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Research productivity of newly established central universities in India

Miteshkumar Yashvadan Pandya[1], J P Singh Joorel[2] and Hiteshkumar Solanki[3]
[1]Scientist - C (LS), [2]Director, [3]Scientist - C (CS), Information and Library Network Centre, Infocity, Gandhinagar – 382007
E-mail: mitesh@inflibnet.ac.in, director@inflibnet.ac.in, hitesh@inflibnet.ac.in

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Analysis of data retrieved from Scopus database pertaining to 3927 articles published by 12 central universities established during 2010-2019 revealed that there is a considerable growth in scholarly publication during the period. The Central University of Rajasthan has contributed highest number of 765 articles among the 12 universities and the highest growth of publications is in chemistry.

Keywords: Research output; Central universities; Bibliometric analysis; Research productivity

Introduction

India is the second largest country in the world by population. After independence, India has improved its higher education sector by creating proper infrastructure for the universities and establishing specialized teaching and research institutions. As per the list released by the UGC (2020)[1] on 01.10.2020, there are 958 university that are offering higher education across the country. The National Education Policy, Ministry of Human Resource Development, Government of India (2020)[2]has given due emphasize to the higher education system by suggesting restructuring the entire higher education system into four verticals i.e., regulation, accreditation, funding, and academic standards. Currently, India is spending a considerable amount of its annual budget on higher education and research. However, compared to the other developed countries, the Indian higher education system is far behind.

The second and fourth verticals of the National Education Policy 2020 states that the accreditation and academic standards will be framed out for the higher education system. The accreditation and academic standards can be framed by regular and periodic assessment of the research publications of higher education institutions.

The Government of India, during the year 2009-10 has established 12 new central universities to provide higher education to the citizens residing in different corners of the country. Some state universities were also elevated as the central universities during this period. It is general understanding that the period of one decade is enough for any new education institution for setting up the administrative and research departments.

Scholarly communication is one of the mediums for communicating research output. Scholarly communication includes journal articles, artifacts, books, review articles, patents, etc. Performance of the research institutions should be evaluated at a regular interval to understand the pattern and progress of research work, research collaboration, citation pattern and its implications on the society. Research publications are one of the criteria for performance evaluation of the academic institutions. The present study attempts to measure the research productivity of the 12 newly established central universities.

Review of literature

Numerous surveys have been conducted by researchers in various subjects to measure research output of institutions - quantitative and qualitative. Many bibliometric analyses have also been undertaken for measuring individual research institutes. Bibliometric studies are generally conducted to find out the contribution of researchers in various institutions and subjects.

A bibliometric study was conducted to find out the academic impact of Chinese humanities and social science research using the CSSCI for the years 2000-2004[3]. The study identified scholarly research papers, institutions and regions having high productivity ratios in Chinese humanities & social science research in terms of number of researchers, papers and works, institutions and regions and suggested the influential research works.

Evaluation of research in terms of its effectiveness and reusability is an important aspect. To measure the performance of the universities in New Zealand, a bibliometric study examining the impact of Performance Based Research Fund on research productivity was conducted[4]. The study revealed that the number of research publications listed in the Web of Science by university researchers is significantly higher on implementing performance-based research funds. The data shows that most universities exhibit a significant increase in research productivity after implementing a performance-based research fund.

A study to investigate the contribution and impact of research output of PEC University of Technology as reflected in its publications covered in Scopus database for the period of 1996-2009 revealed that a total of 177 research papers were published by 9 departments of PEC thus showing an annual average growth of 131.85 per cent[5]. The study has also made an observation which indicates contribution to engineering and technology has steadily increased since then in PEC university. The study has also compared research output with neighbouring NITs and other engineering institutions which has revealed that the research output of PEC university needs substantial improvement.

A scientometric study measuring research output of five top ranked Indian Institutes of Technology (IITs) for the period of five years i.e. 2009-13 was conducted[6]. The study based the Web of Science database considered various parameters such as authorship pattern, collaboration with peers, citations, and h-index, etc. The results revealed that a total of 2,15,019 publications were published from India during the study period and the share of top five IITs was 9.32%.

