

Global Research Productivity in Cloud Computing: A Bibliometric Study

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***Abstract** - Science and Scientific research has been growing at faster rate in recent past, particularly the development of information and communication technology enabled the process as much as simple with minimal time span. The span of study period is 1996 to 2017 (21 years) and the records were downloaded from globally renowned indexed database Web of Science. The analysis has been made by using Histcite and VosViewer software and the records are downloaded in ISO format. The study finds, the Cloud Computing is an emerging area of Computer Science and after 1990s the subject recorded the scientific literature. The Buyya R of Australia is ranked as number one author globally with 3697 citations. The collaborative research has prominence than the individual research. It also found that, the productivity of the journal is based on the article used by citing the article. The cloud computing as a technology will beneficiary to the stakeholders with a limited demerits.*

Keywords: Bibliometrics, Scientometrics, Cloud Computing, Research Mapping, Citation Analysis

Introduction

As the information dissemination era is in transition stage, particularly in higher academic environment towards the analytical part of the knowledge. As a result of the information and knowledge analytics as been gaining momentum not only in corporate and business environment but also in higher academic and research institutions.

It is very much possible and eminent due to the developments in information storage in terms of volatile and dynamic databases integrated with excellent interface and query formulation systems, which paves not only the means for exploring and discovering the information and demand but also to push the knowledge inputs to palms of the user community in more anticipatory manner. The Mapping of the research output in terms of publication strength and analysis of scholarly communication pattern of the stake holder of the particular organization or of particular region indeed of great help to all the stake holders of the academic environment to identify the knowledge potentials and opportunities including human resource expertise existing in the local region.

Cloud computing is a boon for the networking technology to overcome the hindrances of technical capabilities of handling information or data. The cloud is paved way to overcome the problems of infrastructure, storage, servers and other technical capabilities of the handling the information. The paper overviews the concept of cloud computing, architecture, storage and models of cloud computing. The cloud computing is also boon for the libraries to manage

the data or information by using this technology. It also helps in maintaining the large online databases and content management systems. The cloud computing applied in the areas of libraries like Library automation, institutional repositories, web hosting, content management system, hosting databases, Knowledge Management etc.

Quantitative analysis is a main tool for scientific research, recording and communicating research results become complex and enormous through publications. The experience and personal knowledge are no longer sufficient tools to understand the trends in the field and to take decisions on purchase of information to the particular knowledge center. Yet there is need to select, to highlight significant areas of research and to manage the funding patterns in science research. The universities, higher academic councils, labs and government institutions has to decide the area of research should funded and the area of research should not funded and the real researchers should due recognition and support for the project undertaken.

The libraries are faced problems in collection development and making funding agencies to be satisfied. The national research needs must relay on expert analysis of scientific research performance. So Bibliometrics turns as a main tool for quantitative analysis, the quantitative data of publication and citations counts used in all most all countries to evaluative the scientific research. The universities, government laboratories and policy makers are used bibliometrics for research performance evaluation.

Review of Literature

The study of review of literature is an important aspect in any research through which one can understand the past trends in research output in any particular discipline. A review is significant step to get clear picture of what has been done and suggested already with regard to problem understanding.

Procedure for selecting and analyzing the candidate benchmark institutes to assess the position of a particular research institute and demonstrated the combination of mapping and citation analysis for evaluative bibliometric purposes (Noyons, E.C.M and Moed, H.F (1999). An attempt made to explore the scientific landscape on Taiwan through bibliometric citation analysis and mapping techniques the main actors at the university level are identified and the structure of the national research and development (R&D) system is described with respect to article production and publication patterns (Melin, Goran, Danell, Rickard and Persson, Olle (2000). Van Raan, Anthony F. J (2005) made an overview on measuring bibliometric methodology on science like measurement of research performance and mapping of scientific research based on the basic concepts.

