

Role of Big data in HealthCare and Internet of Things: A Detailed Bibliometric Survey

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Survey paper

Keywords: Internet of Things, HealthCare, Big data, Bibliography, VOS Viewer, Co- occurrence, Co- Citation

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Role of Big data in HealthCare and Internet of Things: A Detailed Bibliometric Survey

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ABSTRACT

This paper makes the Bibliographic study of the Big Data involvement in Healthcare and Internet of things. Research contribution towards this area has started from the year 2013 as per the fundamental keywords chosen in this survey. Thus makes the thrust discipline and emerging technology of research, also a trendy domain based on its recognized inception. Upon consideration of the selected keywords there was no work up to 2012 and all together 425 papers are obtained from 2013 onwards through Scopus website. Among these major contribution was in Computer Science Subject area with 308 in number and maximum articles were published in English Language with 421 and highest number of papers contributed were 128 by India. This study uses versatile Bibliometric analysis databases and methods resulting in Statistical and Network Analysis in terms of Authors, Organizations, Citations, Co- Citations etc.

KEYWORDS: Internet of Things, HealthCare, Big data, Bibliography, VOS Viewer, Co-occurrence, Co- Citation.

I. INTRODUCTION

Internet of Things is better defined establishing Pervasive Communication between Physical World and Virtual World. This enables identity of advanced Information and Communication Technology with four different Personalized –P Healthcare factors (Schreier et al., 2014). Research growth is more in Internet of Things from the last ten years under various categories of application, advancements, design, monitoring, and analytics as futuristic research (Azana Hafizah Mohd Aman et al., 2020). Billions of devices are connected to internet and it is increasing day by day, in turn the integrity, storage, security, internal operations are the prime concern. These economical and physiological (Felix Uribe et al., 2018) kind of social impact is the base for identification and classification of various Internet of Things devices. Further the above mentioned factors are evidently addressed. Large scale of Sensors plays prominent role in connecting devices to each other creating smart environments an up hand over Ubiquitous Sensing capabilities which makes Internet of Things a revolutionary technology (Deepthi Sehrawat et al., 2019). An IoT state of art applications and smart sensing has created solutions for many real time problems in large-medium- low levels (Cleber M. de Moraes et al., 2019) It is obvious with support of other concerned enabling technologies. Due to its stupendous growth in both Academia and Industry a great transformation has been made from IoT to IIoT meeting requirements in veracity of Business applications , Service applications, Enterprise applications and so on (Avis Karmakar et al., 2019). Understanding the current scenario and predicting the future need, more research is needed in Healthcare 4.0 in coupling with data gathering, enriching, storage and access, analysis and monitoring, predicting and learning etc. Massive amounts of

data- termed as 'Big Data' can do wonders. Especially in Healthcare multiple versions and types of data viz. patient records, health records, hospital records, nutrition data and significant portions of public and private healthcare is generated and it should be effectively handled by Big data tools (Sabyasachi-Dash et al., 2019).Big data analytics will help in improving the personalized care of patients by employing different methods of data analysis to get rid of un necessary medical spending (Lidong Wang et al.,2019).

II. SURVEY OF INTERNET OF THINGS – HEALTHCARE – BIG DATA

Healthcare is the prominent way of diagnosing, maintaining, managing and organizing the health data of a human with various Healthcare systems. Historical evolution of Healthcare 1.0 to 4.0 ensures smart connectivity (Jingshan Li et al., 2021) under different Qualitative and Quantitative approaches. Ability to use the health devices and patients towards doctors and making health analysis in a needy manner. Industry 4.0 started its transformation from manufacturing industry to all corners of technological changes with respect to the support of IoT, and Big Data Analytics for analysis and remote data storage with Cloud Computing and also allowing Fog Computing (Giuseppe Aceto et al., 2020). Digitization of Healthcare as a key valued embracer to give more care – (IoMT): the future generation medical care in hospitals and healthcare centre (siemens-healthineers) allows to consolidate the patient data, in turn enables better diagnosis in giving extreme results. Healthcare is undergoing a great technical change hand in hand with Big data that is raising some opaque result and interpretation issues will be solved by certain Machine Learning models (Yoo H.a et al., 2021).A new research with Collective Social Intelligence (CSI) creating new product development with effective capability for enabling technologies, online social networks and Collaborative Analysis in Healthcare Systems (Jones J et al., 2020). In the current pandemic COVID -19 scenario the short comings of Healthcare were clearly outraged and can be predicated with advancement in Internet of Things wearable technology by suggesting effective healthcare solutions using smart and connected world. (Li W et al., 2021). In countries like Saudi Arabia, promotional events were organized to propitiate the wide scale adoption of IoT and a Framework is proposed with four modules (Qaffas.A.A et al., 2021).

On the other hand Industry 4.0 enables the communication and enabling technologies with different paradigms in relation to Healthcare 4.0 (Aceto G at al., 2020). A research says the Gynaecology departments are being supported with disruptive innovations of medical era with data collected from wet- labs and transformed as molecular big data, clinical big data, computational big data, digital big data, and physiological big data; in turn handling with proprietary methods for improving the reproductive female health (Khamisy Farah.R et al., 2021). Some studies propose an architectural framework for giving more value to the field of e-health in assisting powerful challenges like continuous monitoring, smart decisions, data processing (Babar.M et al., 2018). Adopting different branches of philosophy, inspiring and involving in versatile technological changes, taking part in advancements of era is the best quality of habituating to research work. Similarly a branch of philosophy studying the being, existence, becoming; shed a ray on internet of things and Healthcare. Ontology based understanding of specific risks like security and privacy on Healthcare information systems have been studied (Abhinaya et al., 2015). Even Big data supports as an analysis method for risks and precautionary measures and a use case driven approach for certain vaccination process to predict the further benefits in Healthcare domain (Liyanage H.et al., 2014).

At every stage the sensors are vital in detecting the data and gathering the data, it is very peculiar and sensitive in healthcare sector. Massive streams of data is being generated from health sensors and the challenges faced in perspective of user identities in analysing bith big data technologies is sports related applications (Cortes. R. et al., 2015). As it is expected that billions of devices connected to Internet are it is rapidly growing for every unit of time, distinguished Artificial Intelligence and Data mining Algorithms have been imposed to generate better accuracy in less time for Smart Healthcare Systems (Alam. F., 2016). Some countries are encouraging best practices to inculcate the understanding of health data generated in crisis situations that can understand the problems in health systems as part of the academic study itself instead of Industry involvements. In Brazilian Aeronautics Institute of Technology: a crisis approach for healthcare systems has been proposed that use an agile testing methos to validate and verify the health data. (da Silva.D.A., 2018).

III. METHODOLOGY

Amongst many databases across the globe for Research Articles, Manuscripts, Research Papers, Short Surveys, Literature Surveys; Scopus is the most populated database in giving search results in a better and multifaceted way. Multiple keywords can be used for searching the papers in view with Organizations, periodical intervals of time along with the usage of Fundamental keywords, Primary Keywords, Secondary Keywords and so on based on narrowing down the search output. In this work the narrowed result for search is 425 artciles based on the chosen fundamental and primary search keys.

Table 1: List of Search Keys

Search Key 1	Internet of Things
Search Key 2 using (AND)	“Health Care” AND “big data”

The query proposed by Scopus for obtaining the articles is:

((TITLE-ABS-KEY("Internet of Things") AND TITLE-ABS-KEY(("Health Care" and "big data"))))

Even though the above query infers the starting publication year is 2013, there is no research article pumped to Scopus database before this year as per the mentioned keywords.

IV. INITIAL SEARCH OUTCOMES

During the initial search the articles have been resulted under various type of Documents Access which are retrieved in different categories. Open Access type, Gold Access type, Green Access type etc. Amongst all, majority are available in Open Access document type with 108 articles.

A. ASSESSMENT BASED ON DOCUMENT ACCESS TYPE

Table 2: Category of Open Access Documents

Document Type	Access	No .of Documents
All Open Access		108

Gold	51
Hybrid Gold	7
Bronze	22
Green	60

Credits: www.scopus.com (Retrieved on 03-06-2021)

B. ASSESSMENT BASED ON SOURCE TYPE

Multiple Sources of publication have been assessed based on the fundamental and primary search keys in the Scopus database, maximum number of articles among 425 have been published in 182 different Journals and in the next level 160 Conference proceedings were observed.

