

## Scientometric Profile of the University of Madras: The Mother of South Indian Universities

R. Santhakumar<sup>#,\*</sup>, K. Kaliyaperumal<sup>#</sup> and S. Louies<sup>s</sup>

*University of Madras, Chennai – 600 005, India*

*<sup>s</sup>Govt. Arts and Science College, Avinashi - 641654, India*

*\*E-mail: santham74@gmail.com*

### ABSTRACT

The Madras University is one of the oldest universities in India which produced many scholars, philosophers, scientists, philanthropists and so on. It has a unique position among the Indian universities in terms of academic and research pursuits. In this context, this paper made an attempt to illustrate the research productivity of the university for a period of ten years from 2009 to 2018. A total of 3283 publications of the university are downloaded from Web of Science database. The results show that the productivity has fluctuating trend in the pattern of publication growth. The overall average for references for each article was 10.89 and h-index of the university is 65 during the study period. The major findings of the study report that the university produces more number of papers in the field of chemistry and the researchers preferred to publish their research output in UK journals.

**Keywords:** Research productivity of University of Madras; Mapping of the productivity; Publication growth rate; Collaboration patterns.

### 1. INTRODUCTION

Madras University is the mother of almost all the old universities of South India. It has a glorious history by serving to the global academic and research community over a period of more than a century. Most of the Nobel Laureates, Presidents of India, Statesman, Chief Justice of India, Ministers, Administrators, Distinguished Researchers and Academicians are the alumni of the University of Madras and it has been accredited with A+ by NAAC. It is recognised as one of the first five Universities, for the UGC's prestigious programme, "University with Potential of Excellence (UPE)".

Few studies have already been made on the research productivity of this institution which are the proofs of the research contributions of it. The principal study made by Senthil kumar and Ulaganathan (2015), suggest a methodology for studying the quantitative profile of the research output of the university, with a view to get idea about the performance and impact of research produced in various departments. For building a more reliable and objective picture on the contribution of University of Madras and understanding how this picture has changed overtime, the present study attempts to analyse the growth and development of research productivities of the University of Madras as reflected in its publications output indexed in the Web of Science.

### 2. LITERATURE REVIEW

Several scientometric studies have been published dealing

with the research performance of various institutions in India as well as at the global level. Among them few are reviewed hereunder:

Maharana and Das (2013) studied the annual growth of Utkal university publications, authorship pattern, degree of collaboration, most prolific contributor, prolific institution, geographical distribution etc. Gopikuttan and Aswathy (2014) analysed the overall performance of the faculty members of Science Departments of University of Kerala in research productivity and the parameters such as form-wise, year-wise and subject-wise distribution.

Satpathy and Sa (2015) studied the research productivity of Odisha's state universities during 2010 to 2014 indexed in SCOPUS. The study found that Utkal University is the most productive institution with 37.76 per cent.

Anil kumar et al. (2015) studied the research publications of Gujarat University during the ten-year period between 2004 and 2013 from Scopus database. Bhakta and Bhui (2018) showcased the escalation of research productivity of University of Petroleum and Energy Studies, Dehradun for the time span of 10 years from 2008 to 2017.

Balasubramani and Parameswaran (2014) studied the research productivity of Banaras Hindu University (BHU) from the Web of Science. The study found that there was a gradual growth of publications during 2000 - 2011. The annual average research output of BHU was 578 records and the research output of the scientists is fairly collaborative.

Parameswaran (2015) studied the research output of Anna University from the Web of Science database for a period of

34 years from 1980 to 2013. The study found that there was a gradual growth of publications during 1980-2013. Bid (2016) studied the research productivity of IIT Kharagpur during 2000 to 2015. The study revealed an exponential growth pattern and journal articles are the most published form of literature.

Maharana and Das (2013) studied the annual growth of Utkal university publications, authorship pattern, degree of collaboration, most prolific contributor, prolific institution, geographical distribution etc. Gopikuttan and Aswathy (2014) analysed the overall performance of the faculty members of Science Departments of University of Kerala in research productivity and the parameters such as form-wise, year-wise and subject-wise distribution.