A study measuring citation impact of CSIR publications indexed in Scopus database during 2007-2011 was conducted[7]. The study identified major areas in which research was carried out by the scientists of 37 CSIR laboratories during the study period. Another study assessing research output from Indian medical research institutes for the years 2005-2014 was conducted[8]. It was observed that the overall research output from Indian medical institutions is poor as compared to other countries. A scientometric assessment was carried out for the publications published during the year 2010-2014 measuring impact of and contributions of IISERs in the research activity[9]. The Scopus database was used to find out the research data and considered various parameters such as growth of publications, citation output, national and international collaboration, subject-wise distribution of research, profiles of different subject groups and most productive author. The study revealed an annual average growth rate of 34.92% and an average citation impact per paper of 9.90. It was also observed that the major areas of research of IISERs were chemistry, physics & astronomy, materials science & biochemistry, genetics & molecular biology, etc.

The bibliometric study to find out the authorship pattern, collaboration, year-wise and designation-wise distributions have been conducted for the three universities namely University of Kerala, Mahatma Gandhi University and University of Calicut[10]. The study revealed the year-wise growth of journal articles during the period of study. The analysis of authorship shows that collaborative research work is high compared to solo authorship in all the three universities. A study was conducted to identify the universities that are most productive and influential in innovation research[11]. The study considered leading innovation research journals to identify the most productive universities for each journal and analysed bibliometric parameters such as co-citation and bibliographic coupling to find out the most influential universities in innovation research.

The review of literature has presented various aspects of research productivity/output analysis for different institutions. The literature survey reveals that research productivity analysis is not a new research area and quite a few studies have been done by researchers for individual institutions and for the specific subject areas. It is also observed that the coverage and scope of different bibliometric study varies from three to five years, ten and forty years. The review of literature also depicts that considerable studies have been published on research output analysis of various Indian institutions, IITs, IISERs and CSIR laboratories. However, there is no study carried out so far that analyses the contribution of newly established Central Universities in India. The newly established Central Universities have completed a decade and it is important to find out their research contributions.

Objectives of the study

- To examine the research output and growth of research publications in different subject domains of the universities;
- To assess the impact of research in the national and global context;

- To study thecitations and self-citation patternsof researchers; and
- To identify the research output subject categories.

Methodology

The data on the research papers published by the 12 newly established central universities of India was downloaded from Scopus database for the ten-year period 2009-2019. The universities which were functioning as state universities and later converted into central universities in the year 2009-10 have not been considered. The bibliometric data was retrieved from the Scopus[12] using affiliation ID assigned by the Scopus to the individual institutions on August 03, 2020. A total of 5469 records were retrieved of which 3927 were research articles. These 3927 articles which included 748 open access articles were included for the analysis.

Analysis

The central universities were established during 2009 and most of them started academic and research activity from the academic year 2010. The data collected from Scopus have been analysed using bibliometrix package of R environment developed by Aria & Cuccurullo[13].

Growth and impact of research publications

The impact of research publication can be measured with the citation received for a research paper. We have gathered year-wise citation data, mean citation per article and mean citation per year for the total 3927 articles. It is observed that the growth of research publications is constant and increasing steadily over the years. It may be noted that a total of 989 documents were published during the year 2019 against a total of 15 documents during the year 2010. It may be inferred from the data that there is a highest annual average growth of 70.95% and compound average growth rate is 52%. The highest annual growth of 186.11% in publications has been noted in the year 2012 (Table 1).

$$CAGR = \left(\frac{V_{final}}{V_{begin}}\right)^{1/t} - 1 \qquad Where$$

$CAGR = Compound\ Annual\ Growth\ Rate$

$V_{begin} = Beginning\ value$

$V_{final} = Final\ value$

$t = Time\ in\ years$

Citation pattern of publications

The average citations per article pertaining to the year 2011 was 17.83. Out of total of 3927 articles, 3238 articles (82.45%) have received citations at the time of this study. Table 2 shows that 87 articles published in *RSC Advances* received the highest number of 1028 citations.