Table 3: Category of Various Source Types

Source Type	No. of Sources
Journal	182
Conference Proceeding	160
Book Series	64
Book	17
Trade Journal	2

Credits: www.scopus.com (as on 03-06-2021)

C. ASSESSMENT BASED ON LANGUAGE TRENDS

On the Scopus database, multiple keywords are used for the searching in view of the work proposed in the paper. Various papers were traced in different languages. Language is one of the parameter for analysis. Observations are that English language with good number 419, followed by Chinese with 4.

Table 4: Language Versions in Publications

Language of Publication	No. of Publications
English	419
Chinese	4
French	1
German	1

Credits: www.scopus.com (as on 03-06-2021)

D. ASSESSMENT BASED ON KEYWORDS

Besides the Fundamental keywords, a variety of keywords will be shown as the outcome form the assessments obtained. Among all “Internet Of Things” a proper way of using and writing the word is in the top priority 331 followed by “Big Data” with 328. Also the fundamental key word used as a part of the query is adopted in different ways in many research articles; like the way shown in the below table with Sl.No: 1,4,8,9,18.

Table 5: Keyword Occurrence in Publications (Top 15)

Sl.No	Keyword	Occurrence
1	Internet Of Things	331
2	Big Data	328
3	Health Care	243
4	Internet Of Things (IOT)	98
5	Healthcare	86
6	Cloud Computing	81
7	Artificial Intelligence	67
8	IoT	64
9	Internet Of Thing (IOT)	55
10	Data Analytics	53
11	Human	51
12	Data Handling	50
13	Machine Learning	49
14	Health-care System	48
15	Data Mining	44

Credits: www.scopus.com (as on 03-06-2021)

V. ASSESSMENT PROCEDURE

To start with analysing the articles, Scopus database provides the best way of considering the search on fundamental keywords along with any additional keywords if necessary in accordance with logical operators like AND/OR. The search outcomes are generated under Years of publication, Authors contribution, Document type, Organization, Funding Sponsor etc. This is one way of analysis process termed as Statistical Analysis.

Another way is a Network Analysis of databases, performed using VOSviewer 1.6.16 very effectively. It has various assessment options in making relationships and allows to generate maps.

VI. RESULTS AND FINDINGS

Major findings obtained in statistical Analysis via Scopus Database and Network Analysis is obtained in VOS viewer 1.6.16.

A. STATISTICAL ANALYSIS

A.1. Document Analysis by Year

Scopus Database generates analysis for various parameters among which the documents are generated from years 2013 to 2021. In this analysis 118 documents are highest position in the year 2019.

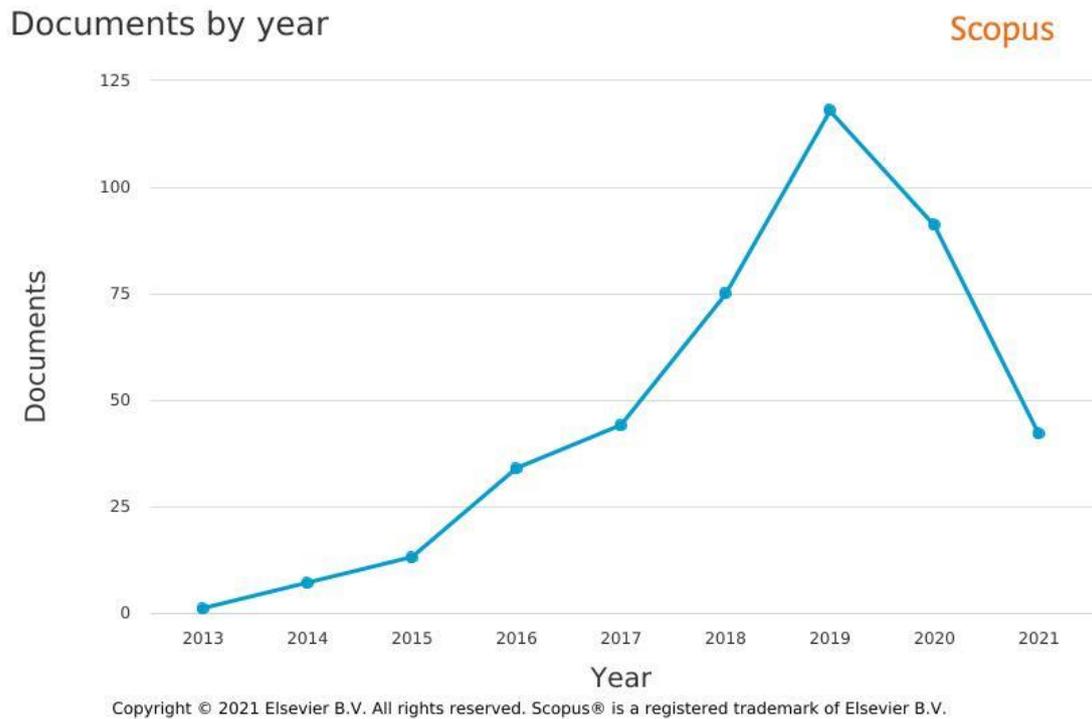


Figure 1: Documents Analysis by Year

Credits: www.scopus.com (as on 03-06-2021)

A.2. Documents Analysis by Author Name

Different Authors have contributed to the research in the area of Internet of Things with Big data and Healthcare. Scopus database generates the following graph showing authors contribution. It is also observed that three authors have more number of publications. Ahmed.M.U, Begum.S, Paul.A are the three authors with 5 publications.

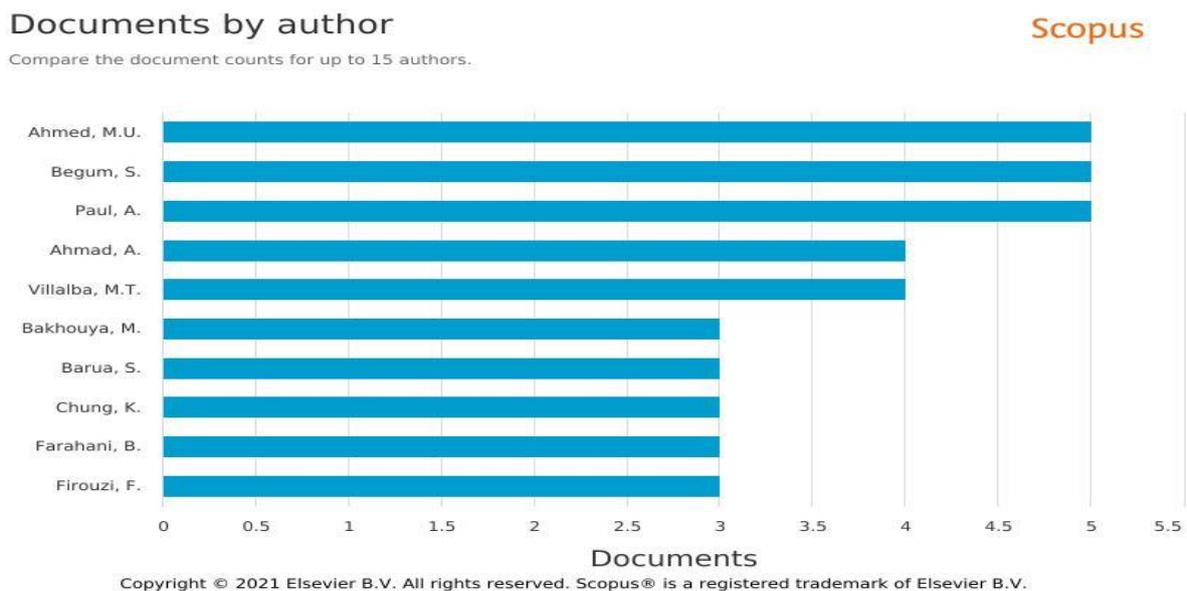


Figure 2: Documents Analysis by Authors

Credits: www.scopus.com (as on 03-06-2021)

A.3. Documents Analysis by Year

Different subject areas took part in handling research across the years. As the Scopus database search keywords are in to multidisciplinary and multi-dimensional subject areas, the following graph shows the major contribution is made from Computer Science area with 34.7%.