Satpathy and Sa (2015) studied the research productivity of Odisha's state universities during 2010 to 2014 indexed in SCOPUS. The study found that Utkal University is the most productive institution with 37.76 per cent.

Anil kumar et al. (2015) studied the research publications of Gujarat University during the ten-year period between 2004 and 2013 from Scopus database. Bhakta and Bhui (2018) showcased the escalation of research productivity of University of Petroleum and Energy Studies, Dehradun for the time span of 10 years from 2008 to 2017.

Balasubramani and Parameswaran (2014) studied the research productivity of Banaras Hindu University (BHU) from the Web of Science. The study found that there was a gradual growth of publications during 2000 - 2011. The annual average research output of BHU was 578 records and the research output of the scientists is fairly collaborative.

Parameswaran (2015) studied the research output of Anna University from the Web of Science database for a period of 34 years from 1980 to 2013. The study found that there was a gradual growth of publications during 1980-2013. Bid (2016) studied the research productivity of IIT Kharagpur during 2000 to 2015. The study revealed an exponential growth pattern and journal articles are the most published form of literature.

Maharana and Das (2013) studied the annual growth of Utkal university publications, authorship pattern, degree of collaboration, most prolific contributor, prolific institution, geographical distribution etc. Gopikuttan and Aswathy (2014) analysed the overall performance of the faculty members of Science Departments of University of Kerala in research productivity and the parameters such as form-wise, year-wise and subject-wise distribution.

Satpathy and Sa (2015) studied the research productivity of Odisha's state universities during 2010 to 2014 indexed in SCOPUS. The study found that Utkal University is the most productive institution with 37.76 per cent.

Anil kumar et al. (2015) studied the research publications of Gujarat University during the ten-year period between 2004 and 2013 from Scopus database. Bhakta and Bhui (2018) showcased the escalation of research productivity of University of Petroleum and Energy Studies, Dehradun for the time span of 10 years from 2008 to 2017.

Balasubramani and Parameswaran (2014) studied the research productivity of Banaras Hindu University (BHU) from the Web of Science. The study found that there was a gradual growth of publications during 2000 - 2011. The annual

average research output of BHU was 578 records and the research output of the scientists is fairly collaborative.

Parameswaran (2015) studied the research output of Anna University from the Web of Science database for a period of 34 years from 1980 to 2013. The study found that there was a gradual growth of publications during 1980-2013. Bid (2016) studied the research productivity of IIT Kharagpur during 2000 to 2015. The study revealed an exponential growth pattern and journal articles are the most published form of literature.

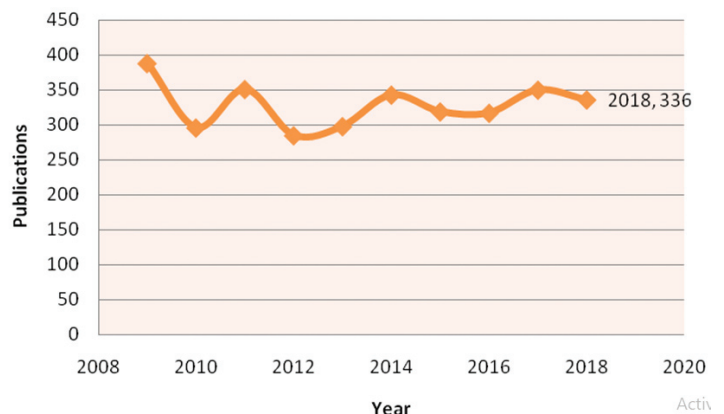
### 3. OBJECTIVES

The objectives are as follows:

- To analyse annual distribution and growth of literature of the University
- To study the forms publications of the University
- To identify the most prolific authors of the University
- To identify the countries that are collaborated with the University
- To identify the choice of the journals for the publications
- Subject wise distribution of the publications
- Identification of the highly cited papers of the institution under study.

