

Research Output of Anna University: A Bibliometric Study Based on Scopus Database

N. Geetha¹ and S. Kothainayaki²

^{1&2}Assistant University Librarian, (Grade-I), University Library, Anna University, Chennai, Tamil Nadu, India
E-Mail: geethavasegaran@yahoo.co.in, kothai.suresh@gmail.com

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Abstract – The study analyses research output of Anna University (Tamil Nadu) using Scopus database during the period 1988 to 2017 (30 years). Further predominance was given for Type of Source, Chronological growth, Subject wise contribution, Document type preferred, Collaborated Country, Collaborated Institutions, Contributed Journal, Highly contributed author, Keywords Preferred and Language of the paper. A total of 23,883 records have been identified and the same has been analyzed using bibliometric study. There has been steady growth of publications and 50% of articles appeared during the last five years between 2013 and 2017. The publications were doubled once in seven years. The average publication per year works out to 795 papers and nearly 78% of contributions were from Engineering; Computer Science; Materials Science, Physics and Astronomy. Around 17 Countries collaborated and contributed to more than 101 papers. The top three journals which have more publications were, “International Journal of Applied Engineering Research”; “European Journal of Scientific Research” and “Journal of Crystal Growth”.

Keywords: Research Output of Anna University, Bibliometric Study, Growth of Publications, Study Based on Scopus Database, Anna University (Tamil Nadu)

I. INTRODUCTION

The metric studies were considered as measure for the Institutional research output. Further they were also used for measuring scholarly communication to identify research trends and growth of knowledge; users of different subjects; estimate comprehensiveness of secondary periodicals; forecast past, present and future publishing trends; authorship and its trends in documents on various subjects; predict productivity of publishers or individual authors etc. Among the metric studies Bibliometrics and Scientometrics has been used to evaluate the research performance of Academic Universities and Research centres. The term ‘Bibliometrics’ was coined by British Scientist Alan Pritchard, defined as the application of Mathematics and Statistical methods to books and other media of communication (Pritchard, 1969). Bibliometric includes studies of the growth of the literature in some subject, how much of it is contributed by various individuals, groups, or organisations or countries; how much exists in various languages and how the literature on some subject becomes obsolete. Bibliometric study also includes what sources author cite, citation studies and geographical distribution of documents (Sangam, 2008; Rao, 2010). The bibliometric studies or research is conducted by applying three laws: Lotka’s Law (Productivity of authors in terms of scientific

papers), Bradford’s Law (Scattering of articles over different journals), and Zipf’s Law (Frequency of occurrence of words in text). In this study an attempt has been made to focus on measuring the research performance of Anna University using bibliometric methods.

II. ANNA UNIVERSITY

The Anna University was established on 4th September, 1978 as a unitary type of University integrating four well known technical institutions in the city of Madras (now Chennai) namely, College of Engineering (CEG) (Established in 1794); Alagappa College of Technology (ACT) (Established in 1944); Madras Institute of Technology (MIT) (Established in 1949) and School of Architecture & Planning (SAP) (Established in 1957). In 2001 Anna University was converted to an affiliating type University by bringing together all the Engineering colleges in the State of Tamil Nadu and again reconverted to the unitary type in 2010. In 2012, Anna University was again converted to an affiliating type of University by bringing together all the Engineering Colleges in the State of Tamil Nadu under one umbrella to ensure uniform quality in engineering education along with the 4 University Department Campuses (CEG/MIT/ACT/SAP Campuses). Presently, Anna University has 13 Constituent Colleges, 3 Regional Campuses at Tirunelveli, Madurai and Coimbatore and 593 Affiliated Colleges (Government, Government Aided and Self-Financing Colleges). In World University Ranking Anna University is ranked 201 as per QS (Quacquarelli Symonds) in the Engineering and Chemical faculty during the year 2017-2018. In the subject of Mechanical, Aeronautical and Manufacturing Engineering, Anna University is ranked between 151 and 200 at the Global level and 7th at National level.

III. NEED FOR THE STUDY

The University was established with the following objectives

1. To constantly raise the quality of engineering education, thereby to produce superior human resource to match the rapid technological developments.
2. To share its academic experience and infrastructure with other institutions for providing quality education across the State and help students to fulfil their dreams.

3. To uphold the highest ethical and professional standards while imparting Engineering education and fulfilling its obligations to students and staff.
4. To serve the society with technological advancement and to actively take part in building a knowledge-based society. The publication trends would enable to identify the direction in which the stated objectives were adhered by the academics of the University.