Documents by subject area

Scopus

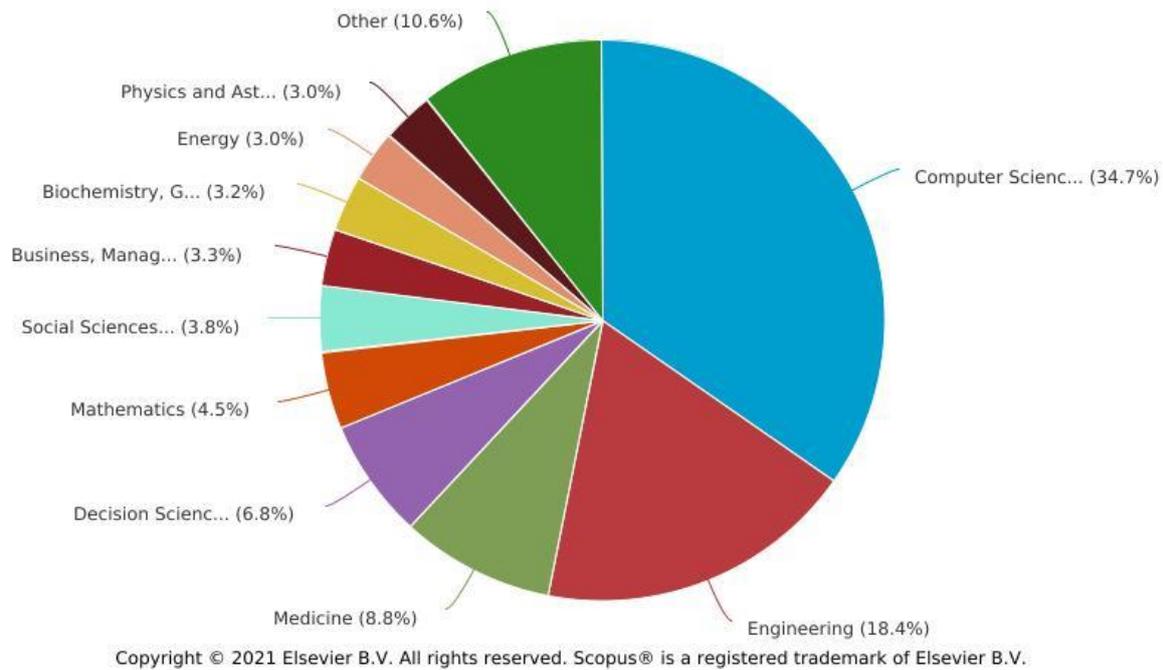


Figure 3: Documents Analysis by Subject Area

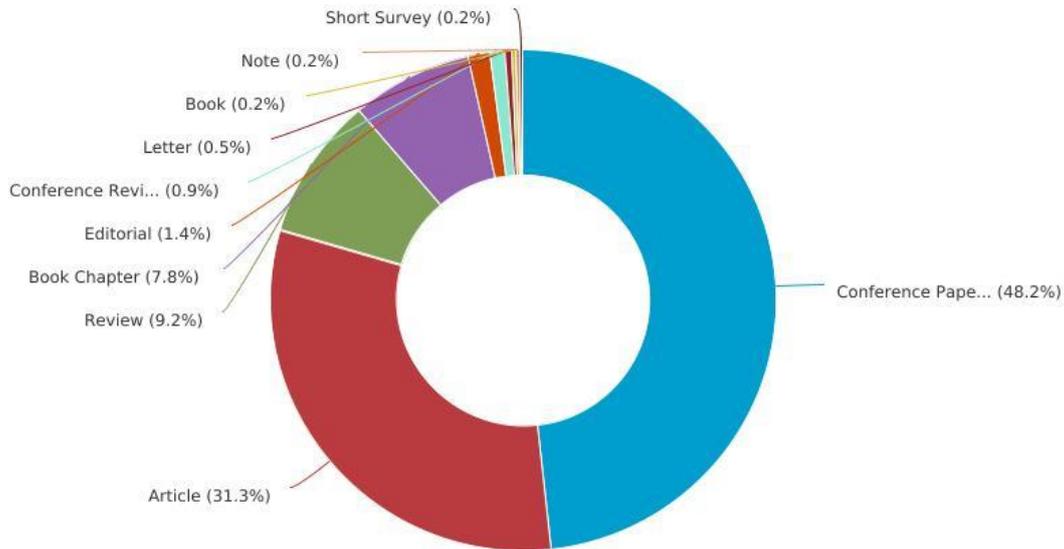
Credits: www.scopus.com (as on 03-06-2021)

A.4. Analysis by Document Type

Scopus database handles research work to be published and stored different kinds of documents like Books, Chapters, Conference Reviews, Short Surveys, Letters, and Articles etc. The diagram shown below depicts document type analysis with maximum 48.2% of Conference Proceedings.

Documents by type

Scopus



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Figure 4: Analysis by Documents Type

Credits: www.scopus.com (as on 03-06-2021)

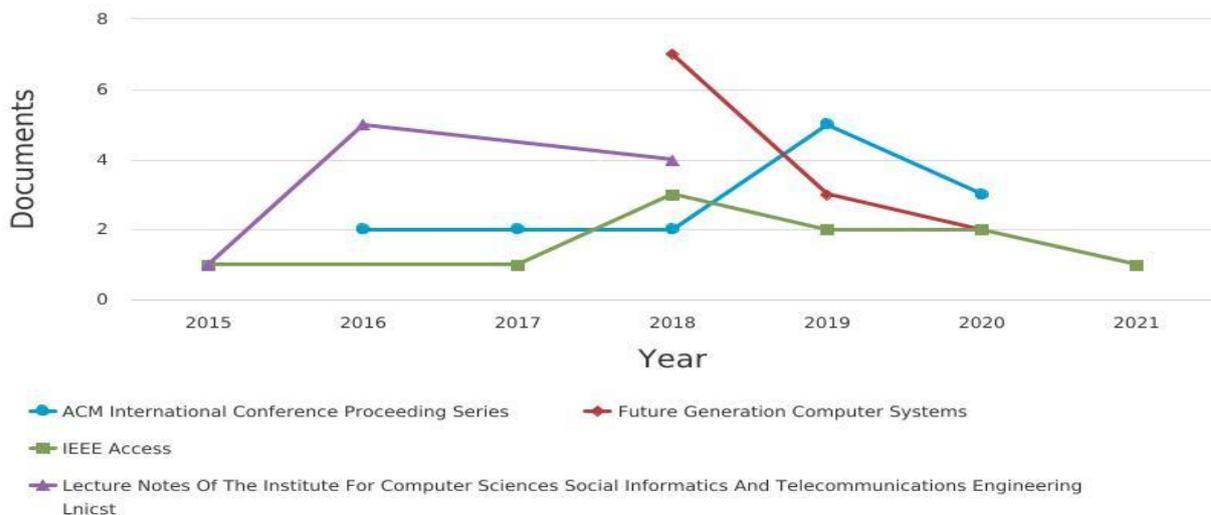
A.5. Document Analysis by Source Title

Scopus Database handles various Publication sources under different constraints. The following graph shows publications in comparison to 10 count in different Source Titles.

Documents per year by source

Scopus

Compare the document counts for up to 10 sources. Compare sources and view CiteScore, SJR, and SNIP data



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Figure 5: Documents Analysis by Source Titles

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A.6. Document Analysis by Affiliation

Across the globe research work on these lines have been contributed from Universities, Research Centres, Engineering Schools, and R& D Institutes etc. The following graph shows the analysis of documents up to 15 affiliations made by Scopus database with Vellore Institute of Technology in the top position with 9 documents.

Documents by affiliation

Scopus

Compare the document counts for up to 15 affiliations.