**Table 1. Year wise distribution publications**

Year	Articles	Percentage	Growth Rate	Citations	CPP
2009	388	11.82	-	132	0.34
2010	296	9.02	-23.71	604	2.04
2011	351	10.69	18.58	1485	0.45
2012	285	8.68	-18.80	2126	7.46
2013	298	9.08	4.56	2789	9.36
2014	343	10.45	15.10	3674	10.71
2015	319	9.72	-7.00	4498	14.10
2016	317	9.65	-0.63	5496	17.34
2017	350	10.66	10.41	6866	19.62
2018	336	10.23	-4.17	8071	24.02
Total	3283	100		35741	10.89



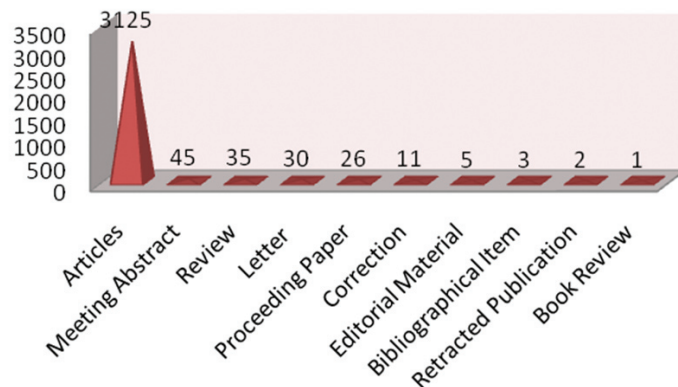
**Figure 1. Annual growth of publications.**

**Table 2. Types of publications**

Types of publications	Articles	%	Citations	H Index	ACCP
Articles	3125	95.19	33793	63	10.81
Meeting Abstract	45	1.37	10	2	0.22
Reviews	35	1.07	1873	16	53.51
Letters	30	0.91	240	5	8
Proceeding Papers	26	0.79	118	6	4.54
Corrections	11	0.34	1	1	0.09
Editorial Materials	5	0.15	5	1	1
Bibliographical Items	3	0.09	0	0	0
Retracted Publications	2	0.06	21	2	10.5
Book Reviews	1	0.03	0	0	0

#### 4. METHODOLOGY

The bibliographic details of the published literature were collected using general search option of Web of Science. In the address field of the general search option, the name of the university as 'University of Madras' was provided. The search was limited for a period of ten years, i.e., 2009 to 2018 and 3283 records were downloaded. The collected data were analysed using MS-Excel spreadsheet and MS-Word. After

**Figure 2. Types of publications.**

data validation, data were analysed as per the objectives of the study.

### 5. DATA ANALYSIS AND INTERPRETATIONS

#### 5.1 Year Wise Growth of Publications and Citations

Among 3283 publications, the citation patterns are analysed and presented in the Table 1. It is seen from the table that fluctuating trend in the pattern of citations, it varies from 0.34 to 24.02 in different years. Thus, 35741 citations were received with average of 10.89 citations per paper.

##### 5.1.1 Year-wise Distribution of Publication

It is seen from Table 1 and Fig. 1 that the year 2009 has

**Table 3. Identification of most prolific authors**

Author	Department/Centre	Articles	Citations	H Index	ACCP	Intl. Collab. Paper
Narayanan, V	Dept. of Inorganic Chemistry	146	3614	26	24.75	47
Velmurugan, D	Centre of Advanced Study in Crystallography and Biophysics	133	722	15	5.43	54
Mohanakrishnan, A K	Dept. of Organic Chemistry	118	623	14	5.28	0
Raghunathan, R	Dept. of Organic Chemistry	117	948	18	8.10	15
Ponnuswamy, M N	Centre for Advanced Study in Crystallography and Biophysics	102	304	8	2.98	14
Rajakumar, P	Dept. of Organic Chemistry	93	522	13	5.61	4
Stephen, A	Dept. of Nuclear Physics	81	2490	23	30.74	40
Bakthadoss, M	Dept. of Organic Chemistry	63	433	13	6.87	0
Suthanthiraraj, S A	Dept. of Energy	56	332	11	5.93	5
Balakumar, S	National Centre for Nanoscience and Nanotechnology	55	480	13	8.73	7
Suresh, R	National Centre for Ultrafast Processes	55	750	15	13.64	7
Pandian, K	Dept. of Inorganic Chemistry	50	682	14	13.64	25
Ramamurthy, P	Dept. of Inorganic Chemistry	50	746	15	14.92	5