IV. REVIEW OF LITERATURE

Jia Zhu and others (2014) measured Research Performance of Chinese Universities using Bibliometric Methods. Moed *et al.*, (2002, 2010) studied on the potentialities of bibliometric data as tools for university research policy. In this study, the authors concluded that the use of bibliometric data can provide monitoring for university research-management and science policy even if there are a lot of problems during data collection and handling. The author further focused on how to measure research activities in China based on data extracted from the Science Citation Index (SCI), using bibliometric techniques.

Raan (1996) gave an overview of the potentials and limitations of bibliometric methods for the assessment of the strengths and weaknesses in research performance based on two different methods viz. research performance assessment and monitoring scientific developments. Cao *et al.*(2010) focused on the academic output in overall publication activity and the influential strength of certain disciplines of selected universities based on the Essential Science Indicators (ESI) database. Hassan *et al.*, (2013) presented case studies based on a system called Global Research Bench-marking System (GRBS), which provides objective data to benchmark research performance for the purpose of strengthening the quality and impact of research.

V. OBJECTIVES OF THE STUDY

The objectives of the study were:

1. To examine the research production of Anna University.
2. To identify the type of publications document preferred by the academics.
3. To identify the collaborated Countries and Organizations in the academic research of Anna University.
4. To identify the subject domain that has more research productivity.
5. To compare and measure the growth rate of literature published.

VI. HYPOTHESES

The following hypotheses will be formulated for this study based on the stated objectives.

1. There exists substantial research production among academics of Anna University.
2. There exists the domination of collaborative research among Anna University.

3. The research productivity can also be seen in other languages too, besides English.
4. Journals are the major source of publications in Anna University research.
5. There exists steady growth in publication production among academics of Anna University.

A. Data Collection

For this study, the literature on Anna University publications data has been downloaded from ‘SCOPUS’, multidisciplinary online database, which is an international indexing and abstracting database, using the search term (AFFIL(Anna University) AND PUBYEAR > 1987 AND PUBYEAR < 2018). Publications for the period 1988-2017 (30 years) have been downloaded from the database and a total of 23883 data has been identified. The collected data has been classified by using Excel and the same was loaded into SPSS (statistical package for social sciences) for the purpose of analysis. Statistical tools such as frequency distribution and percentage analysis and Scientometric techniques such as Relative Growth Rate (RGR), doubling time (Dt) citation analysis etc., were used for the study

B. Data Analysis

In the data analysis, predominance were given for Type of Source, Chronological growth, Subject wise contribution, Document type preferred, Collaborated Country, Collaborated Institutions, Contributed Journal, Highly contributed author, Keywords Preferred and Language of the paper.

C. Type of Source

The data thus collected from Scopus data base has been listed based on type of sources preferred for publications by the academics for their research output and shown in Table I.

TABLE I TYPE OF SOURCE

S. No.	Type of journal	No. of Papers	%
1	Open Access	741	3.10
2	Others	23,142	96.90
	Total	23883	100.00

Out of 23,883 publications, 23,142 (96.90%) papers appeared in other than the open source i.e. private access sources and the remaining 741 (3.10%) appeared in open access journals.

D. Chronological Growth

The chronological academic output has been analysed as shown in Table II. Further the Ratio of Growth (RoG), Relative Growth Rate (RGR) and doubling time (Dt) of the publications have also been calculated and shown in Table II.