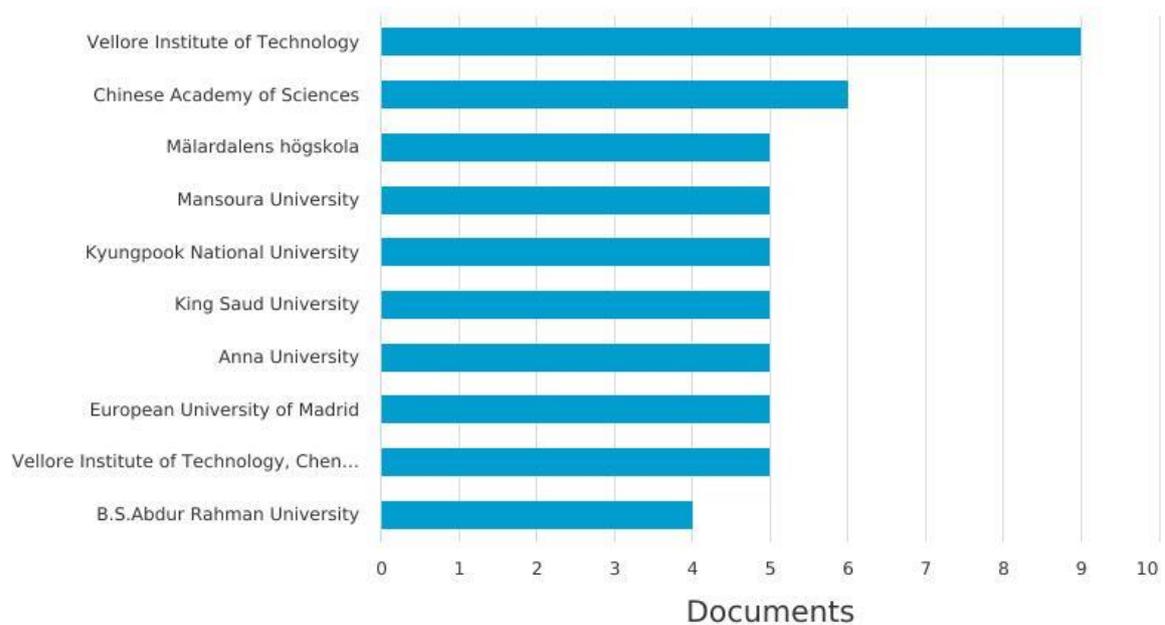


Figure 6: Documents Analysis by Affiliation

Credits: www.scopus.com (as on 03-06-2021)

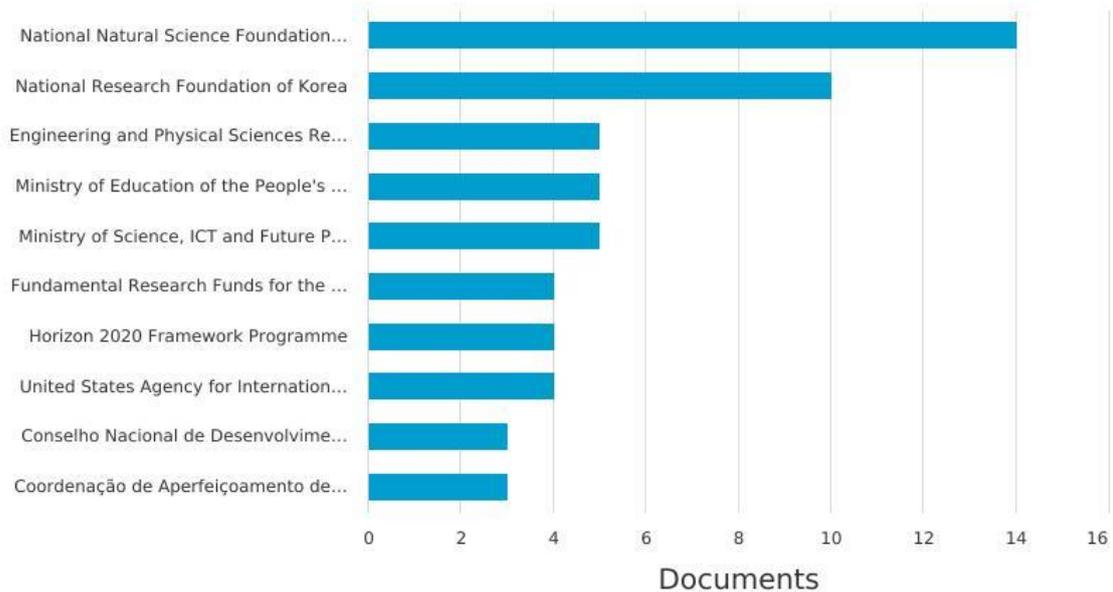
A.7. Document Analysis by Funding Sponsor

Analysing the documents based on Funding Sponsor is best parameter provided by Scopus database. Below is the graph obtained for documents published under Scopus that are sponsored by various Funding Agencies/ Institutes. Top 10 funding sponsors are obtained as shown in the graph below and National Natural Science Foundation of China has given Fund support for producing 14 documents as top of the list.

Documents by funding sponsor

Scopus

Compare the document counts for up to 15 funding sponsors.



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Figure 7: Documents Analysis by Funding Sponsor

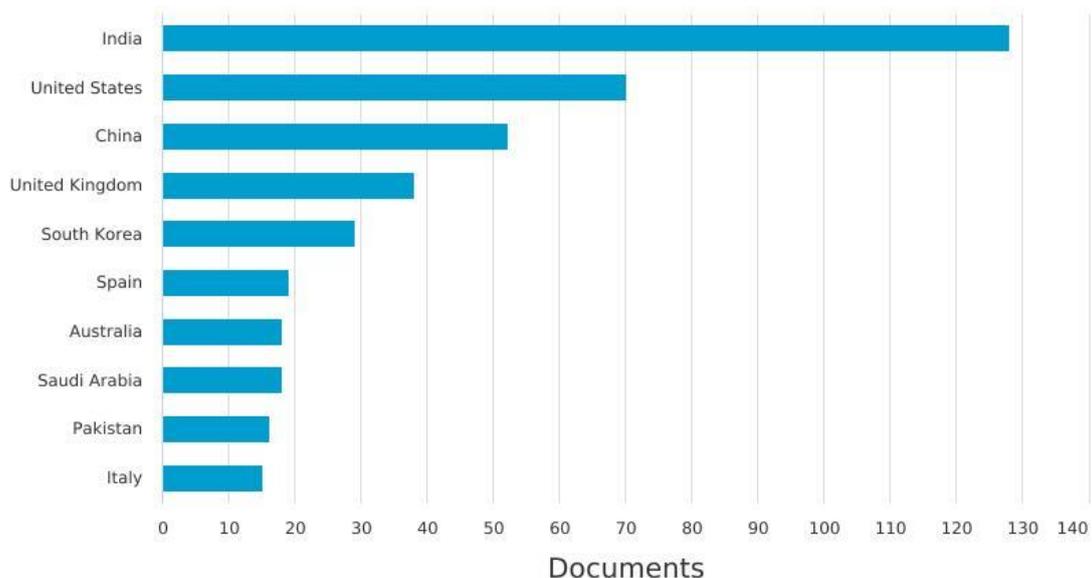
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A.8. Document Analysis by Country/Territory

Documents by country or territory

Scopus

Compare the document counts for up to 15 countries/territories.



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Figure 8: Documents Analysis by Country/ Territory

Credits: www.scopus.com (as on 03-06-2021)

The above graph shows the documents obtained based on Country/Territory and it is observed that India occupied the first position with 128 documents followed by United States (70) and then China with 52. Analysis is shown for top 10 countries only.

B. NETWORK ANALYSIS

B.1. VOS Co-authorship Analysis

B.1.1. Co-authorship to Authors Analysis

Network analysis is made with VOS viewer 1.6.16. This analysis is made under Unit of analysis of Authors, Organizations and Countries.

For Co-authorship with of authors the documents for maximum number of 20 authors are ignored, threshold parameters set atleast number of documents of an authoris 2, least number of citations of an author is 3. It is observed that a total of 121 authors have been obtained meeting the threshold among 1380authors.

Author named Paul.A has maximum number of documents equal to 5 and author namely Farahani.B has maximum number of Citations equal to 424.

