journal of Geophysical Research-Atmospheres	7	25
6.	Journal of Supercomputing	7	16
7.	Cybernetics and Information Technologies	6	2
8.	International Journal of Remote Sensing	6	17
9.	Atmospheric Environment	5	75
10.	Future Generation Computer Systems-The International Journal of Grid Computing and E-science	5	61

Country wise Distribution

Table 6 indicates that 36 countries were contributed 9474 records in the field of cloud computing, among those 3344 (35.29 %) articles contributed in

collaboration with United States of America, followed by China 1618 (17.08%), France 755 (7.99%) and Germany with 738 (7.99%). India ranks in 12th place.

Table-6: Country wise distribution of Publications

S. No.	Countries/Territories	Records	% of 9474
1.	USA	3344	35.29
2.	Peoples R China	1618	17.08
3.	France	755	7.99
4.	Germany	738	7.79
5.	England	664	7.09
6.	Italy	541	5.71
7.	Canada	511	5.39
8.	Australia	505	5.33
9.	Spain	478	5.04
10.	South Korea	397	4.19

S. No.	Countries/Territories	Records	% of 9474
11.	Taiwan	384	4.05
12.	India	332	3.50
13.	Japan	287	3.03
14.	Netherlands	208	2.19
15.	Brazil	166	1.75
16.	Switzerland	165	1.74
17.	Greece	148	1.56
18.	Austria	121	1.27
19.	Russia	117	1.23
20.	Singapore	113	1.19

Ranking of Authors

Authors are ranked by number of publications and find the most published authors in the field of cloud computing (Table 7). Thus the most-published ones are distinguished from the most-cited authors. The individual citation frequencies for these papers are totaled. Calculation of h-index is based on a list of publications ranked in descending order by the Times

Cited. The value of h is equal to the number of papers (N) in the list that have N or more citations. Among 832 authors, Chakrabarti SK. has highest number of publications with 13 records, with 106 citation and received 5 h-index & ranked first based on number of publications and followed by Chana I and so on. But author Das A has only 8 records with highest of 132 citations & h-index 6 ranks first.

Table-7: Author wise distribution of Publications

S. No.	Author	Author Affiliation		Records	TGCS	h-index
1.	Chakrabarti SK	Maharaja Manindra Chandra College	Kolkata	13	106	5
2.	Chana I	Thapar University, Dept Comp Science & Engg	Patiala, Punjab	10	28	3
3.	Das A	Indian Centre Space Physics	Kolkata	8	132	6
4.	Rakshit A K	Maharaja Sayajirao University, Dept Chemistry	Baroda, Gujarat	6	97	5
5.	Sarddar D	University of Kalyani, Dept Comp Science & Engg	Kalyani, West Bengal	6	1	1
6.	Singh S	Shah Satnam Ji Special Hospital	Sirsa, Haryana	6	26	3
7.	Sood S K	Guru Nanak Dev University, Dept Comp Science & Engg	Gurdaspur, Punjab	6	18	2
8.	Kaur P D	Thapar University, Dept Comp Science & Engg	Patiala, Punjab	5	20	2
9.	Kumar N	Thapar University, Dept Comp Science & Engg	Patiala, Punjab	5	13	2
10.	Misra S	Indian Inst Technology, School of Information Tech.	Kharagpur, West Bengal	5	11	2

Findings and Conclusion

The findings of the year wise distribution of research output of Cloud Computing bring out the fact that the highest number of publication is 117 in 2015 followed by 43 papers in 2014 and 35 papers in 2016. The ranking of authors brings out the fact that “Das A” with highest of 132 citations for 8 papers with h-index 6 ranks first based on number of citations, h-index and followed by other scientist.

The finding of the source wise distribution of research output brings out the fact that the journal articles occupied the predominant place among the other sources of publications. Through country wise analysis USA ranks first in the field of cloud computing research. It is to conclude that publication is not a matter but the citation scores & h-index is an important factor for an article. India has to improve the research in the field of cloud computing.

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