TABLE II CHRONOLOGICAL GROWTH

S. No.	Year	Papers	%	Cum. Paper	%	RGR	Dt	RoG
1	1988	44	0.18	44	0.18	3.78	0.18	1.00
2	1989	51	0.21	95	0.39	0.77	0.90	1.16
3	1990	69	0.29	164	0.68	0.55	1.27	1.35
4	1991	56	0.23	220	0.91	0.29	2.36	0.81
5	1992	71	0.3	291	1.21	0.28	2.48	1.27
6	1993	74	0.31	365	1.52	0.23	3.06	1.04
7	1994	87	0.36	452	1.88	0.21	3.24	1.18
8	1995	84	0.35	536	2.23	0.17	4.07	0.97
9	1996	206	0.86	742	3.09	0.33	2.13	2.45
10	1997	204	0.85	946	3.94	0.24	2.85	0.99
11	1998	216	0.9	1162	4.84	0.21	3.37	1.06
12	1999	245	1.03	1407	5.87	0.19	3.62	1.13
13	2000	229	0.96	1636	6.83	0.15	4.60	0.93
14	2001	262	1.1	1898	7.93	0.15	4.67	1.14
15	2002	312	1.31	2210	9.24	0.15	4.55	1.19
16	2003	382	1.6	2592	10.84	0.16	4.35	1.22
17	2004	444	1.86	3036	12.7	0.16	4.38	1.16
18	2005	551	2.31	3587	15.01	0.17	4.16	1.24
19	2006	737	3.09	4324	18.1	0.19	3.71	1.34
20	2007	803	3.36	5127	21.46	0.17	4.07	1.09
21	2008	861	3.61	5988	25.07	0.16	4.46	1.07
22	2009	915	3.83	6903	28.9	0.14	4.87	1.06
23	2010	1163	4.87	8066	33.77	0.16	4.45	1.27
24	2011	1766	7.39	9832	41.16	0.20	3.50	1.52
25	2012	2068	8.66	11900	49.82	0.19	3.63	1.17
26	2013	2197	9.2	14097	59.02	0.17	4.09	1.06
27	2014	2635	11.03	16732	70.05	0.17	4.04	1.20
28	2015	2766	11.58	19498	81.63	0.15	4.53	1.05
29	2016	2296	9.61	21794	91.24	0.11	6.23	0.83
30	2017	2089	8.75	23883	99.99	0.09	7.57	0.91
Total		23883	8.75	Average Publication per year				795

There exists steady growth of publications as 50% of articles appeared during the last five years of 2013 and 2017. More than 1000 articles are made shown only from 2010 (1163, 4.87%). The ratio of growth (RoG) ranges between 0.81 and 1.52. Steep fall of publications can be noted during the years 1991, 1995, 1997, 2000, 2016 and 2017. RGR ranges between 0.09 and 0.77. Average RGR works out to 0.34. The doubling time ranges between 0.90 and 7.57. The publication doubles once in seven years and the average publication per year works out to 795 papers per year.

E. Subject Wise Contribution

Subject wise contribution of Anna University academicians has been analysed. The field which has more than 1000

contribution have been studied as shown in Table III. Majority of the contributions were in engineering discipline (8507papers, 35.62%); Computer Science (5757, 24.11%); Materials Science (4680, 19.60%) and Physics and Astronomy (3539, 14.82%) respectively. Nearly 78% of contributions were from above domains.

F. Document Type Preferred

The document type in which the contributions were made during the study has been analysed as shown in Table IV. Out of 23,883 papers, 17,523 (73.37%) papers were published as Journal Articles. It is followed by Conference Paper (5039, 21.11%); Reviews (576, 2.41%) and Book Chapter (228, 0.95%).

