

Measuring Research Productivity of ‘Universities with Centre with Potential for Excellence in Particular Area (CPEPA) status’ in Karnataka State

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ABSTRACT

This paper aims to track the research output of the ‘Universities with CPEPA status in Karnataka’ during 2010–2019 as considering the Web of Science database. The Karnatak University, Dharwad, Bangalore University, Bangalore, and the University of Mysore, Mysore have been selected. A total of 8952 documents have been retrieved consisting of journal articles, conference papers, book chapters, so on. A steady increase in research output has been observed. The University of Mysore (UMM) has the largest number of publications. The study shows that multi-authored papers have greater research influence in receiving citations. The study found the most productive authors and their production impacts in terms of the number of citations (ACPP) and also identified the most occurred keywords and journals used to publishing the research results. For visualisation purposes, VOSviewer and Bibliometrix R Package were used.

Keywords: Centre with Potential for excellence in particular area; CPEPA; UGC; Participation index; Research productivity; Scopus; Relative growth rate; Scientometrics; Doubling time; Karnataka

1. INTRODUCTION

The pursuit of excellence is an ongoing process involving teachers, students, and administrators. The pursuit of excellence is also the process of continuously cultivating and improving the skills and abilities of universities to reach the highest level in the world. It is a process that raises the university's awareness of a new community of knowledge, focusing on the changing needs and expectations of students and stakeholders, including institutions and jobs where graduate students find opportunities to live, work and develop. Continuous efforts and pursuit of the university should eventually make it reach the highest level of education, not only comparable to Indian and world-class universities, and also as a benchmark for other universities. In this context, the UGC significantly contributed to the development of the Indian higher education system. UGC encourages the country's well-performing universities to pursue excellence in their chosen academic and research fields of work. In this approach, the UGC has been providing significant financial assistance to selected universities through various schemes. These schemes include “Universities with Potential for Excellence (UPE)” launched in the IX Plan period, “Colleges with Potential for Excellence (CPE)” launched in the X Plan period, and “Centre with Potential for Excellence in a Particular Area (CPEPA)” launched in the IX Plan period. The focus of the CPEPA Scheme is to support the development of the interdisciplinary field of selected universities and specific research projects in these fields.

The UGC¹ has conferred the status of Universities with Potential for Excellence to 12 Universities (as of 18th October 2011). As per the UGC eligibility criteria laid down in the XI Plan Guidelines on CPEPA, 12 universities were selected, among them three are from Karnataka. They are Karnataka University, Dharwad; Bangalore University, Bangalore, and the University of Mysore, Mysore. The current study was confined to three CPEPA's of Karnataka and identified how the institutions are performing in various fields of research and development.

Karnataka University, Dharwad; Bangalore University, Bangalore, and the University of Mysore, Mysore are the highly reputed universities of Karnataka. These three CPEPA's are identified by ‘National Institutional Ranking Framework (NIRF) 2020’, MHRD, Government of India's ranked 68th and 27th, unfortunately, Karnataka University, Dharwad didn't get placed in top 100. these universities are also appeared with a good rank, in world's ranking list which is conducted by various academic ranking agencies.

2. LITERATURE REVIEW

Over the year's various bibliometric studies/scientometric studies has been accomplished to assess the research output of an organisation, subject, country, author, sources, etc. Essential factors were identified, the complexity of difference defined, and solutions were recommended to overcome.

Mahala & Singh² conducted the scientometric study of the research output of Indian universities in sciences during 2015 – 2019 using the WoS database. The study exposes that how

the science research publications of top Indian universities have grown in the last few years. GN Gourikeremath *et al.*; Gouri Gourikeremath & Hiremath³⁻⁴ studied comparative assessments of scientific research output of science faculties of the University of Mysore and the Karnatak University, and Scientific Productivity of Universities with Potential for Excellence (UPE) status in India using different bibliometric indicators, by using Web of Science database during 2002-16 and 1999-2014 respectively. Kappi *et al.*; Kumar, Satish & Senthilkumar⁵⁻⁶ examined the research performance of India's NIRF first-ranked institute, the Indian Institute of Science (IISc), Bangalore during 2014-2018 using WoS database and Research Productivity of NIRF 2020 Top Indian Law Institutions during 2009–2019 using SCOPUS database. Kappi & Biradar⁷ evaluated the scientific research output of the Kuvempu University using different bibliometric indicators during 1990–2019 based on the Web of Science database. Kumar *et al.*⁸ examined the growth of publication in the different subject categories, the impact of growth before and after NIRF. The sample data is considered for 20 universities from the top 25 top universities ranked last three years in NIRF using the Web of Science database for the period 2014–2016.