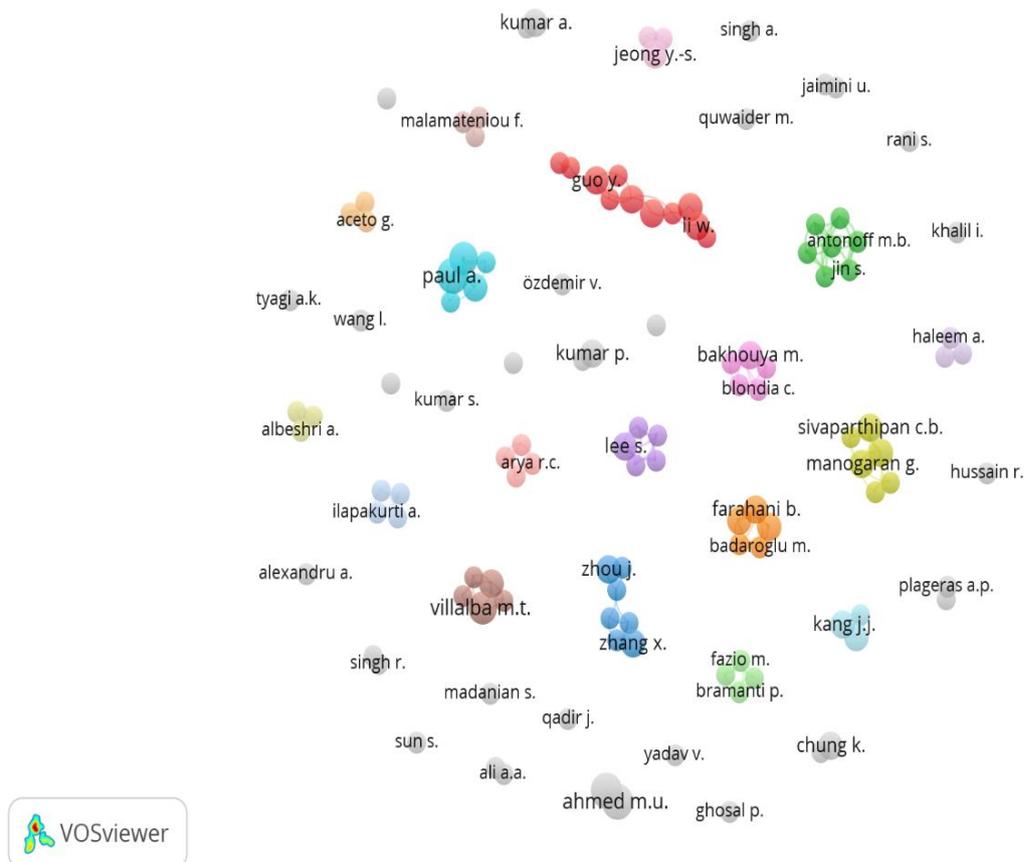


Figure 9: Network Analysis of Co-authorship under Authors

B.1.2. Co- authorship to Organizations Analysis

Here the analysis method is Co-authorship to organizations under full counting by ignoring more number of authors per organization (20). Threshold levels are set as least number of documents per organization is 2 and least number of citations for organization is zero.

20 organizations meet the threshold with School of Computer Science and Engineering- Kyungpook National University having 4 documents and Sri Ramanujar Engineering College- Chennai having 266 citations.

Waning: Organizations may not have a consistent name.

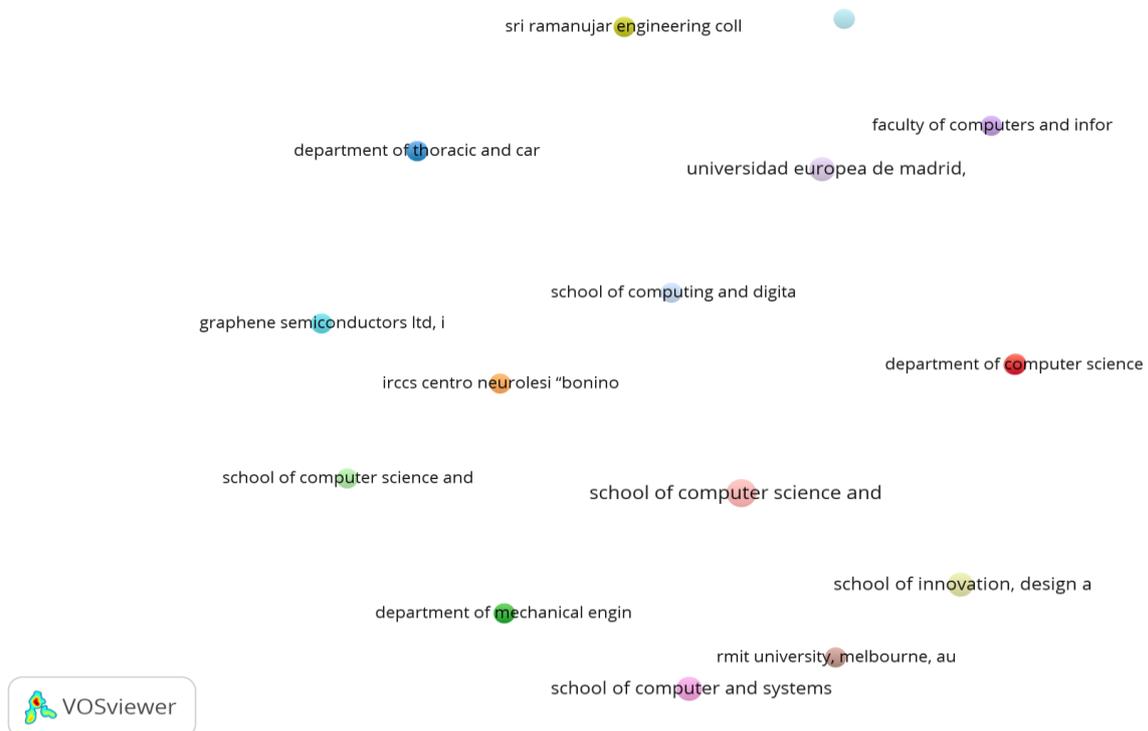


Figure 10: Network Analysis of Co-authorship under Organizations

B.1.3. Co-authorship to Countries Analysis

With a constraint of ignoring maximum number of countries per document is 25, considering threshold is 5, zero; of 75 countries 30 meet the threshold. The analysis says the India has more co authorship documents with 128 in number and United States has 2578 citations.

B.2.2. Co-occurrence to Author Keyword Analysis

To perform this analysis the least number of occurrences of a keyword is 3. Out of 1130 keywords 92 meet the threshold parameters and maximum number of occurrences is 158 and the key word is “big data”.