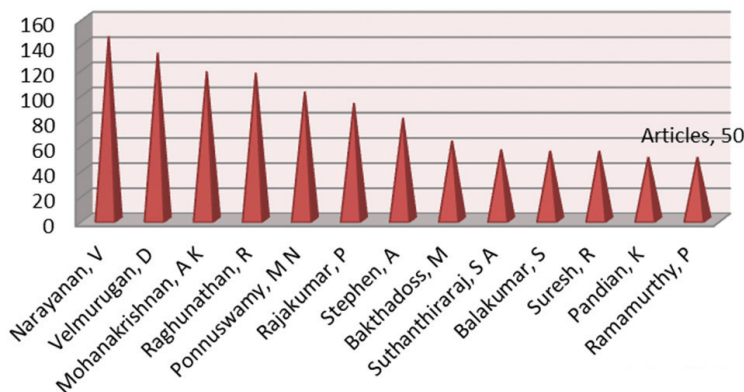


Figure 3. Most prolific authors.

Table 4. Collaborative research activities of the university

Name of the institution	Articles	%	Citations	H Index	ACCP
Anna University	378	11.51	3062	38	8.10
Council of Scientific Research	181	5.51	2422	25	13.38
IIT System	103	3.14	3670	26	35.63
Presidency University	98	2.98	551	14	5.62
CLRI	86	2.62	1368	18	15.91
IIT Madras	74	2.25	1303	18	17.61
Alagappa University	61	1.86	897	17	14.70
Bharathithasan University	60	1.83	512	13	8.53
SRM Institute of Science and Technology	50	1.52	987	15	19.74
Loyola College	46	1.40	504	13	10.96
Madurai Kamaraj University	46	1.40	408	12	8.87
Pondicherry University	41	1.25	699	13	17.05
Prist University	41	1.25	47	3	1.15

the highest number of publications i.e. 388 (10.31 %), and the year 2012 has the lowest number of publications with 285 (0.16 %). It is also seen that 388 articles published in the year 2009 but in 2010 it has decreased into 296 (9.02 %) articles. It reveals that fluctuating trend in the research contributions of the university.

Table 1 is also illustrate the Annual Growth Rate (AGR) of the quantum of publications. It shows a negative change of -23.71 per cent in 2010 and an increase of 18.58 per cent in 2011, and again there is a drop in 2012. The above trend of the publication contributions of the university exhibiting a fluctuating trends in the research contribution of the institution.

## 5.2 Types of Publications

Table 2 and Fig. 2 present that 95.19 per cent, i.e., 3125 documents are the journal articles which forms the majority of the contribution. Meeting Abstract and Review comes in second and third position with 45 (1.37 %) and 35 (1.07 %) contributions each. Thus, most of the contributions of the university are journal articles.

## 5.3 Identification of Most Prolific Authors

A total of 9912 authors, including international authors are involved in the university publications. An average number of author per article is 3.02. From the Table 3, it is apparent that Dr. V. Narayanan from Department of Inorganic Chemistry, holds the first position with 146 articles who has high productivity and impressive h-index, followed by Dr. D. Velmurugan, from Centre of Advanced Study in Crystallography and Biophysics poses second rank and Dr. A. K. Mohanakrishnan, from Department of Organic Chemistry, third position with 118 articles and Dr. R. Raghunathan, from Department of Organic Chemistry, with 117 articles and Dr. M. N. Ponnuswamy, Centre for Advanced Study in Crystallography and Biophysics, with 102 articles respectively. While observing, it is clear that these top 13 authors are from lab-oriented departments of the Guindy campus of the university.