Conducted a study on bibliometric analysis of library collections and it proved useful in analyzing the function of the library and to some extent on general context and they are not useful for creating cognitive maps for scientific fields (Astrom, Fredrik and Pettersson, Lennart (2006). Parvathamma, N. and Gobbur, Devendra S. (2007) made bibliometric analysis of 6444 publications related to Plastics, as indexed in Biological Abstracts on CD, during 1998- 2002 was undertaken. This shows that team research is prevalent in the area of Plastics. USA produces largest amount of literature related to Plastics and English is the most predominant language used for publishing the literature related to Plastics during the study period. Bibliometric maps have the potential to become useful tools for science policy issues. The complexity of the structures, however, makes it often very difficult to interpret the

results. The results revealed the increased utility of bibliometric mapping within the science policy context (Ed Noyons and Clara Calero-Medina (2009).

They examined the bibliometric and other innovation indicators, to find out the present state of development of nanotechnology research and innovation in India. These findings are discussed in the context of China's activity in this field Bhattacharya, Sujit and Shilpa (2011). Campos, Hector Montiel; Parellada, Francesc Sole and Palma, Yarissa (2012) used bibliometric techniques and cluster analyses to present an empirically grounded picture of the entrepreneurship research. The results presented here provide abundant opportunities for identifying insightful, influential, and creative research topics in the entrepreneurship field. The performance of publication covering annual outputs, mainstream journals, Web of Science categories, leading countries, institutions, research tendencies and hotspots. The results indicated that annual output of the related scientific articles increased steadily. Water Research, Environmental Science and Technology, and Journal American Water Works Association were the three most common journals in drinking water research. The USA took a leading position out of 168 countries/territories, followed by Japan and Germany (Fu, Hui-Zhen; Wang, Ming-Huang and Ho, Yuh-Shan (2013). Kolle, Shankar Reddy and et al (2015) had made bibliometric analysis of published works in the IJPM published during the period between 2005 and 2014 was conducted. The data was collected from the Web of Science. Found a global trend in increased research on pest management. Muralidhara K; Srinivasa Ragavan S and Venkatarama Reddy C S (2016) analysed the contribution (27394 papers) by the faculties of the universities of the Karnataka covered in Web of Science during last 15 years (2000-2015). Yathirajan H S tops in the first rank by producing 515 records. Journals are the main document for refereeing and to bring up research in the form of records. The bibliometric studies reveal the focused areas of the research of interest among the faculties of the universities of the Karnataka.

Objectives of the study

1. To identify and analyse the rate of growth of scientific literature published in journals
2. To map the proliferation of research output in various subject categories by the researchers
3. To reveal the research collaboration of the faculty publication in global level
4. To find out the growth of research productivity of faculties of global during 1996 – 2017.

Methodology

The research papers abstracted and indexed in Web of Science database were taken as the primary source for the present study to identify the research performance of the Cloud Computing Subject in global level. The source of the study is Web of Science™, the researcher used the Keywords for the search and download records in ISO format and the search terms used are include the “Cloud”, “Computing” and “Cloud Computing”, and individual years starting from 1996 to 2017. Data items are collected for each of records included author(s), title, locus information, cited references, document type like article, proceedings paper, Note, meeting abstracts, reviews, letters, editorial material, news item, item about an individual and biographical item-all indexing term used in the source database for categorizing the published materials, language, institution and year of publication.

Data was collected from Web of Science™ (WOS) for the period 1996-2017 and 2462 records in ISO format received from these publications were transferred to Histcite and

Vosviewer tabulated with MS-Excel and analysed the data as per objectives of the study. The bibliographic fields were analysed by normal count procedure for countries, domains, authorships and journals.