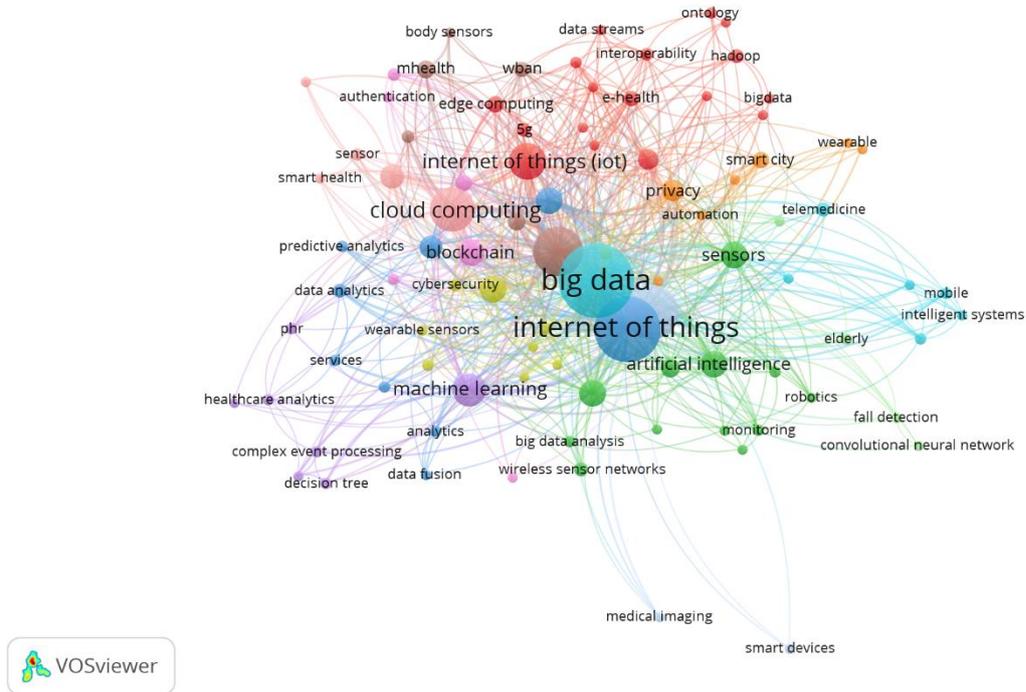


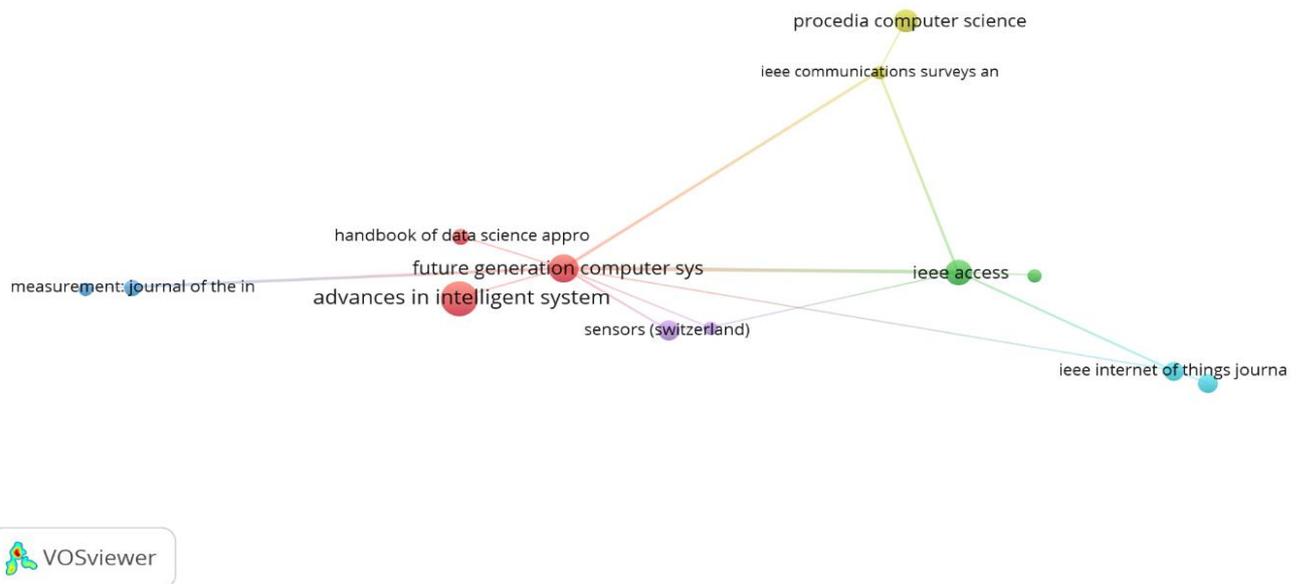
Figure 13: Network Analysis of Co-occurrence under Author Keywords

B.2.3. Co-occurrence to Index Keywords Analysis

For this analysis the threshold value is mentioned like minimal number of occurrences of a keyword is 3, of 2740 keywords 404 keywords match the threshold. Among all, “Internet of Things” is matching with 308 occurrences as co relation with Index Keywords.

B.3.2. Citation to Sources Analysis

Any threshold value can be mentioned under this analysis. In this work the least number of documents of a source is 3 and minimal citations of a sources is 2 under threshold, based on which 280 sources have been obtained out of which 23 meet the threshold parameters. Among the sources Advances in Intelligent Systems and Computing has 18 documents on the



top of list and IEEE Access with 1452 number of citations.

Figure 16: Network Analysis of Citation in terms of Sources

B.3.3. Citation to Authors Analysis

Here Type of Analysis is Citation under which Unit of Analysis is Authors, under no Counting method, Minimum number of documents is chosen 10. Number of documents per author is 2 and number of citations of an author is 5 under threshold values. Of 1327 authors 113 meet the threshold, out of which the author Paul.a has 5 documents with 90 citations and the author Farahani.b has 424 citations in 3 documents.

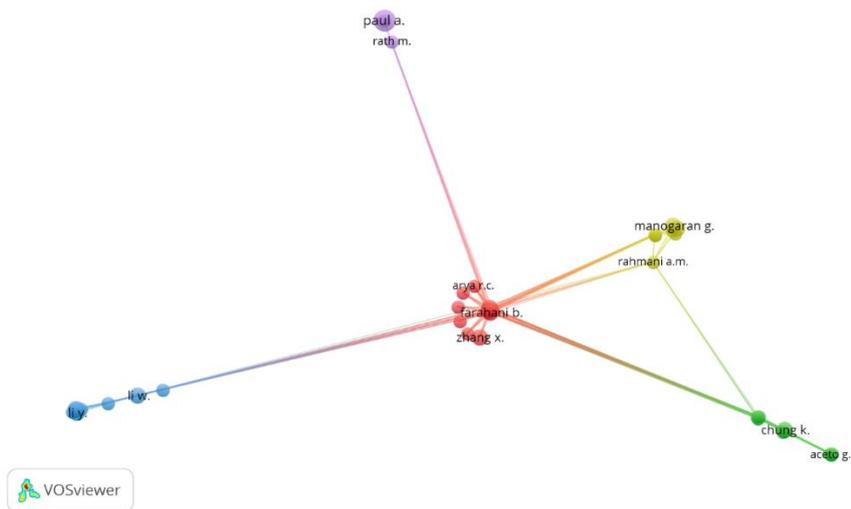


Figure 17: Analysis of Citation under Authors

B.3.4. Citation to Organizations Analysis

Type of analysis is citation and unit of analysis is Organization under no counting method. Ignoring the documents co-authored by large number of organizations with maximum number of organizations per document is 20 and the threshold parameters are set as minimum number of documents of an organization is 2, minimum number of citations of an organization is 1. Out of 951 organizations 19 meet the threshold, School of Computer Science and Engineering- Kyungpook National University having 4 documents and Sri Ramanujar Engineering College- Chennai having 266 citations.

Warning: Organizations may not have a consistent name.

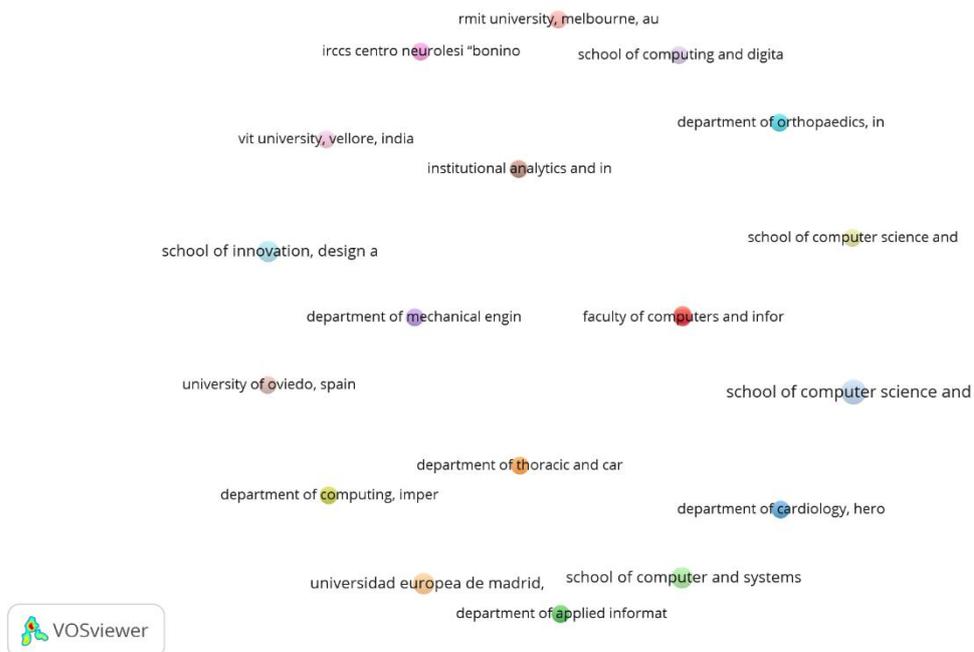


Figure 18: Citation under Organizations Network Analysis

B.3.5. Citation to Countries Analysis

By ignoring the co-authored documents by large number of countries, giving atmost number of countries per document is 20. Least number of documents of a country is 3 and least number of citations of a country is 3 is chosen under threshold. Of the 75 countries 41 meet the threshold having 128 documents for India and 2578 citations for United States.