The m-Index is being calculated to find out the impact of source over a period of years. The calculation formula for m-Index is based on the h-Index for that particular year and divided by total citable years. The journal *Scientific Reports* has received maximum m-Index of 2.80. The *g-Index* is a metric that is being used to calculate distribution of citations received by a researcher's publications. The journal *RSC Advances* has received the highest *g-Index* of 24.

$$g^2 \leq \sum_{i \leq g} C_i$$

Most productive authors

Singh M (98 articles) and Raza K (51 articles) affiliated with Central University of Gujarat and

Table 1 — Publication growth and citation metrics

Year	No. of articles	Annual Growth Rate (in %)	Cited articles	Non-cited articles	No. of citations received	Mean citations per article	Mean citations per year	Citable years
2010	15	100.00	12	3	149	9.93	0.99	10
2011	36	140.00	34	2	642	17.83	1.98	9
2012	103	186.11	89	14	1652	16.04	2	8
2013	204	98.06	181	23	2977	14.59	2.08	7
2014	271	32.84	246	25	4056	14.97	2.49	6
2015	312	15.13	283	29	4007	12.84	2.57	5
2016	497	59.29	459	38	6326	12.73	3.18	4
2017	656	31.99	579	77	6136	9.35	3.12	3
2018	844	28.66	737	107	6091	7.22	3.61	2
2019	989	17.18	618	371	2545	2.57	2.57	1
Total	3927		3238	689	34581			

Central University of Rajasthan respectively have received the highest numbers of citations. Authors get credit for the publications in terms of citation count and therefore, many authors cite their own articles to increase number of citations. To identify the most prolific author, the self-citations are removed from the citation data to find out the actual impact and demand of research work of the author. The author, Singh, M. has also received highest citations without self-citations (Table 3).

University-wise publications

The Central University of Rajasthan has published highest 765 research publications while Central University of Punjab and Central University of Kerala have published 528 and 520 papers respectively (Fig. 1). It is important to note that these numbers include only papers indexed in *Scopus* and it does not mean that the universities have contributed only aforementioned number of articles. There are many research publications published in journals which have not been indexed by international databases.

Highly cited papers

Table 4 shows the mega-authorship paper, 'Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global

Table 2 — Preferred sources and impact

Source	Year of first article	No. of articles	No. of citations	h-Index	g-Index	m-Index
RSC Advances	2012	87	1028	19	24	2.11
Scientific Reports	2016	49	632	14	23	2.80
Journal of Molecular Liquids	2011	47	506	14	20	1.40
ChemistrySelect	2016	34	144	7	9	1.40
Journal of Biomolecular Structure and Dynamics	2014	31	323	11	16	1.57
International Journal of Biological Macromolecules	2016	28	292	12	15	2.40
Environmental Science and Pollution Research	2013	27	387	10	19	1.25
New Journal of Chemistry	2013	27	286	10	15	1.25
ACS Omega	2017	22	117	6	9	1.50
Physical Chemistry Chemical Physics	2015	22	163	9	12	1.50

Table 3 — Most productive authors

Author name	Affiliations	Articles	Total citations	h-index based on total citations received	Citations without self-citations of all authors	h-index based citations without self-citations of all authors
Singh, M.	Central University of Gujarat	98	900	16	553	13
Jha, P.C.	Central University of Gujarat	74	653	13	377	10
Rathie, A.K.	Central University of Kerala	51	73	5	28	3
Raza, K.	Central University of Rajasthan	51	712	17	428	13
Kavitha, L.	Central University of Tamil Nadu	41	598	15	490	14
Mathew, V.	Central University of Kerala	35	153	6	114	5
Prajapati, V.K.	Central University of Rajasthan	35	574	14	328	11
Athar, M.	Central University of Gujarat	34	161	11	66	6
Kumar, R.	Central University of Punjab	29	236	12	147	8
Munshi, A.	Central University of Punjab	29	146	9	127	9