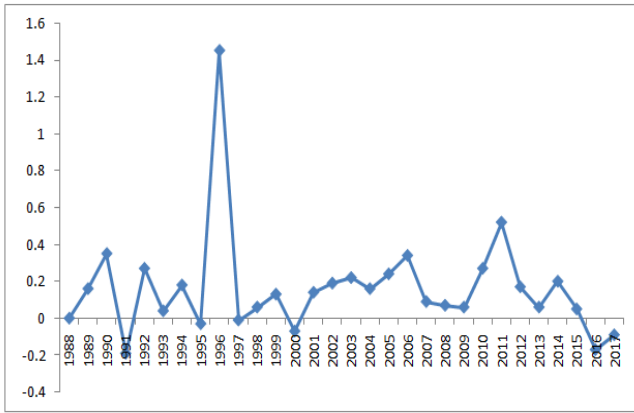


Fig. 1 Comparison of publications within year

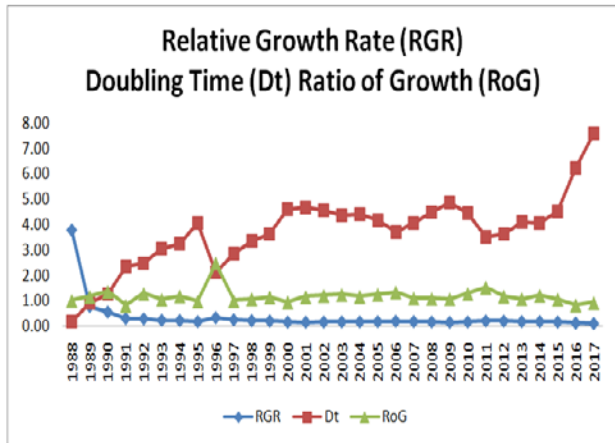


Fig. 2 RGR, Dt, RoG

TABLE III SUBJECT WISE DISTRIBUTION

S. No.	Subject	No. of Papers	%
1	Engineering	8507	35.62
2	Computer Science	5757	24.11
3	Materials Science	4680	19.60
4	Physics and Astronomy	3539	14.82
5	Chemistry	2937	12.30
6	Medicine	2709	11.34
7	Mathematics	2308	9.66
8	Chemical Engineering	2181	9.13
9	Biochemistry, Genetics and Molecular Biology	2089	8.75
10	Environmental Science	1903	7.97
11	Energy	1193	5.00
12	Earth and Planetary Sciences	1160	4.86

TABLE IV DOCUMENT TYPE PREFERRED

S. No.	Document Type	No. of Papers	%
1	Article	17523	73.37
2	Conference Paper	5039	21.11
3	Review	576	2.41
4	Book Chapter	228	0.95
5	Letter	192	0.80
6	Article in Press	137	0.57
7	Editorial	76	0.32
8	Note	46	0.19
9	Erratum	38	0.16
10	Book	14	0.06
11	Short Survey	14	0.06
	Total	23883	100.00

G. Collaborated Countries

The country that has collaborated for more than 100 papers with Anna university has been analysed as shown in Table V. Nearly 17 Countries collaborated and contributed more than 101 papers. Out of 17 Countries, Italy contributed for 1616 (6.78%) papers, United States (771,3.24%); United Kingdom (466,1.96%); Germany (454, 1.90%) and South Korea (422, 1.77%).

TABLE V COLLABORATED COUNTRIES

S. No.	Country	No. papers	%
1	Italy	1616	6.78
2	United States	771	3.24
3	United Kingdom	466	1.96
4	Germany	454	1.90
5	South Korea	422	1.77
6	Japan	373	1.57
7	Malaysia	344	1.44
8	Austria	289	1.21
9	France	202	0.85
10	Canada	188	0.79
11	Czech Republic	175	0.73
12	Switzerland	156	0.65
13	Netherlands	138	0.58
14	China	126	0.53
15	Spain	121	0.51
16	Australia	103	0.43
17	Sweden	101	0.42

TABLE VI COLLABORATED INSTITUTIONS

S. No.	Affiliated Institutions	No. of papers	%
1	Madras Institute of Technology	1379	5.79
2	Anna University of Technology, Tiruchirappalli	1057	4.44
3	College of Engineering, Guindy	1023	4.29
4	University of Ferrara	727	3.05
5	Alagappa College of Technology	627	2.63
6	UniversitadegliStudi di Firenze	458	1.92
7	University of Madras	433	1.82
8	Sri Siva subramaniyaNadar College of Engineering, Chennai	430	1.80
9	Indian Institute of Technology, Madras	429	1.80
10	OspedalePediatico Meyer	400	1.68
11	Centre for Environmental Studies, India	390	1.64
12	S. Anna Hospital	380	1.59
13	Sathyabama University	304	1.28
14	St. Josephs College of Engineering	286	1.20

TABLE VII CONTRIBUTED JOURNALS

S. No.	Source Title	No. ofpapers	%
1	International Journal of Applied Engineering Research	563	2.36
2	European Journal of Scientific Research	341	1.43
3	Journal of Crystal Growth	244	1.02
4	Communications In Computer And Information Science	200	0.84
5	Asian Journal of Information Technology	186	0.78
6	Journal of Chemical and Pharmaceutical Sciences	176	0.74
7	Journal of Computer Science	158	0.66
8	Acta Crystallographica Section C Crystal Structure Communications	156	0.65
9	Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	153	0.64
10	Journal of Theoretical and Applied Information Technology	144	0.60
11	ActaCrystallographica Section E Structure Reports Online	136	0.57
12	Advanced Materials Research	131	0.55
13	Applied Mechanics and Materials	130	0.54
14	Journal of Computational And Theoretical Nanoscience	121	0.51
15	International Journal of Chemtech Research	119	0.50
16	Advances in Intelligent Systems and Computing	118	0.49
17	Procedia Engineering	118	0.49
18	RSC Advances	118	0.49
19	International Journal of Engineering and Technology	112	0.47
20	Indian Journal of Science and Technology	109	0.46
21	AIP Conference Proceedings	105	0.44
22	Crystal Research And Technology	104	0.44
23	Journal of Applied Polymer Science	103	0.43
24	Journal of Materials Science Materials in Electronics	102	0.43
25	ARNP Journal of Engineering and Applied Sciences	101	0.42
26	Indian Journal of Environmental Protection	100	0.42