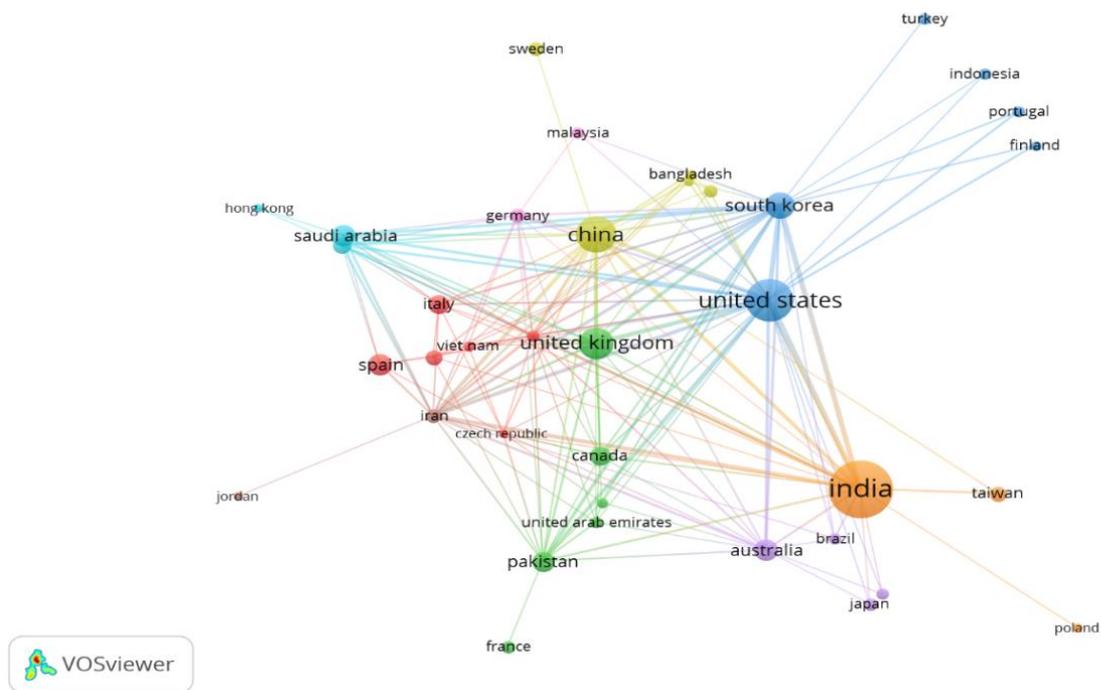


Figure 19: Network Analysis of Citation in terms of Countries

B.4. Bibliographic Coupling Analysis

B.4.1. Bibliographic Coupling to Documents Analysis

Full counting method is selected for Bibliographic Coupling type of analysis and Documents unit analysis with minimum number of citations of a document is given 3 for threshold parameter. 220 documents meet threshold out of 425 with aceto.g (2018) document for 72 citations and total strength link is 277.

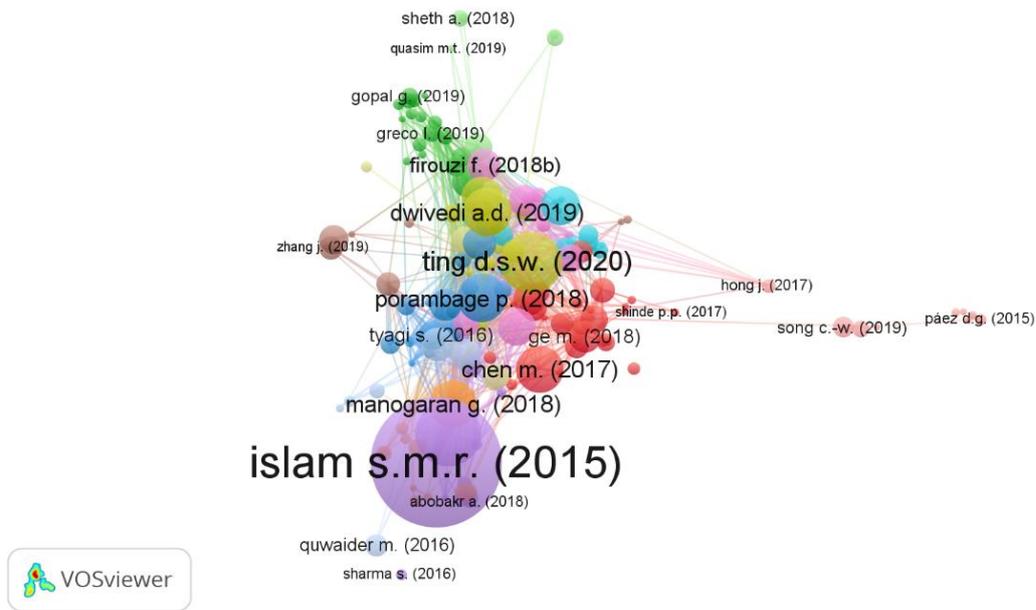


Figure 20: Bibliographic Coupling Network Analysis under Documents

B.4.2. Bibliographic Coupling to Sources Analysis

Considering least number of documents of a source is 3 and citations of a source is 0 as threshold; 25 meet threshold out of 280 sources.

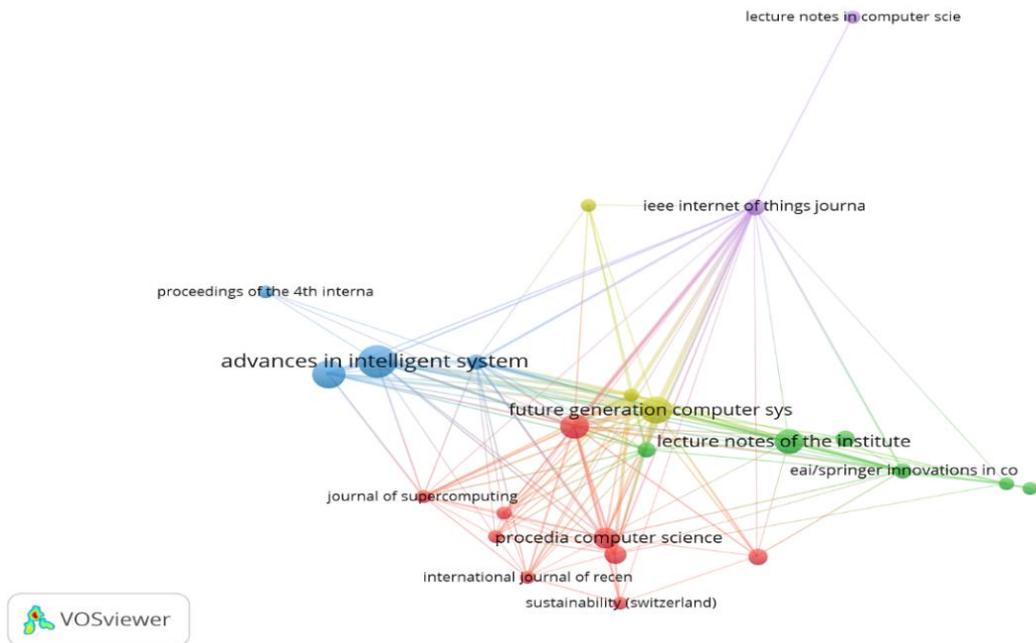


Figure 21: Bibliographic Coupling analysis under Sources

B.4.3. Bibliographic Coupling to Authors Analysis

Choosing full counting for Bibliographic coupling and Authors with ignoring documents having 25 maximum number of authors. Alongside threshold parameters are set as 2 for minimum number documents of an author and citations of an author is 2. Of 1380 authors 136 meet the threshold and the same is shown in the network diagram below.