Table 4 — Highly cited papers

Paper	Published year	Citable year	Total citations	Total citations per year
GBD 2017 Mortality Collaborators, 2018, *Lancet*	2017	4	695	173.75
Dakal TC, 2016, *Frontiers in Microbiology*	2016	5	302	60.40
Singh RP, 2012, *Toxicology Letters*	2012	9	201	22.33
Mini S, 2014, *IEEE Sensors Journal*	2014	7	199	28.43
Loganathan R, 2012, *Inorganic Chemistry*	2012	9	151	16.78
Vanburen R, 2015, *Nature*	2015	6	136	22.67
Kumar R, 2017, *ACS Applied Materials & Interfaces*	2017	4	135	33.75
Sharma PR, 2015, *The European Physical Journal Special Topics*	2015	6	133	22.17
Nisar J, 2013, *ACS Applied Materials & Interfaces*	2013	8	124	15.50
Akcil A, 2014, *Waste Management*	2014	7	120	17.14

Burden of Disease Study 2017' published in *Lancet* is the most highly cited paper with 695 citations. One of the researchers is from the Central University of Tamil Nadu.

Dynamic trend of sources

Source dynamic is a form of analysis that is being used to identify the publications that are often considered by the researchers for publishing their research work. The researchers from newly established central universities have considered a wide range sources for publications during 2010-2019. It has been observed that the *RSC Advances* journal was the most preferred choice of the researchers till the year 2015. Most research publications have shown similar trends except few sources namely, *ACS Omega*, *Physical Review C*, *Journal of Biomolecular Structure*, *International Journal of Biological Macromolecules* and *New Journal of Chemistry* (Fig. 2). It may be noted that the journal *ACS Omega* has become the preferred choice of researchers from the year 2016 onwards.