The faculties of organic and inorganic departments of the university, Guindy Campus, have been participating significantly in the totality of the research productivity of the institution. On the other hand, the nature of collaboration among most prolific authors of department of inorganic chemistry reveals that the collaboration at local level is quite higher as compared to national and international level. However, the collaboration of the inorganic chemistry department faculties at international level is fairly good.

### 5.3.1 H-index

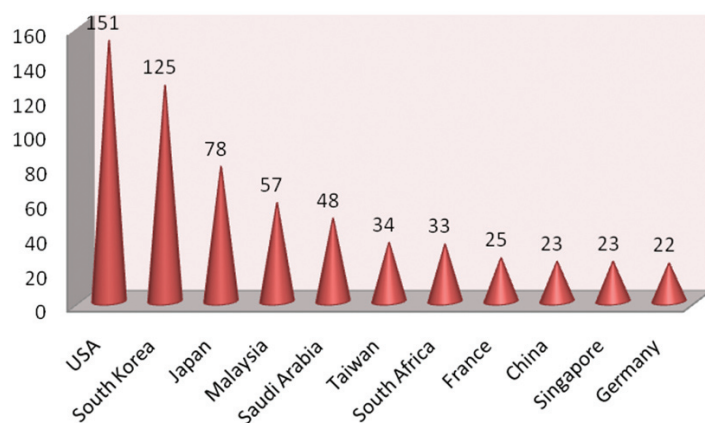
The h-index of 13 most prolific authors in University of Madras varied from 8 to 26 with average h-index of 15.23. Three faculty of the university have got more than the average h-index of all faculties. Dr. V. Narayanan from Department of Inorganic Chemistry, with h-index 26 followed by Dr. A. Stephen from Department of Nuclear Physics, with h index of 23 and Dr. R. Raghunathan from Department of Inorganic Chemistry with h index of 18 respectively.

### 5.3.2 Average Citation Per Publications

The Average Citation Per Publications is a scientometric indicator to analyse the quality of publications. Average citation per publication varied from 5.28 to 30.74, with average citation impact 12.13. Dr. A. Stephen, from Department of Nuclear Physics with ACPP of 30.74 followed by Dr. V. Narayanan of the Department of Inorganic Chemistry with ACPP of

**Table 5. International research collaboration**

Countries	Articles	%	Citations	CPP
USA	151	4.60	2927	19.38
South Korea	125	3.81	1551	12.41
Japan	78	2.38	1142	14.64
Malaysia	57	1.74	443	7.77
Saudi Arabia	48	1.46	2038	42.46
Taiwan	34	1.04	393	11.56
South Africa	33	1.01	1417	42.94
France	25	0.76	988	39.52
China	23	0.70	995	43.26
Singapore	23	0.70	660	28.70
Germany	22	0.67	286	13

**Figure 4. Research collaboration countries.****Table 6. Preference of journals for publications**

Title of the journals	Articles	Country	Citations	Impact Factor
ACTA Crystallographica Section E Structure Reports Online	165	UK	256	2.333
RSC Advances	89	UK	1116	2.936
ACTA Crystallographica Section E Crystallographic Communications	68	UK	107	0.567
International Journal of Biological Macromolecules	48	Netherlands	571	4.784
Tetrahedron Letters	45	UK	641	2.259
New Journal of Chemistry	41	UK	295	3.069
Spectrochimica ACTA Part A Molecular and Biomolecular Spectroscopy	35	UK	836	2.931
Synthetic Communications	35	USA	130	1.439
Journal of Materials Science Materials in Electronics	34	Netherlands	177	2.195
Molecular and Cellular Biochemistry	34	USA	552	2.884

24.75 and Dr. P. Ramamurthy from Department of Inorganic Chemistry with ACPP of 14.92 respectively.