Utama *et al.*⁹ studied the research productivity of Diponegoro University, Indonesia by using various bibliometric tools during 2014 – 2018 by using the SCOPUS database. Nair¹⁰ examined the research productivity and impact of 20 central and 237 state universities during 2017–2019 using the Scopus database. Kherde & Bapte¹¹ conducted scientometric studies on various universities using the Web of Science database. The study analysed 4212 papers and measured research output using Lotka's law. Patel & Bhatt¹² have evaluated the Gujarat University research productivity using the Scopus database during 2008–2017. Wei & Zhang¹³ conducted a quantitative study of scientific publications of the reputed universities using international and national Chinese databases from 2006 to 2018. Basu *et al.*¹⁴ evaluated the research productivity of the central institutions in India during 2010 – 2014. Solanki *et al.*¹⁵ done a scientometric study of the research productivity of IISER for the period 2010-2014. Rajan *et al.*¹⁶ examined the research output of Indian institutions for the period 2011–2016 based on data gained from the SciVal bibliometric tool. Das; Prathap^{17,18} assessed the research output of the IITs in India by using Web of Science (WoS) and SCOPUS databases. Banshal *et al.*¹⁹ done a bibliometric study of the research output of the NIT's in India for the period 2005–2016. Sharma *et al.*²⁰ during 2008-2017 studied the research output of Indian institutions in biotechnology research. Sangam & Bagalkoti²¹ assessed and measured the growth of publications of the National Assessment and Accreditation Council (NAAC) accredited universities in India during 2001-2010 using the SCOPUS database.

The concept of measuring the research productivity of universities/institutions has been mentioned and widely used by more and more people. However, there are few studies on Universities of the ‘Status of Centre with Potential for Excellence in Particular Area (CPEPA)’ In Karnataka from the views of bibliometrics and visualisation. In addition, a systematic review of the literature is also very important, especially in the initial stage of research productivity research in universities/

Table 1. Summary of the Study

| Description | Results |
|------------------------------------|-----------|
| Main information about data | |
| Timespan | 2010:2019 |
| Sources (Journals, Books, etc) | 2398 |
| Documents | 8952 |
| Average years from publication | 6.57 |
| Average citations per document | 7.724 |
| Average citations per year per doc | 1.02 |
| References | 266757 |
| Document types | |
| Article | 7213 |
| Book | 17 |
| Book chapter | 245 |
| Conference paper | 1118 |
| Data paper | 68 |
| Editorial | 27 |
| Erratum | 29 |
| Letter | 19 |
| Note | 33 |
| Review | 173 |
| Short survey | 10 |
| Document contents | |
| Keywords plus (ID) | 38347 |
| Author's keywords (DE) | 20437 |
| Authors collaboration | |
| Single-authored documents | 253 |
| Multi-authored documents | 8699 |
| Documents per Author | 0.826 |
| Authors per Document | 1.21 |
| Co-authors per Documents | 4.03 |
| Collaboration Index | 1.23 |

institutions to ensure high-quality research results. This paper aims to explore the bibliometric analysis and visualisation of CPEPA institutions to explore the characteristics of this area. Table 1 summarises the full paper concept.

3. OBJECTIVES

The current study emphasises the research output of the three leading Universities with CPEPA status in Karnataka with the following objectives:

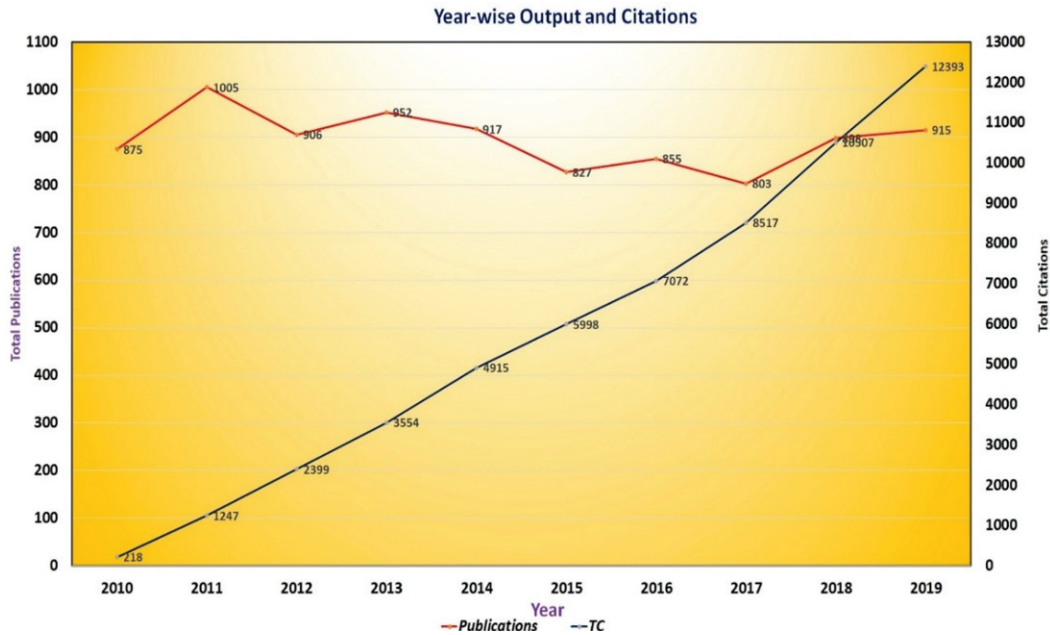


Figure 1. Annual publications and total citations of the universities with CPEPA status in Karnataka.