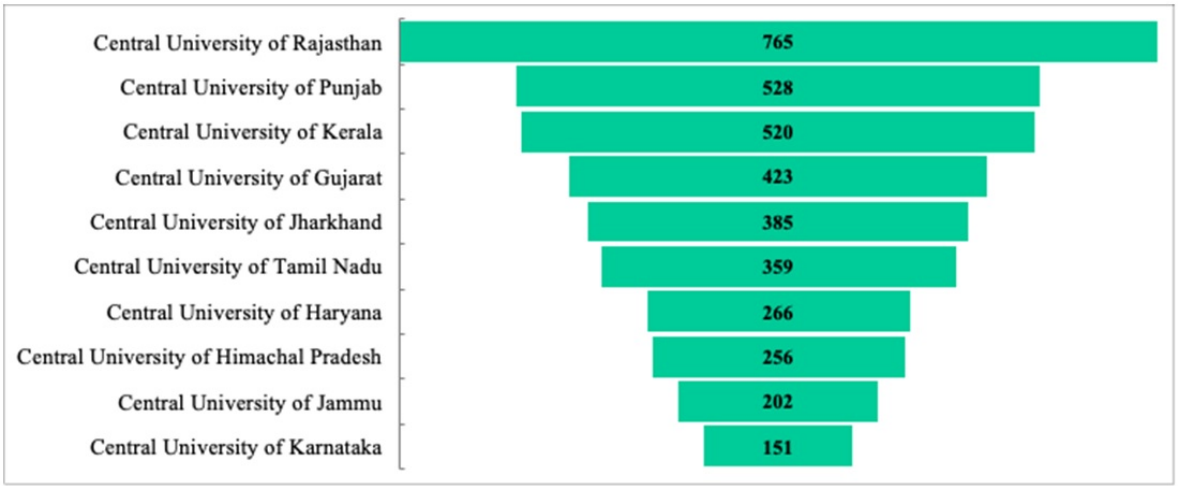

Fig. 1 — University-wise publications

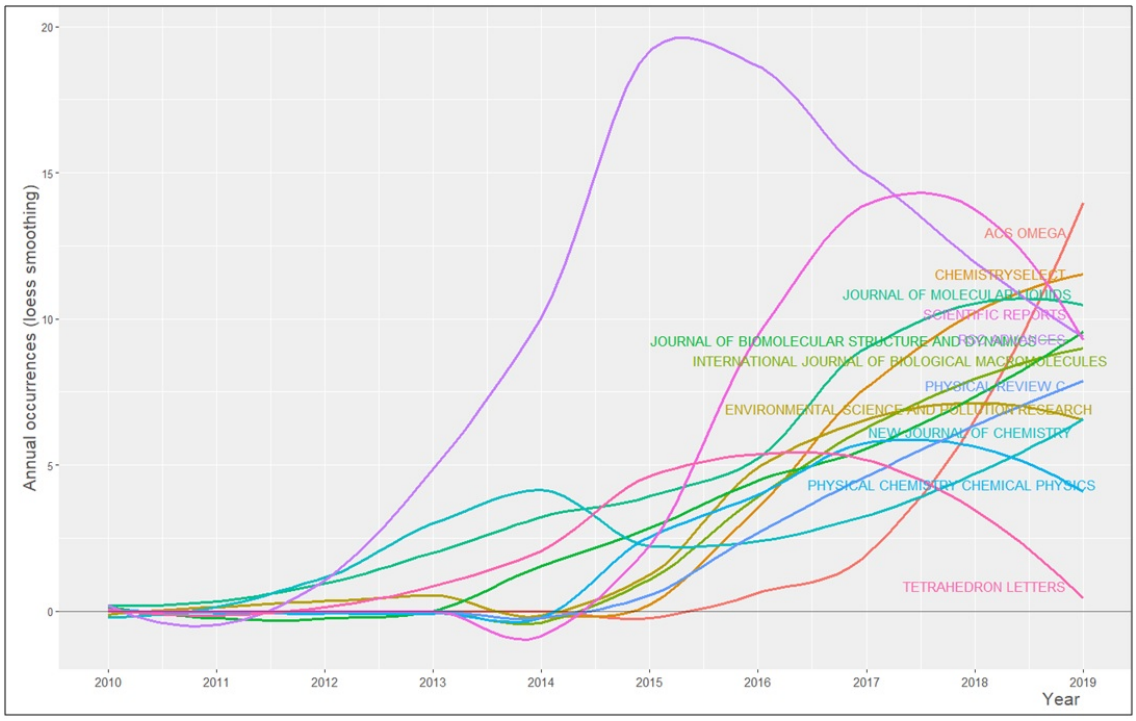

Fig. 2 — Top tendynamic sources

Thematic evolution

To find out the thematic evolution of research work contributed by the newly established central universities, the author assigned keywords have been considered with a time interval for the years 2010-14, 2015-2017 and 2018-2019. To refine and identify the proper by thematic subject, maximum 100 keywords assigned by author's have been considered with minimum 3 clusters per thousand documents. It may be observed from Fig. 3 that during the period of 2010-2014 green synthesis has been merged with heterocyclic compounds. Similarly, 'India' keyword remains continuous till the period of study i.e. 2018-19. It may be noted that the keyword 'Cancer' was used during 2010-2014 and it has been merged with 'molecular docking' and that remains in force till 2018-19.

Global collaboration network

It is imperative to note that the contributions of Indian authors have spanned across the globe. The researchers of the newly established central universities have collaborated with foreign researchers across the globe. The data shows that the major collaborative research work by the Indian researchers covered under the study includes the USA, Germany, Korea, Saudi Arabia, UK, Canada and China.