Results and Findings

Table 1: Yearly output of global research on cloud computing

| Sl. No. | Year | Records | Percentage | TLCS | TGCS |
|--------------|------|-------------|------------|-------------|--------------|
| 1 | 1996 | 3 | 0.1 | 3 | 339 |
| 2 | 1997 | 1 | 0 | 0 | 3 |
| 3 | 1999 | 1 | 0 | 0 | 45 |
| 4 | 2002 | 1 | 0 | 0 | 4 |
| 5 | 2003 | 1 | 0 | 0 | 165 |
| 6 | 2004 | 1 | 0 | 0 | 2 |
| 7 | 2005 | 1 | 0 | 0 | 1 |
| 8 | 2006 | 4 | 0.2 | 3 | 120 |
| 9 | 2007 | 1 | 0 | 1 | 5 |
| 10 | 2008 | 6 | 0.2 | 44 | 362 |
| 11 | 2009 | 38 | 1.5 | 353 | 9056 |
| 12 | 2010 | 86 | 3.5 | 711 | 5506 |
| 13 | 2011 | 140 | 5.7 | 746 | 5257 |
| 14 | 2012 | 191 | 7.8 | 573 | 4129 |
| 15 | 2013 | 322 | 13.1 | 753 | 5035 |
| 16 | 2014 | 320 | 13 | 473 | 2972 |
| 17 | 2015 | 509 | 20.7 | 338 | 2385 |
| 18 | 2016 | 583 | 23.7 | 97 | 704 |
| 19 | 2017 | 253 | 10.5 | 12 | 54 |
| Total | | 2462 | 100 | 4107 | 36144 |

The full records are downloaded from Web of Science (WoS) in ISO format and analysed through Histcite software. The total 2462 records are found on Cloud Computing for the span of 1996 – 2017 (21 Years). The records having 4107 Local Citation Score (LCS), 36144 Global Citation Score (GCS) and 72644 records are Cited References (CR). There is a good citation score in global level and cited references.

The table 1 shows that the yearly output of scholarly literature on cloud computing. In the year 2016 has produced highest number of records (583) with 704 Total Global Citation Score (TGCS). In 2015, 509 records are produced with 2385 TGCS and in 2013, 322 records are produced with highest TGCS 5035.

There is healthy trend in publication of records from 2009 to 2016 but it is fall down in the year 2017. It is very interesting to note that, in the year 2009 produced only 38 records but there is a large number of TGCS (9056 Records) has been noticed and even in the year 2010 produced only 86 but 5506 TGCS are recorded. This shows that, the scientific literature on cloud computing was emerging in the year 2009 and 2010 with very few records. But after 2011 there is increase in cloud computing research and good number of records are produced.

And also 24 authors are produced collaborative article on “McIntosh-Smith, Dr Tchertanov, Dr Nerukh, Stone, Dr Baaden, et al. Computing power revolution and new algorithms: GP-GPUs, clouds and more: general discussion, Faraday Discussions. 2014; 169: 379-401”

H-Index

Buyya R is in 1st rank produced 44 records with 3697 TGCS and his h-index is 17 with 39.39 CR and Gani A is in 3rd rank, produced 25 records with 689 TGCS and his h-index is 13 with 63.80 CR. Rest of the authors of top 10 list, their h-index is below 10 and Li J secured 2nd rank and his h-index is 9 with 30.16 CR.

Productivity of the Journals

The journals are ranked according to the highest number of articles are published in that particular journal in bibliometrics but the productivity of the journals is based on the article used or cited by the number of authors based the quality of the journal and the article. In the area of cloud computing according to the internationally renowned indexed database the Web of Science, International Journal of Grid and Distributed Computing has published 98 records with 22 global citations but the journal “Communications of the ACM” has ranked in 45 place and published only 11 high quality articles and has recorded 2859 global citations and the journal “Future Generation Computer Systems-The International Journal of Grid Computing and Escience” has ranked 5th place and published 41 records with 2844 global citations. The study shows that, the quality articles will have a high impact on the researcher and also the productivity and usage of article will increases.

Conclusion

Measuring the performance of research output of academics and researchers in a particular region enabled the policy makers and organizations to have valuable inputs towards designing and updating the science, technology and research policy in order to regulate funding provisions and to identify the grey areas where the support and encouragement is needed along with sensitization of stakeholders. There is a healthy trend in research output in the area of Cloud Computing and it has been doubled in a period of ten years confirming the statement of Derek de Solla Price. In the year 2016 has recorded highest number of records (583) with 704 global citations. The scientific literature on cloud computing was emerged in the year 2009 and 2010 with very few records and after 2011 there is momentum in cloud computing research and good number of records have been recorded. The author Buyya R of Australia has contributed the highest number of articles (44) on cloud computing globally. The collaborative research has more prominence than individual research. It is interesting to note that, 42 and 24 authors are produced one record each in collaboration with the authors.

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