Table 2. Year-wise distribution of publications and citations of universities with CPEPA status in Karnataka

| Year | KUD | | | | BUB | | | | UMM | | | |
|------|-----|------|--------|-------|-----|------|--------|-------|-----|------|--------|------|
| | TP | TC | ACPP | PoI | TP | TC | ACPP | PoI | TP | TC | ACPP | PoI |
| 2010 | 213 | 59 | 0.277 | 2.321 | 238 | 69 | 0.29 | 2.593 | 443 | 96 | 0.217 | 4.83 |
| 2011 | 214 | 337 | 1.575 | 2.332 | 317 | 384 | 1.211 | 3.454 | 496 | 540 | 1.089 | 5.41 |
| 2012 | 199 | 649 | 3.261 | 2.168 | 273 | 836 | 3.062 | 2.975 | 456 | 958 | 2.101 | 4.97 |
| 2013 | 182 | 938 | 5.154 | 1.983 | 293 | 1262 | 4.307 | 3.193 | 502 | 1401 | 2.791 | 5.47 |
| 2014 | 225 | 1284 | 5.707 | 2.452 | 251 | 1785 | 7.112 | 2.735 | 466 | 1953 | 4.191 | 5.08 |
| 2015 | 234 | 1533 | 6.551 | 2.55 | 208 | 2148 | 10.327 | 2.267 | 421 | 2542 | 6.038 | 4.59 |
| 2016 | 226 | 1839 | 8.137 | 2.463 | 242 | 2472 | 10.215 | 2.637 | 407 | 3058 | 7.514 | 4.44 |
| 2017 | 205 | 2327 | 11.351 | 2.234 | 224 | 2889 | 12.897 | 2.441 | 392 | 3573 | 9.115 | 4.27 |
| 2018 | 248 | 2963 | 11.948 | 2.702 | 290 | 3482 | 12.007 | 3.16 | 381 | 4532 | 11.895 | 4.15 |
| 2019 | 240 | 3534 | 14.725 | 2.615 | 325 | 3979 | 12.243 | 3.541 | 366 | 5413 | 14.79 | 3.99 |

KUD=Karnatak University, Dharwad; BUB=Bangalore University, Bangalore; UMM=University of Mysore

- To examine the year-wise research performance and distribution of citations;
- To examine the Discipline-wise of research publications;
- To identify the most productive authors and sources;
- To examine the highly cited papers; and
- To identify the most occurred keywords.

4. SCOPE AND METHODOLOGY

The search was conducted in October 2020 to extract

research publications that include the following advanced search query ((AFFILCOUNTRY(India) AND AF-ID ("Karnatak University" 60029908) OR AF-ID ("Bangalore University" 60009220) OR AFID ("University of Mysore" 60013290)) AND (LIMIT-TO 2010 – 2019)). The search resulted in 8952 records. The downloaded data contained the information about the types of documents alike articles, reviews, book chapters, conference papers, and editorials, etc., name of the author with their affiliation, year of publication, journal name, country, citation received by article, the title of the article and keywords. The study was further enriched by the impact factor of publishing sources. The downloaded data were analysed using MS Excel. Further, the VOSviewer²² and Bibliometrix 'R'²³ package has been used for collaboration study.

5. BIBLIOMETRIC INDICATORS

Some of the bibliometric indicators are used to analyse the collected data, based on the SCOPUS database.

5.1 Participative Index (PaI)

To assess the level of research performance of institutions, an index called the "Participation Index (PaI)"²⁴

has been calculated. PaI is the ratio between the number of articles generated in a country or institution and the total number of documents collected in this repertoire. It can be expressed as:

$$\text{PaI} = \frac{\text{No of papers generated in an institution}}{\text{Total No of documents collected in this repertoire}} \times 100$$

6. DATA COLLECTIONS AND RESULTS

6.1 Research Publications Growth and Citation Analysis of Universities with CPEPA Status in Karnataka

The research output of the Universities with CPEPA status

in Karnataka, as shown by our study data, has seen significant growth in the last 10 years. A total of 8, 952 papers were published by these three CPEPA's and Fig. 1 shows the annual growth rate of total publications and total citations received by the Universities with CPEPA status in Karnataka. It is found that the most productive year in terms of publication count is 2011 with 1,005 papers, followed by 952 papers published in 2013 and 917 papers published in 2014. Whereas, in 2019 placed the top in terms of total citations with 12,393, followed by 10,507 TC in 2018 and 8,517 TC in 2017. Further, the study shows the year-wise average citation per paper trend was rapidly increasing. It indicates that many researchers were cited these three CPEPA's published papers and also, in the future, there should be more efforts and policies from these Universities to encourage the faculty members to publish their research papers in higher quartile of journals to get more citations at the global level.