#### 5.4 Collaborative Research Activities of the University

Table 4 presents the collaborative patterns of the university. It is noted from the table that, out of 3283 records, 378 records are collaborated with Anna University authors and followed by Council of Scientific and Industrial Research. The remaining collaborations are made with other major institutions of the country.

#### 5.5 International Research Collaboration

Table 5 and Fig. 4 present that the university authors are collaborated with 69 countries. This university had the highest number of collaborating publications mainly with (151 articles) with USA, followed by South Korea with 125 articles and Japan with 78 publications. Thus, University of Madras also has international collaboration in attracting more citations as well as these collaborative articles have much more impact in terms of citation per paper.

#### 5.6 Preference of Journals for Publications

It is seen from the Table 6 that ACTA Crystallographica Section E Structure Reports Online journal tops the list with more articles of 165 (5.03 %) contributed by the university. Followed by RSC Advances with a share of 89 (2.71 %) and ACTA Crystallographica Section E Crystallographic Communications occupies third position with 68 (2.07 %) publications.

It is also seen that top ten publications are published in the journals with impact factor ranging from 0.567 to 4.784. It shows that the faculty and researchers are preferred to publish their publications with high impact factor journals.

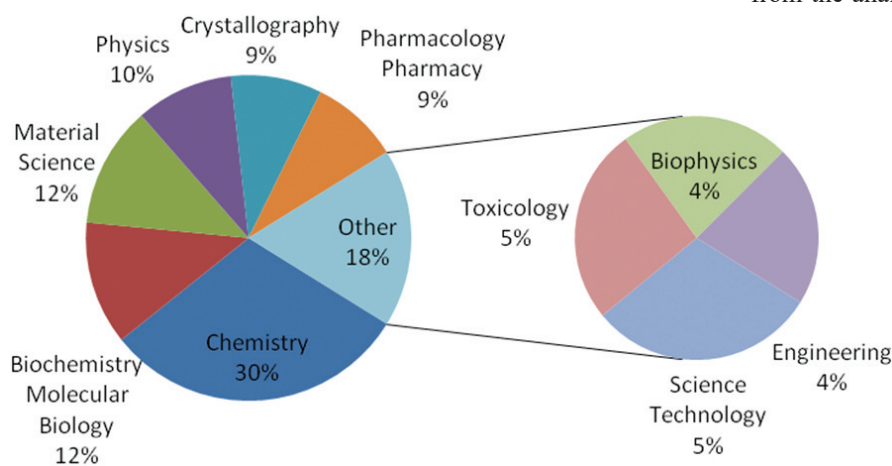
Further, country wise distribution of the top 10 journals shows that UK has published 443 articles in 6 journals which received 3251 citations followed by Netherlands with 82 articles in 2 journals which received 748 citations and USA with 69 publications in two journals which received 682 citations. It shows that the researchers have preferred to publish their research articles in international journals.

#### 5.7 Subject wise Distribution

Table 7 shows that the subject Chemistry has more number of articles, i.e., 992 (30.22 %) followed by Biochemistry owns the second position with 400 (12.18 %) articles. Material Science occupies the third position with 392 (11.94 %) articles. The fourth highest articles belong to the subject physics with 316 (9.62 %) followed by Crystallography with 295 (8.98 %) articles and Pharmacology Pharmacy with 289 (8.80 %) articles respectively.

**Table 7. Subject wise distribution**

Title	Articles	%	Citations	ACCP
Chemistry	992	30.22	13787	13.90
Biochemistry	400	12.18	5437	13.59
Material Science	392	11.94	6833	17.43
Physics	316	9.63	3401	10.76
Crystallography	295	8.99	873	2.96
Pharmacology Pharmacy	289	8.80	4588	15.88
Science Technology	174	5.30	2737	15.73
Toxicology	150	4.57	2382	15.88
Biophysics	129	3.93	2611	20.24
Engineering	123	3.75	1563	12.71