H. Collaborated Institutions

The Institutions that has collaborated for more than 250 papers i.e. 1% of publications has been analysed as shown in Table VI. There were 14 institutions that has collaborated and contributed to a minimum of 1% of the research papers. Madras Institute of Technology has collaborated 1379(5.79%) papers, Anna University of Technology, Tiruchirappalli (1057, 4.44%); College of Engineering, Guindy (1023, 4.29%) and University of Ferrara (727; 3.05%).

I. Contributed Journals

The source title that has a minimum of 100 papers by Anna University contributors has been analysed as shown in Table VII. Among the 26 sources that have more than 100 contributions, “International Journal of Applied Engineering Research” has 563 (2.36%) papers followed by “European Journal of Scientific Research” (341, 1.43%); “Journal of Crystal Growth” (244, 1.02%); “Communications in Computer and Information Science” (200, 0.84%) and “Asian Journal of Information Technology” (186, 0.78%).

TABLE VIII CONTRIBUTIONS OF AUTHORS

S. No.	Author Name	No. of Papers	%
1	Ramasamy, P.	364	1.52
2	Jayavel, R.	341	1.43
3	Kannan, A.	216	0.90
4	Alagar, M.	200	0.84
5	Vaidehi, V.	199	0.83
6	Murugesan, V.	177	0.74
7	Gopalakrishnan, R.	168	0.70
8	Chinnakali, K.	166	0.70
9	Pandurangan, A.	151	0.63
10	Fun, H.K.	150	0.63
11	Palanichamy, M.	142	0.59
12	Dhanasekaran, R.	139	0.58
13	Sivakumar, K.	128	0.54
14	Nagarajan, G.	126	0.53
15	Rajendran, N.	125	0.52
16	Sakthivel, R.	125	0.52
17	Rajagopalan, M.	113	0.47
18	Sivanesan, S.	113	0.47
19	Velraj, R.	113	0.47
20	Baskar, K.	112	0.47
21	Kannan, P.	111	0.46
22	Subramanian, C.	107	0.45
23	Geetha, T.V.	106	0.44
24	De Martino, M.	105	0.44

J. Highly Contributed Author

The academicians of Anna University who has contributed more than 100 papers included in Scopus database has been analysed and the same has been shown in Table VIII. Nearly 24 authors have contributed more than 100 publications. Out of 24 authors “Ramasamy, P” has contributed 364(1.52%) papers, followed by “Jayavel, R” (341,1.43%); “Kannan, A.” (216, 0.90%); “Alagar, M.”(200, 0.84%); and “Vaidehi, V.”(199, 0.83%). Only one female among the top five authors is listed.

K. Keywords Preferred

The keywords used by the authors in their articles appearing more than 500 times were also ascertained as shown in Table IX.

TABLE IX KEYWORDS USED

S. No.	Keywords	Papers	%
1	Article	3581	14.99
2	Human	2557	10.71
3	Humans	1943	8.14
4	Priority Journal	1631	6.83
5	Controlled Study	1466	6.14
6	Female	1381	5.78
7	Male	1298	5.43
8	X Ray Diffraction	978	4.09
9	Scanning Electron Microscopy	947	3.97
10	Nonhuman	943	3.95
11	Adult	930	3.89
12	Algorithms	789	3.30
13	India	735	3.08
14	Unclassified Drug	717	3.00
15	Optimization	684	2.86
16	Major Clinical Study	632	2.65
17	Child	571	2.39
18	Fourier Transform Infrared Spectroscopy	536	2.24
19	Synthesis (chemical)	532	2.23
20	Single Crystals	528	2.21

For a maximum of 500 times, 20 keywords were used in Anna University research publications. Among the 20 words, the key word “Article” has been used 3581 (14.99%) of papers followed by “Human” (2557, 10.71%); “Humans” (1943, 8.14%); “Priority Journal” (1631, 6.83%) and “Controlled Study” (1466, 6.14%). It shows majority of the Articles carries inappropriate keywords in both singular and plural forms. The use of proper keywords and singular form would increase the citation of articles as well as h Index of the authors.

L. Language of the Paper

The language of the publication of Anna University has been analysed as shown in Table X.