6.2 Year-wise Performance of Universities with CPEPA Status in Karnataka

Table 2 describes the year-wise performance of Universities with CPEPA status in Karnataka during 2010 – 2019. University of Mysore, Mysore has contributed with 4,330 publications with 47.183 of PaI and placed first, followed by Bangalore University, Bangalore contributed 2,660 publications with 28.996 of PaI and Karnatak University, Dharwad contributed 2,186 publications with 23.820 of PaI. During the study period, the University of Mysore (UMM), Mysore published the highest publications 4,330 with 24,066 citations of papers closely followed by Bangalore University (BUB), Bangalore 2,661 with 19,306 citations of the papers. The lowest number of papers was published by Karnatak University (KUD), Dharwad 2,186 with 15,463 of the output. The UMM has contributed 47.18 per cent of PaI is placed first, followed by BUB with 29 per cent of PaI and KUD with 23.82 per cent of PaI. Varying performance is noted in PoI during the study period by all the Universities. It is evident from Table 2 that the performance of UMM in terms of total publications is good and BUB and KUD were found quite low, in terms of ACP the BUB (7.37) performance was comparatively good with KUD (6.87) and UMM (5.97).

6.3 ‘Universities with CPEPA Status in Karnataka’ Publications Relative Growth Rate (RGR), and Doubling Time (Dt)

Table 3 explains the relative growth rate and doubling time of publications of Universities with CPEPA status in Karnataka during the study period of 10 years (2010-2019). Growth rates for all publications were measured using the RGR and Dt model, which was developed by Mahapatra²⁵ in 1985. RGR is calculated to analyse the increase in the number of publications over time, and Dt and RGR. The mathematical expression of the average relative

growth rate of publications in a specific period can be derived from the following equation:

Where,

RGR = Growth Rate over the specific period of the interval,

W1 = Loge (natural log of the initial number of articles)

W2 = Loge (natural log of the final number of articles)

T1 = the unit of initial time

T2 = the unit of the final time

6.3.1 Doubling Time (Dt)

It can be determined from the calculation that there is a direct equivalent relationship between RGR and Dt. If the number of contributions to a topic doubles, from (2010-2019), the logarithm of the number and the last of the period must be the logarithm of the number 2. If the logarithm of the natural number is used, the difference is 0.693²⁶. The highest 0.765 RGR was recorded in the year 2011 and 6.428 Dt was recorded in the year 2019 during the study period. The formula of corresponding Dt for papers and page measurement.

$$Dt = \frac{0.693}{RGR}$$

6.4 Discipline-wise of Research Publications

Although the results of the above analysis help assess the overall research performance and capabilities of Universities with CPEPA status in Karnataka, they do not provide information on which University is performing well in which subject area. Therefore, we evaluated these universities' research performance in different subject/research areas. The results of this analysis can help determine the research strengths of these Universities with CPEPA status in Karnataka. Table 4 presents the top 15 subject/research area-wise research performance during 2010–2019. Authors have observed that in 10 years, the largest amount of research output was published in the fields of Chemistry (TP 2,823) and Physics (TP 2,049). Followed

Table 3. Relative growth rate (RGR) and doubling time (Dt) of publications

| Year | Publications | CTP | W1 | W2 | RGR | Mean RGR | Dt | Mean Dt |
|------|--------------|------|-------|-------|-------|----------|-------|---------|
| 2010 | 875 | 875 | 0 | 6.774 | 0 | | 0 | |
| 2011 | 1005 | 1880 | 6.774 | 7.539 | 0.765 | | 0.906 | |
| 2012 | 906 | 2786 | 7.539 | 7.932 | 0.393 | | 1.762 | |
| 2013 | 952 | 3738 | 7.932 | 8.226 | 0.294 | | 2.358 | |
| 2014 | 917 | 4655 | 8.226 | 8.446 | 0.219 | 0.233 | 3.159 | 3.529 |
| 2015 | 827 | 5482 | 8.446 | 8.609 | 0.164 | | 4.238 | |
| 2016 | 855 | 6337 | 8.609 | 8.754 | 0.145 | | 4.781 | |
| 2017 | 803 | 7140 | 8.754 | 8.873 | 0.119 | | 5.809 | |
| 2018 | 898 | 8038 | 8.873 | 8.992 | 0.118 | | 5.850 | |
| 2019 | 915 | 8953 | 8.992 | 9.100 | 0.108 | | 6.428 | |

CTP=Cummulative Total Publications; RGR=Relative Growth Rate; Dt=Doubling time

Table 4. Most preferred subject/ research areas

| Subject area | Publications |
|--|--------------|
| Chemistry | 2823 |
| Physics and Astronomy | 2049 |
| Materials Science | 1763 |
| Biochemistry, Genetics and Molecular Biology | 1458 |
| Engineering | 1249 |
| Agricultural and Biological Sciences | 1033 |
| Pharmacology, Toxicology and Pharmaceutics | 1006 |
| Computer Science | 832 |
| Mathematics | 726 |
| Chemical Engineering | 692 |
| Medicine | 692 |
| Environmental Science | 591 |
| Social Sciences | 310 |
| Immunology and Microbiology | 266 |
| Energy | 231 |

by Materials Science (TP 1,763) and Biochemistry, Genetics, and Molecular Biology (TP 1,458), and surprisingly, very few amounts of research output were published in the field of Social Sciences (TP 310). This subject area-based analysis of research results can be used to identify universities with potential for excellence in a particular discipline. Subject/research area-wise research analysis helps establish a differentiated financing plan for universities and it may also help potential students choose a university for doctoral research and advanced research in their specific discipline.