**Figure 5. Subject wise publications.**

### 5.8 Highly Cited Articles

Appendix 1 listed 10 highly cited papers which received citations from 240 to 1518. These 10 papers altogether received 4472 citations, which averaged to 447.2 citations per paper. Among the top 10 highly cited papers, 7 were published in articles and the remaining 3 are reviews. The top 10 highly cited papers involved the participation of 98 authors and 50 organisations. With reference to the Table 8, the first two articles which got maximum citation, i.e., 1518 & 623 are authored by Dr. K.K. Krishnasamy of Department of Microbiology, Dr. A.L.M. Post Graduate Institute of Basic Medical Sciences, University of Madras Taramani Campus which is followed by the article of Dr. Fayaz, A.M of Centre for Advanced Study in Botany, University of Madras, Guindy Campus which received 541 citations.

### 6. MAJOR FINDINGS

The followings are the major findings of the study:

- Most of the contributions of the university are journal

articles which constituted in to 95.19 per cent of the total publications

- ACTA Crystallographica Section E Structure Reports top the list with the highest number of articles of 165
- Dr. V. Narayanan is a highly productive author in terms of contributions with an impressive h-index
- The researchers are collaborated with 69 countries
- The research productivity of the University is much recognised at the international level.

### 7. SUMMARY AND CONCLUSIONS

The quantity and quality of the publications are one of the major factors to be considered for ranking of the universities. As far as university research output is concerned, a major role played by the science departments (Guindy Campus) of the university. Faculties preferred to publish their papers in international journals. Their preference is more for journals from UK which also happens to be one of the countries publishing maximum journals. Further, the productivity of the university illustrates a substantial growth. It is also observed from the analysis that the university main campus (Chepauk)

contributions are very less. Therefore, more attention may be taken for increasing the number of publications by the main campus researchers. Besides, there is an urgent need for the bibliographic control of University of Madras publications and citations of a comprehensive database of publications.

### REFERENCES

1. Senthilkumar, R & Ulaganathan, G. Mapping of research productivity in University of Madras: A scientometric study. *IIR J. Engineering Res. Applications*, 2015, 2(1), 19-31.
2. Maharana, Rabindra & Das, Prangya. Research publication trend of Utkal University's researchers indexed in scopus during 2008 to 2012: A Bibliometric Analysis. *Libr. Philos. Pract. (e-journal)*, 2013, 999. <http://digitalcommons.unl.edu/libphilprac/999>.
3. Gopikuttan, A. & Aswathy, S. Publication productivity of University of Kerala: A scientometric view. *DESIDOC J. Libr. Inf. Technol.*, 2014, 34(2), 31-139.
4. Jeysankar, R.; Babu, B.R. & Rajendran, P. Research output of CSIR-Central Electro Chemical Research Institute (CECRI): A study. *Annals Libr. Inf. Stud.*, 2011, 58(4), 301-06.
5. Satpathy, Sunil Kumar & Kumar, Manoj. Research outputs of State Government Universities of Odisha: A bibliometric study, *Libr. Philos. Pract. (e-journal)*, 2015, 1309. <http://digitalcommons.unl.edu/libphilprac/1309>.
6. Kumar, Anil; Dora, Mallikarjun & Desai, Asha. A bibliometrics profile of Gujarat University, Ahmedabad during 2004-2013. *DESIDOC J. Libr. Inf. Technol.*, 2015, 35(1), 9-16. doi: 10.14429/djlit.35.1.7699.
7. Bhakta, Jayanta & Bhui, Trishna. Mapping the research

- productivity in University of Petroleum and Energy Studies: A scientometric approach. *Libr. Philos. Pract. (e-journal)*, 2018, 1972. <http://digitalcommons.unl.edu/libphilprac/1972>.
8. Balasubramani, R. & Parameswaran, R. Mapping the research productivity of Banaras Hindu University: A scientometric analysis. *J. Theor. Appl. Inf. Technol.*, 2014, **59**(2), 367-371. <http://www.jatit.org/volumes/Vol59No2/16Vol59No2.pdf>.
  9. Parameswaran, R. Research output of Anna University: A scientometric study. *Knowl. Libr.*, 2015, **2**(2), 85-100. <http://www.klibjlis.com/2.2.5.pdf>.
  10. Bid, Subhodip. Indian Institute of Technology, Kharagpur: A scientometric study of research output. *SSARSC Int. J. Libr. Inf. Network Knowl.*, 2016, **1**(1), 1-15.