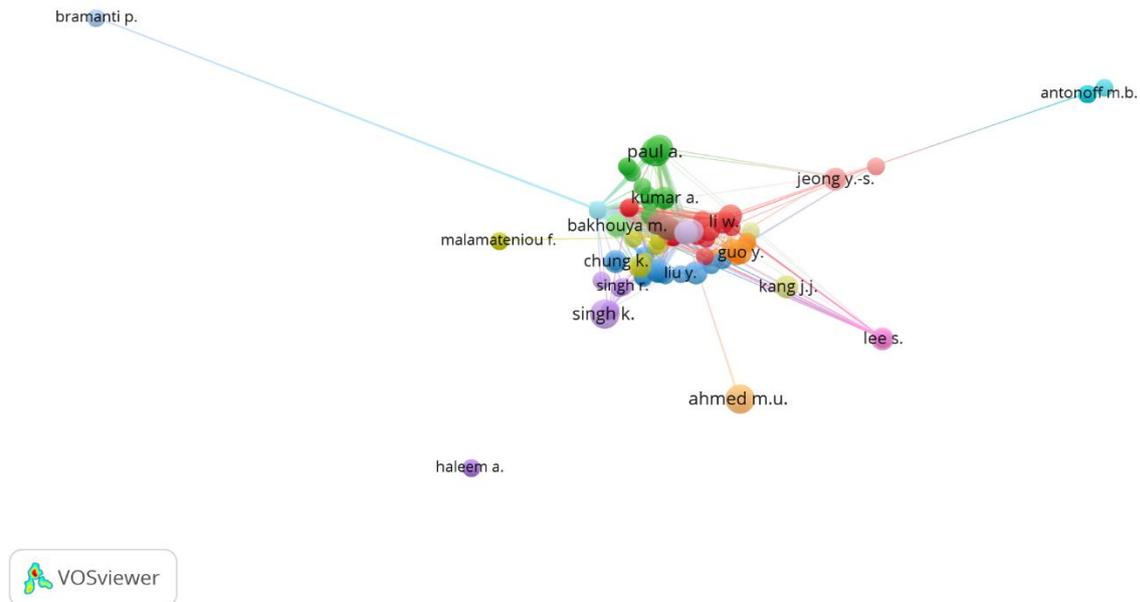


Figure 22: Bibliographic Coupling Analysis under Authors

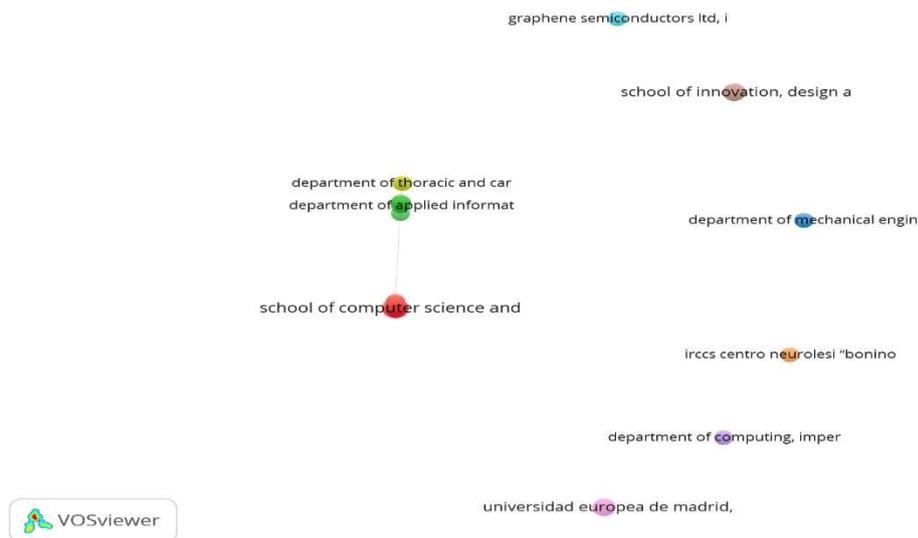


Figure 23: Bibliographic Coupling Analysis under Organizations

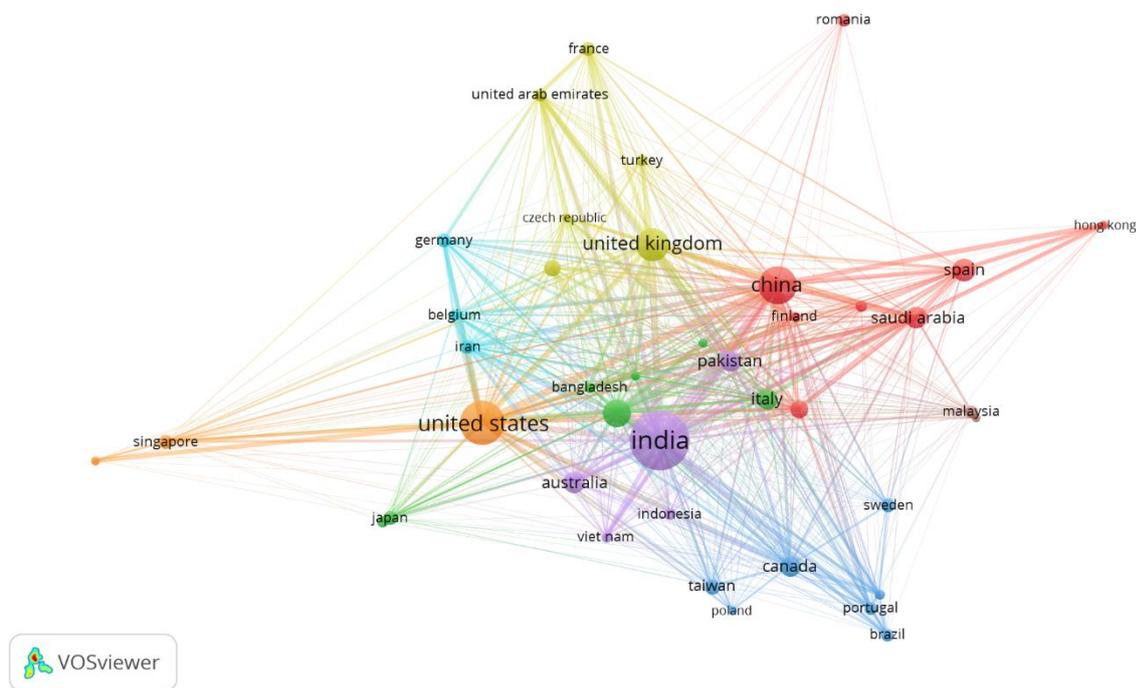


Figure 24: Bibliographic Coupling Network Analysis under Countries

VII. CONCLUSION

Internet of Things has become more popular in the technological environment now a days in addition to other enabling technologies like Big data, Cloud computing, Wireless Sensor Networks etc. The Industrial shift 1.0 to 4.0 has adhered to Internet of Things and showed its support in Healthcare/ Healthcare 4.0.

In this paper Bibliometric analysis of the role of big data in Health care and Internet of Things is carried out using AND logic operator. A total of 425 documents were obtained from Scopus database from 2013 to 2021 as on 3rd June 2021. Major observation is the work is not existed before 2013 as per the search out come given by Scopus database. It is observed that maximum articles were published in English language followed by Chinese. Research went more in Computer Science subject area across different countries and organizations with major publications in the year 2019. Statistical analysis of documents is made under different parameters like keywords, funding sponsor, organizations, year, source title, document type etc. using Scopus database.

On these same lines Network Analysis is made using VOSviewer 1.6.16, of course with the support of data generated by Scopus database. The analysis is performed under Type of analysis, Unit of analysis and counting method for Co-authorship, Co-occurrence, Citations, and Bibliographic coupling in terms of Authors, Organizations, Countries, Keywords, Author keywords, Index keywords and Sources. Analysis outcomes were clearly generated and showed in form of Network visualization graphs. It can be concluded that a good amount of work is expected in future as per the statistics.

DECLARATIONS

Ethics approval and consent to participate

Not Applicable

Consent for publication

Not Applicable

Availability of data and materials

All the data included in this article is generated from Scopus database and Vos Viewer, the same is used in this article.

Competing interests

Not Applicable

Funding

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Authors' contributions

All the authors have substantial contribution towards the work.

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