6.5 Publications of Most Productive Authors and Impact of their Output

Table 5 shows the top 20 most productive authors of Universities with CPEPA status in Karnataka who published more than 76 papers. These 20 authors published 2,669 (29.81 %) papers of the total output. The remaining 70.19 per cent of papers were contributed by other authors. This shows the research output was highly scattered among the authors. The study aimed to determine the ACPP and h index of the most prolific authors. The value of ACPP for three authors, namely, Girish KS (University of Mysore), Murthy HN (Karnatak University), and Rangappa KS (University of Mysore) is higher than double the average value. The Yathirajan HS (UMM) top

Table 5. Most productive authors and impact of their output

| Author | Affiliation | NP | TC | ACPP | h_index | g_index | m_index |
|-------------------|---------------------------------|-----|------|--------|---------|---------|---------|
| Yathirajan H S | UMM | 355 | 1417 | 3.992 | 17 | 24 | 1.417 |
| Lokanath N K | UMM | 213 | 820 | 3.850 | 12 | 19 | 1.2 |
| Jasinski J P | Keene State College, USA | 201 | 561 | 2.791 | 8 | 13 | 0.667 |
| Rangappa K S | UMM | 191 | 2687 | 14.068 | 27 | 38 | 2.25 |
| Narayana B | Mangalore University, Mangalore | 182 | 892 | 4.901 | 14 | 21 | 1.167 |
| Venugopal K R | BUB | 172 | 572 | 3.326 | 9 | 19 | 0.75 |
| Nandibewoor S T | KUD | 152 | 1677 | 11.033 | 21 | 34 | 1.75 |
| Basavaiah K | UMM | 128 | 506 | 3.953 | 10 | 12 | 0.833 |
| Byrappa K | UMM | 112 | 1037 | 9.259 | 20 | 27 | 1.667 |
| Sureshbabu V V | BUB | 104 | 940 | 9.038 | 18 | 24 | 1.5 |
| Naveen S | UMM | 99 | 553 | 5.586 | 13 | 20 | 1.083 |
| Patnaik L M | IISc, Bangalore | 96 | 345 | 3.594 | 9 | 15 | 0.75 |
| Guru D S | UMM | 95 | 455 | 4.789 | 11 | 18 | 0.917 |
| Murthy H N | KUD | 92 | 1462 | 15.891 | 19 | 35 | 1.583 |
| Shivakumara I S | BUB | 90 | 905 | 10.056 | 16 | 23 | 1.333 |
| Girish K S | UMM | 79 | 1518 | 19.215 | 23 | 34 | 1.917 |
| Somashekar R | UMM | 78 | 366 | 4.692 | 9 | 16 | 0.75 |
| Chandraju S | UMM | 77 | 312 | 4.052 | 10 | 12 | 0.833 |
| Devarajegowda H C | UMM | 77 | 242 | 3.143 | 7 | 12 | 0.583 |
| Badiger N M | KUD | 76 | 986 | 12.974 | 16 | 28 | 1.333 |

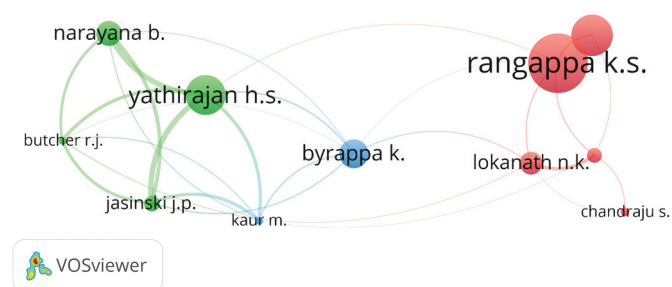


Figure 2. Top 20 productive authors co-citation network of the Universities with CPEPA status in Karnataka.

JP (Keene State College, USA) contributed 201 papers with 561 citations and having 8 h-index respectively. The majority of most productive authors belong to UMM (11), followed by KUD and BUB with 3 authors each. The remaining three other authors got placed in the top 20 list which is the highest collaboration with these three Universities.

