

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:

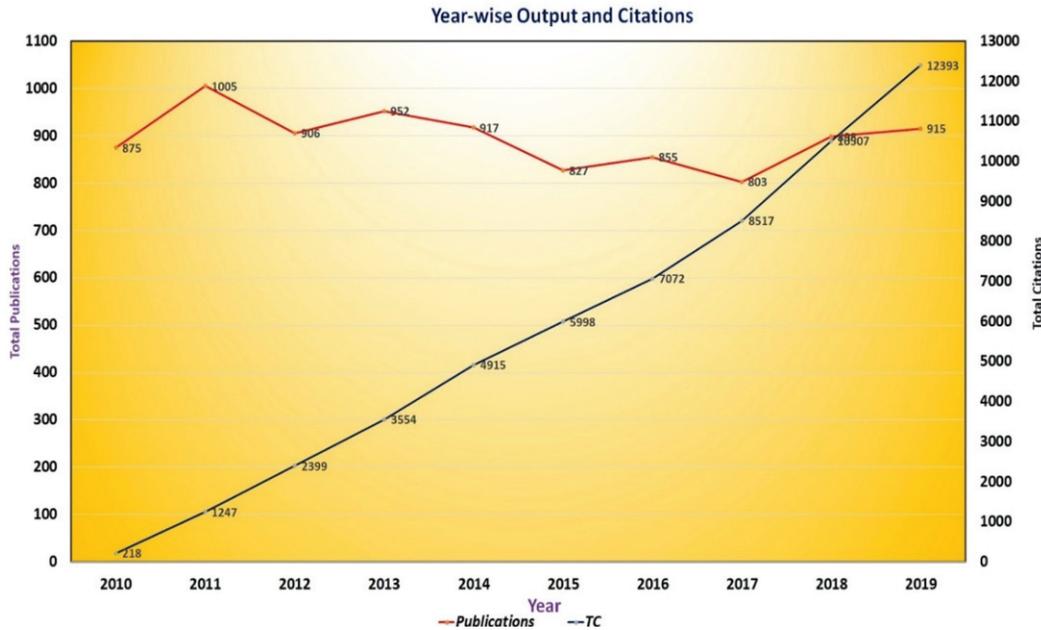


Figure 1. Annual publications and total citations of the universities with CPEPA status in Karnataka.

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:

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

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

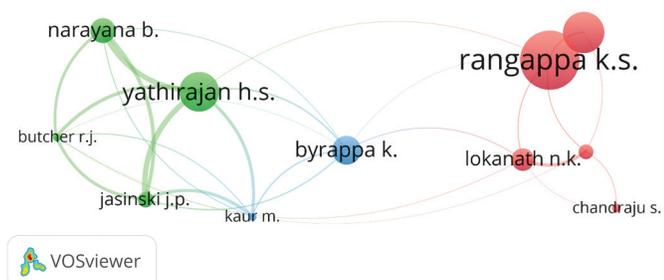


Figure 2. Top 20 productive authors co-citation network of the Universities with CPEPA status in Karnataka.

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

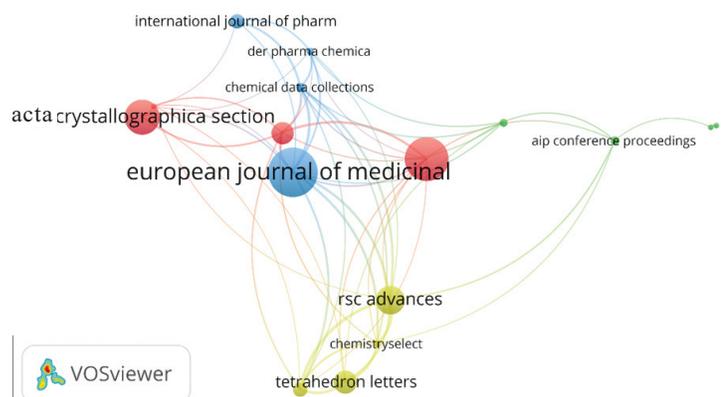


Figure 3. The journal co-citation network of the universities with CPEPA status in Karnataka.

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.

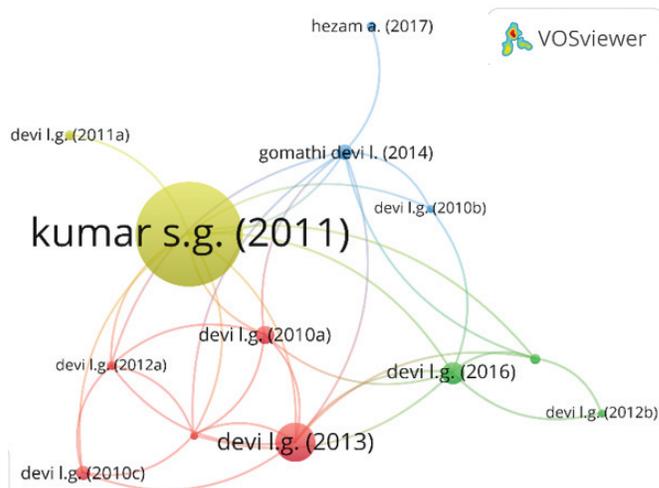


Figure 4. Highly cited papers network with a minimum of 50 citations.

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.

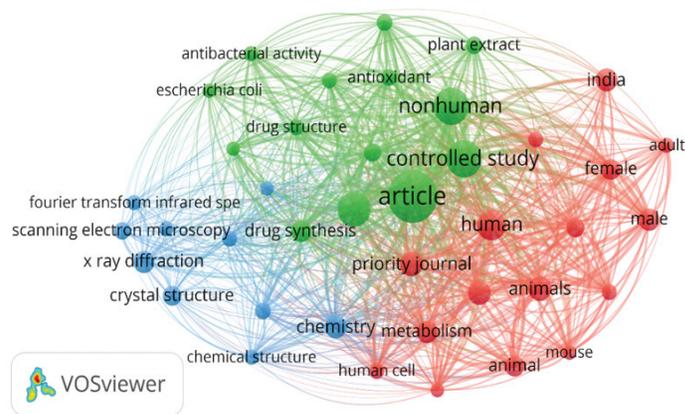


Figure 5. Keyword's co-occurrence network (with minimum 200 occurrences) of the universities with CPEPA status in Karnataka.

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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