Multiple correspondence analysis

Multiple correspondence analysis is one of the techniques for factorial analysis. To derive the conceptual structure map between the concepts of research work during the period of study, top 100 keywords have been considered. The research trend is an essential element to understand the thematic expansion of research areas in the knowledge world. The data analysis shows that there are few subjects that appear to be major subjects and over a period they are merged into broader subject disciplines. Topic dendrogram shows that the relationship between narrow homogenous keywords by bottom-up

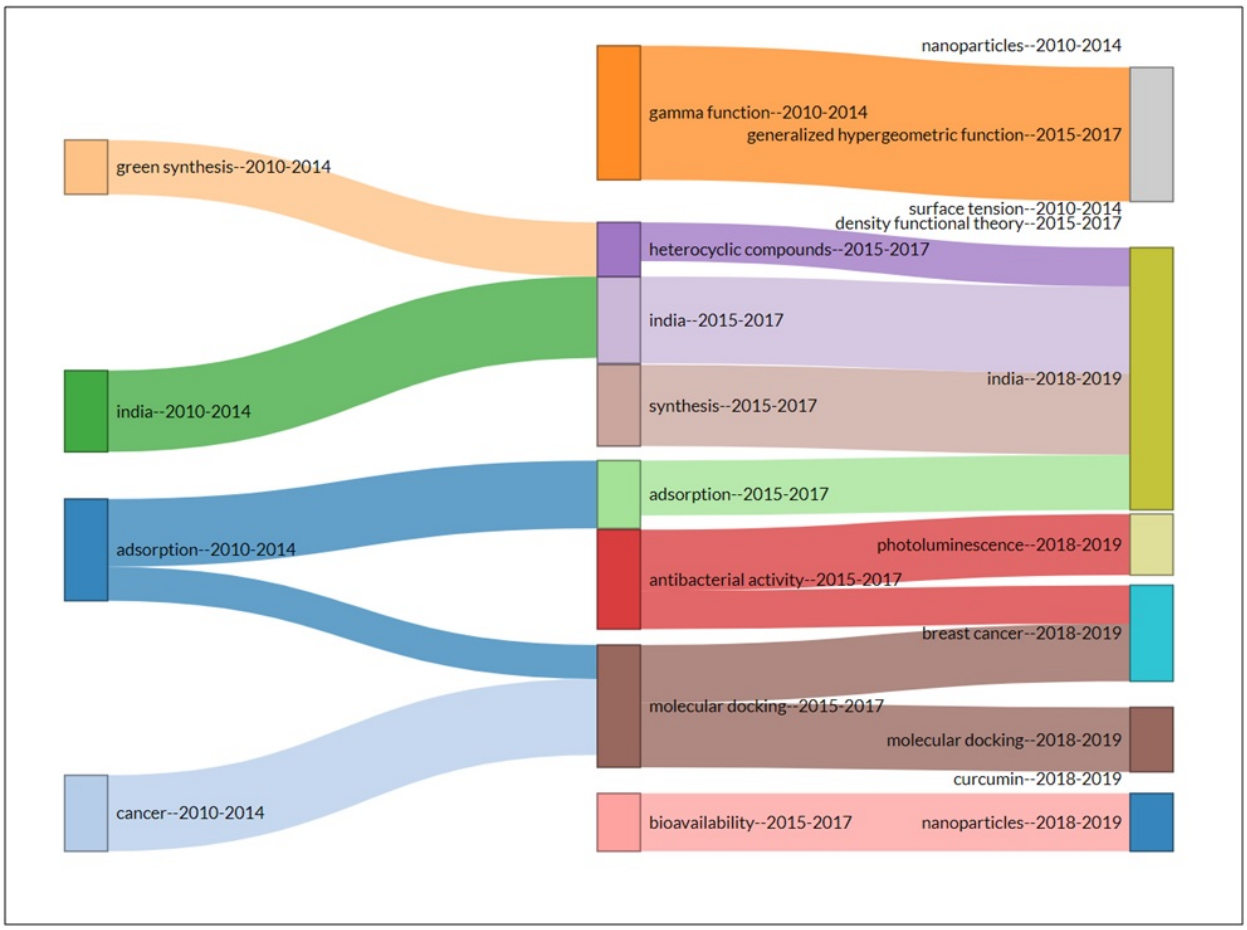

Fig. 3 — Thematic evolution of keywords

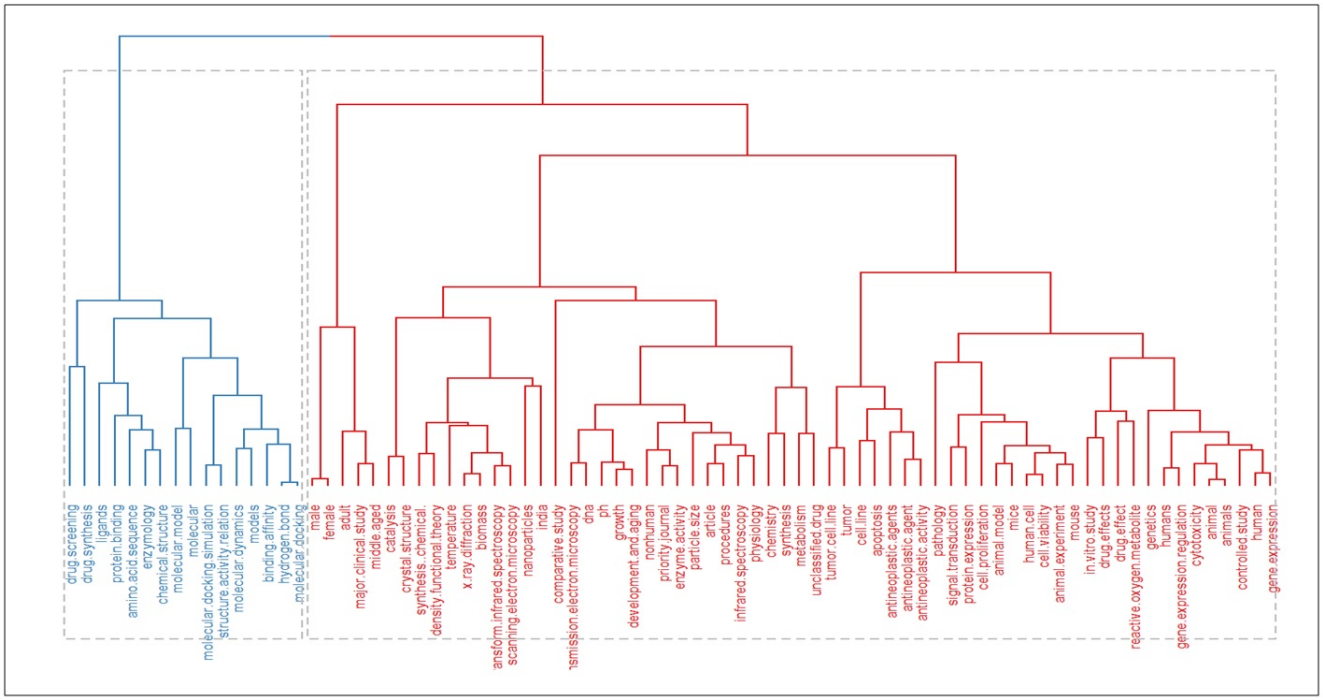

Fig. 4 — Topic dendrogram of keywords

approach. It may be inferred from Fig. 4 that the relationship of two major keyword clusters with multiple nested hierarchical clusters and two broad level clusters have emerged as a result of factorial analysis.

Conclusion

Discovering the scholarly publications of 12 newly established central universities in India gives the insights of their research progress. The trend of collaborative research is increasing among the researchers in majority of fields. Finding of the research reveals that there is a considerable research activity in the areas of physical and allied sciences compared to other subjects. The results of the study revealed that all the twelve universities exhibit a significant increase in research productivity during the last ten years. However, there are some subject disciplines where the amount of research is very negligible and therefore, it is suggested that the researchers of the universities should give equal emphasize to all the subject disciplines and carry out more research work in the less worked subject areas that includes education, law, political science, transportation, demography, gender studies, international relations, public administration, and urban studies, etc.

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