Figure 2 shows the top 20 authors' network visualisation during 2010–2019. The analysis categorised authors into four different colored clusters, which means there are four main groups within the top 20 authors. The blue, green, and red clusters were largest, thereby suggested greater scope of

Table 6. Most preferred journals and impact of their output

| Journal name | Country | NP | TC | Cite Score | SNIP | SJR -2019 | Rank | h_index | g_index | m_index |
|---|-------------|-----|------|------------|-------|-----------|------|---------|---------|---------|
| Acta Crystallographica Section E: Structure reports online | UK | 482 | 1285 | NA | NA | NA | NA | 11 | 18 | 1.00 |
| AIP Conference Proceedings | USA | 266 | 239 | 0.6 | 0.373 | 0.19 | 190 | 5 | 7 | 0.50 |
| Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy | Netherlands | 95 | 1740 | 5.1 | 1.088 | 0.55 | 33 | 27 | 37 | 2.50 |
| Acta Crystallographica Section E: Crystallographic Communications | UK | 76 | 112 | 1 | 0.301 | 0.179 | 279 | 5 | 6 | 0.80 |
| Journal of Molecular Structure | Netherlands | 76 | 751 | 4 | 0.918 | 0.45 | 45 | 15 | 21 | 1.40 |
| International Journal of Pharma and BioSciences | India | 73 | 156 | NA | NA | NA | NA | 7 | 8 | 0.60 |
| International Journal of Pharmacy and Pharmaceutical Sciences | India | 70 | 420 | NA | NA | NA | NA | 12 | 16 | 1.10 |
| Chemical data collections | India | 68 | 224 | 1.2 | NA | NA | 249 | 7 | 10 | 1.40 |
| Synthetic communications | USA | 59 | 442 | 2.6 | 0.58 | 0.367 | 111 | 12 | 17 | 1.10 |
| RSC advances | UK | 56 | 1003 | 6.5 | 0.827 | 0.736 | 58 | 20 | 27 | 2.50 |
| Molecular Crystals and Liquid Crystals | UK | 53 | 200 | 1.2 | 0.271 | 0.209 | 298 | 8 | 11 | 0.73 |
| Advanced Studies in Contemporary Mathematics (Kyungshang) | South Korea | 52 | 32 | 1.5 | 0.595 | 0.286 | 120 | 4 | 4 | 0.36 |
| Advances in Intelligent Systems and Computing | Germany | 51 | 56 | 0.9 | 0.429 | 0.184 | 160 | 4 | 4 | 0.50 |
| Communications in Computer and Information Science | Germany | 51 | 86 | 0.7 | 0.403 | 0.188 | 180 | 5 | 8 | 0.45 |
| European Journal of Medicinal Chemistry | France | 50 | 1995 | 8.3 | 1.54 | 1.144 | 13 | 28 | 44 | 2.55 |
| International Journal of Earth Sciences and Engineering | India | 50 | 21 | NA | NA | NA | NA | 2 | 3 | 0.18 |
| Der Pharma Chemica | India | 49 | 193 | NA | NA | NA | NA | 8 | 12 | 0.80 |
| Tetrahedron Letters | UK | 47 | 763 | 4.5 | 0.64 | 0.582 | 53 | 17 | 25 | 1.55 |
| Nature Environment and Pollution Technology | India | 46 | 43 | 0.5 | 0.157 | 0.127 | 167 | 4 | 5 | 0.36 |
| Chemistryselect | UK | 43 | 188 | 2.6 | 0.466 | 0.445 | 176 | 7 | 8 | 1.40 |

NP= Number of Publications; TC=Total Citations; SNIP= Source Normalised Impact per Paper

of the list by contributing 355 papers, 1,417 citations with 17 h-index, followed by Lokanath NK (UMM) contributed 213 papers with 820 citations and having 12 h-index and Jasinski

influence in this field. The clusters did not overlap with each other; however, a group of nodes in the middle of the Fig. 2 shows the links between blue and green and was closely related

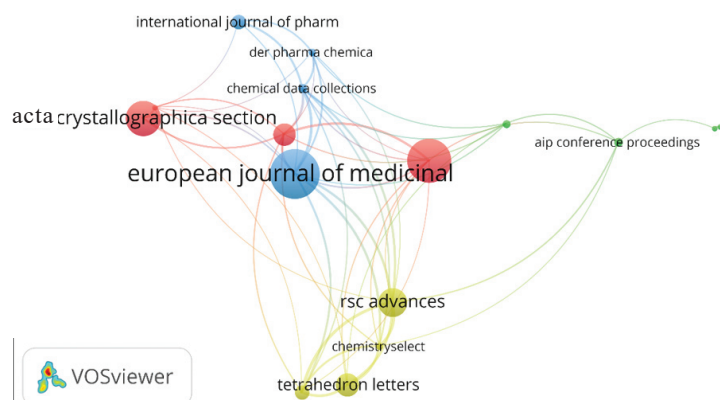


Figure 3. The journal co-citation network of the universities with CPEPA status in Karnataka.

to blue, as seen by their proximity. The blue cluster, which was largest, represents the highest paper produced by authors. This predominant node included key authors Yathirajan HS (355), Jasinski JP (201), and Narayana B (182); followed by the green cluster which included key authors Lokanath NK (213), Naveen S (99), and Chandraju S (77) and so on. The size of the circle denotes the sums of publications. The distance and thickness between the two circles show their correlation.