## CONTRIBUTORS

**Dr R. Santhakumar** is presently working as Technical Associate in Madras University Library, University of Madras, Chennai. He

obtained MSc (Physics) from Alagappa University, Karaikudi, and MLIS, MPhil and PGDCA from Madurai Kamaraj University. He has published 30 articles in national and international journals and presented 16 articles both in national and international conferences.

The contribution in the study is the application of scientometric indicators to the data of the article downloaded from web of science database. Required guidance and suggestions are also given to follow in the final draft of the article.

**Dr K. Kaliyaperumal** working as University Librarian, Madras University Library and authored five books and published 30 journal article.

The contribution in the study is the analysis data which has been systematically interpreted. When ever suggestions made by the article is interpreted him in the interpretation of the study.

**Mr. S. Louies** working as Librarian, Govt. Arts and Science College, Avinasi.

The contribution in the study is to download pertaining to the article from web of science. After final analysis research methodology to the article for the three authors.

## Appendix 1

### Highly cited articles

Highly cited research work of the University of Madras	Types of publications	Citations
Kumarasamy, K.K, et al. (2010). Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: a molecular, biological, and epidemiological study, <i>Lancet Infectious Diseases</i> , 10 (9), pp. 597-602	Article	1518
Munoz-Price, L. Silvia, et al. (2013). Clinical epidemiology of the global expansion of Klebsiella pneumoniae carbapenemases, <i>Lancet Infectious Diseases</i> , 13 (9), pp. 785-796	Review	623
Fayaz, Amanulla Mohammed et al. (2010). Biogenic synthesis of silver nanoparticles and their synergistic effect with antibiotics: a study against gram-positive and gram-negative bacteria, <i>Nanomedicine-Nanotechnology Biology And Medicine</i> , 6(1), pp. 103-109	Article	541
Krishnaraj, C et al., (2010). Synthesis of silver nanoparticles using Acalypha indica leaf extracts and its antibacterial activity against water borne pathogens, <i>Colloids And Surfaces B-Biointerfaces</i> , 76 (1), pp. 50-56	Article	527
Saravanan, R et al. (2013). Enhanced photocatalytic activity of ZnO/CuO nanocomposite for the degradation of textile dye on visible light illumination, <i>Materials Science &amp; Engineering C-Materials For Biological Applications</i> , 33 (1), pp. 91-98	Review	418
Rajendran, P et al, (2013). The Vascular Endothelium and Human Diseases, <i>International Journal Of Biological Sciences</i> , 9 (10), pp. 1057-1069	Article	302
Kasthuri, J.; Veerapandian, S and Rajendiran, N (2009). Biological synthesis of silver and gold nanoparticles using apiin as reducing agent, <i>Colloids And Surfaces B-Biointerfaces</i> , 68 (1), pp. 55-60	Article	276
Kaviya, S et al, (2011). Biosynthesis of silver nanoparticles using citrus sinensis peel extract and its antibacterial activity, <i>Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy</i> , 79 (3), pp. 594-598	Article	250
Saravanan, R (2013). ZnO/Ag nanocomposite: An efficient catalyst for degradation studies of textile effluents under visible light, <i>Materials Science &amp; Engineering C-Materials For Biological Applications</i> , 33 (4), pp. 2235-2244	Review	245
Swetha, M et al (2010). Biocomposites containing natural polymers and hydroxyapatite for bone tissue engineering, <i>International Journal of Biological Macromolecules</i> , 47 (1), pp. 1-4.	Article	240