6.6 Most Preferred Journals and Impact of their Output

Table 6 depicts the list of journals used by the researchers and faculties of Universities with CPEPA status in Karnataka. Researchers publish their work in various journals. The source pattern indicates the total research output has been published

Table 7. Top 10 most cited papers

| Title | Author | Sources | Country | Citations | TCPY |
|---|--|---|-------------|-----------|---------|
| Review on Modified TiO ₂ Photocatalysis under UV/Visible Light: Selected Results and Related Mechanisms on Interfacial Charge Carrier Transfer Dynamics | S. Girish Kumar, L. Gomathi Devi | The Journal of Physical Chemistry A | USA | 1277 | 127.700 |
| Emissive ZnO–graphene quantum dots for white-light-emitting diodes | Son, D., Kwon, B., Park, D., <i>et al.</i> | Nature Nanotechnology | UK | 509 | 56.556 |
| A review on non-metal ion doped titania for the photocatalytic degradation of organic pollutants under UV/solar light: Role of photogenerated charge carrier dynamics in enhancing the activity | L. Gomathi Devi, R. Kavitha, | Applied Catalysis B: Environmental | Netherlands | 377 | 47.125 |
| Mycotoxins in Food and Feed: Present Status and Future Concerns | Rajeev Bhat, Ravishankar V. Rai, A.A. Karim | Comprehensive Reviews in Food Science and Food Safety | USA | 278 | 25.273 |
| Production of secondary metabolites from cell and organ cultures: strategies and approaches for biomass improvement and metabolite accumulation | Murthy, H.N., Lee, E.J. & Paek, KY | Plant Cell Tiss Organ Cult | Netherlands | 241 | 34.429 |
| Role of Microbial Enzymes in the Bioremediation of Pollutants: A Review | Chandrakant S. Karigar and Shwetha S. Rao | Enzyme Research | USA | 215 | 21.500 |
| n-Vivo analgesic and anti-inflammatory activities of newly synthesized benzimidazole derivatives | Kavitha C.S. Achar, Kallappa, M. Hosamani, Harisha R.Seetharamareddy | European Journal of Medicinal Chemistry | France | 204 | 18.545 |
| Structural, optical and EPR studies on ZnO: Cu nanopowders prepared via low temperature solution combustion synthesis | A. Jagannatha Reddy, M.K.Kokila | Journal of Alloys and Compounds | Netherlands | 189 | 18.900 |
| MicroRNA let-7: an emerging next-generation cancer therapeutic | D Barh et al. | Current Oncology | USA | 185 | 16.818 |
| Neoproterozoic greenstone volcanism and continental growth, Dharwar craton, southern India: Constraints from SIMS U–Pb zircon geochronology and Nd isotopes | M. Jayananda et al. | Precambrian Research | Netherlands | 182 | 22.750 |

TCPY=Total citations per year

in 1,249 different journals. Among these 20 most productive journals published 20.25 per cent of papers and the remaining 79.75 per cent papers were published in 1,229 journals. These journals were published the highest number of papers of Universities with CPEPA status in Karnataka in sciences with impact factor and publishing country. Of these UK and the India hold six journals, the USA, Netherlands, and Germany hold two journals, and South Korea and France hold one journal. This shows that the research output of Universities with CPEPA status in Karnataka is highly distributed in terms of journals also and the 14 journals were placed in the SJR 2019 ranking. Among these, the European Journal of Medicinal Chemistry published from France had the highest impact factor among all the journals.

These journal citation's impact was shown in Fig. 3. the journal co-citation network with 20 nodes. The size of the node represents the activity of the journal and the number of published papers. The distance between two nodes is also important. In general, the shorter the distance between two nodes is, the higher the citation frequency is. In Fig. 3, each cluster has a color that indicates the group to which the cluster is assigned. All these journals are divided into four clusters. The red cluster covers the ACTA Crystallographica Section E: Crystallographic Communications, ACTA Crystallographica Section E: Structure Reports Online, Journal of Molecular Structure, and Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy. The blue cluster covers the European Journal of Medicinal Chemistry and others. The green cluster covers the AIP Conference Proceedings and others. The yellow cluster covers the RSC Advances, Chemistryselect, etc.

6.7 Most Cited Papers

Table 7 shows the top 10 papers with the most citations by the authors of the Universities with CPEPA status in Karnataka. These highly cited papers in terms of title, Authors, source, country, total citations, and total citations per year. All these papers have been published in 10 different journals and papers that received 180 or more citations. All of these 10 papers were co-authored. The paper “Review on Modified TiO₂ Photocatalysis under UV/Visible Light: Selected Results and Related Mechanisms on Interfacial Charge Carrier Transfer Dynamics by S. Girish Kumar and L. Gomathi Devi” has been cited 1,277 times with 127.7 TCPY followed by “Emissive ZnO–graphene quantum dots for white-light-emitting diodes by Dong Ick Son, Byoung Wook Kwon, Dong Hee Park, Won-Seon Seo, Yeonjin Yi, Basavaraj Angadi, Chang-Lyoul Lee & Won Kook Choi” with 509 citations and 56.556 TCPY and “A review on non-metal ion doped titania for the photocatalytic degradation of organic pollutants under UV/solar light: Role of photogenerated charge carrier dynamics in enhancing the activity by L Gomathi Devi & R.Kavitha” with 377 citations and 47.125 TCPY. Figure 4 displays the highly cited paper's network with a minimum of 50 citations and all the highly-cited papers divided into 4 clusters. Namely, Yellow, red, green, and blue. The size of the circle denotes the total citations received and curved and the thickness of the line shows the relation between the papers.

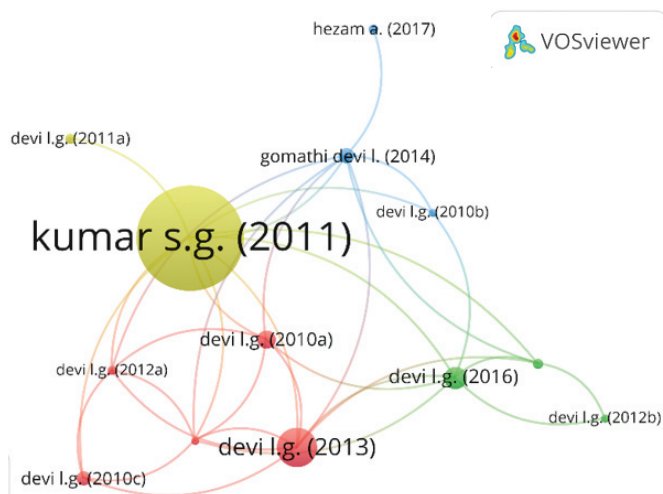


Figure 4. Highly cited papers network with a minimum of 50 citations.

6.8 Most Occurred Keywords Analysis

Keyword co-occurrence can effectively reflect the key research points in the subject field and provide auxiliary support for scientific research. In all 8,952 publications, we got a total of 38,347 keywords. Among them, the keyword co-occurrence network selected 40 keywords, which appeared more than 200 times. The size of the node and the word in Fig. 5 indicate the weight of the node. The larger the node and word, the greater the weight. The distance between two nodes reflects the strength of the relationship between the two nodes. A shorter distance usually indicates a stronger relationship. The line between two keywords indicates that they have appeared together. The thicker the line, the more they co-occur. Nodes with the same color belong to the cluster. VOSviewer divides all keywords of publications into 3 clusters. The keyword “article” has the highest frequency of 2,093. Other high-frequency keywords include “nonhuman” (1,146), “controlled study” (1,129), and “Unclassified Drug” (1,020). The strength of the link between two nodes refers to the frequency of simultaneous occurrence. It can be used as a quantitative indicator of the relationship between two nodes.

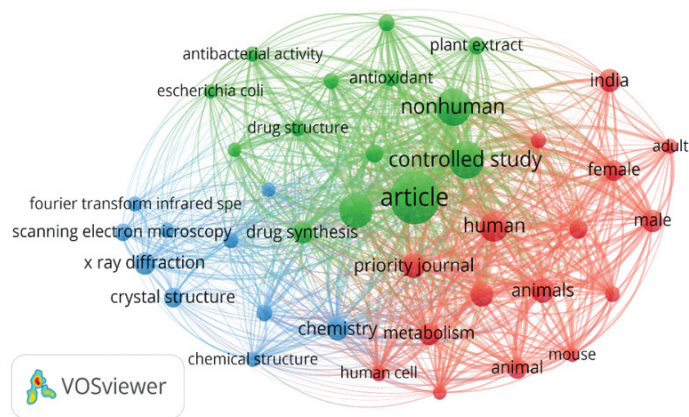


Figure 5. Keyword's co-occurrence network (with minimum 200 occurrences) of the universities with CPEPA status in Karnataka.

7. CONCLUSION

This study measured research productivity and visualisation of the 'Universities with CPEPA status in Karnataka' publications during 2010–2019. The analysis focused on significant indicators of research productivity, distribution of publications, and most productive authors and keyword analysis. Most of the papers are in article format and observed the increasing trend in publications during the study period. Although the leading faculty members of universities contributed much of their work in journals covered by Scopus, a significant number of publications of universities appear in national and other international journals, which are not covered by Scopus. All the highly cited articles are related to the science discipline. The University of Mysore performs well in most of the indicators among the Universities with CPEPA status in Karnataka and the other two also performed reasonably well in some indicators.

The authors suggested that the Universities with CPEPA status in Karnataka state should pay special attention to develop a suitable research policy. As these universities receive funds from UGC (University Grants Commission), these institutions should utilise funds for improving research facilities and availing equipment for scientific productivity. To increase citations and visibility of publications from universities and to improve their research impact, universities should establish repositories at the regional or institutional level.

The Indian government contributes about one-fourth of total governmental expenditure on education in India, though it has a key share in research funding. The data points towards the fact that organised and planned efforts by the governments are essential in the higher education sector to progress the overall environment in which Indian higher education institutions are working at present. In the modern time of a globalised world and knowledge-based economies, it becomes more significant that authors initiate an efficient and honest effort to progress the Indian higher education system, particularly the multidisciplinary universities.

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His contribution in the current study is to examine the downloaded bibliographic data and wrote the final paper.