TABLE X LANGUAGES PREFERRED

S. No.	Languages	No. Of. papers	%
1	English	23,785	99.58
2	Portuguese	20	0.08
3	Bulgarian	19	0.08
4	German	11	0.05
5	Italian	11	0.05
6	Polish	11	0.05
7	Croatian	6	0.03
8	French	5	0.02
9	Spanish	5	0.02
10	Russian	4	0.02
11	Bosnian	2	0.01
12	Czech	2	0.01
13	Latvian	1	0.00
14	Lithuanian	1	0.00
Total		23,883	100.00

Nearly 99.58% of publications were published in English. Besides the authors have also contributed in more than 13 Languages. Among the 13 languages, the three most preferred were Portuguese (20, 0.08%); Bulgarian (19, 0.08%) and German (11, 0.05%).

VII. FINDINGS OF THE STUDY

1. A total of 23,883 publications were contributed by the academics of Anna University for the 30 years period i.e. 1988-2017.
2. Out of 23,883 publications, 23,142 (96.90%) papers appeared in other than the open source i.e. private access sources and the remaining 741 (3.10%) appeared in open access journals.
3. There exists steady growth of publications. 50% of articles appeared during the last five years between 2013 and 2017 and more than 1000 articles from 2010 (1163, 4.87%).
4. The ratio of growth (RoG) ranges between 0.81 and 1.52. Steep fall of publications can be seen during the year 1991, 1995, 1997, 2000, 2016 and 2017. RGR ranges between 0.09 and 0.77 and average RGR works out to 0.34. The doubling time ranges between 0.90 and 7.57.
5. The publication doubles once in seven years and a average publication per year works out to 795 papers per year.
6. Majority of the contributions were in Engineering (8507 papers, 35.62%); followed by Computer Science (5757, 24.11%); Materials Science (4680, 19.60%) and

Physics and Astronomy (3539, 14.82%). Nearly 78% of contributions were from the above domains.

7. 17,523 (73.37%) papers were published as Journal Articles followed by Conference Papers (5039, 21.11%); Reviews (576, 2.41%) and Book Chapters (228, 0.95%).
8. Nearly 17 countries collaborated and contributed to more than 101 papers. Out of 17 countries, Italy contributed 1616 (6.78%) papers followed by United States (771,3.24%); United Kingdom (466, 1.96%); Germany (454, 1.90%) and South Korea (422, 1.77%).
9. There were 14 institutions that has collaborated and contributed to a minimum of 1% of the research papers. Madras Institute of Technology has collaborated 1379 (5.79%) papers followed by Anna University of Technology, Tiruchirappalli (1057, 4.44%); College of Engineering, Guindy (1023, 4.29%) and University of Ferrara (727; 3.05%).
10. Among the 26 sources that have more than 100 contributions, “International Journal of Applied Engineering Research” has 563 (2.36%) papers, followed by “European Journal of Scientific Research” (341, 1.43%); “Journal of Crystal Growth” (244, 1.02%); “Communications in Computer and Information Science” (200, 0.84%) and “Asian Journal of Information Technology” (186, 0.78%).
11. Nearly 24 authors have contributed to more than 100 publications. Out of 24 authors “Ramasamy, P” contributed 364 (1.52%) papers, “Jayavel, R” (341,1.43%); “Kannan, A.”(216, 0.90%); “Alagar, M.” (200, 0.84%); and “Vaidehi, V.”(199, 0.83%). Only one female is listed among the top five authors.
12. The 20 keywords were used a maximum of 500 times in Anna University research publications. Among the 20 words, the key word “Article” has been used 3,581 (14.99%) of papers followed by “Human” (2557,10.71%); “Humans” (1,943,8.14%); “Priority Journal” (1,631, 6.83%) and “Controlled Study” (1,466, 6.14%).
13. Nearly 99.58% of publications were published in English. Besides English, the authors have contributed in 13 more languages and three most preferred were Portuguese (20, 0.08%); Bulgarian (19, 0.08%) and German (11, 0.05%).

VIII. CONCLUSION

The study thus carried out was primarily to examine the research production of Anna University. Further it aims to identify the document type of the publications preferred by the academics. The collaborated countries and organizations in the academic research were identified. The various subject domains that have more research productivity for Anna University was one among the many objectives of the study meant to compare and measure the growth rate of literature published. The publications that appeared in Scopus database alone were taken up for the study. There may be a possibility of more number of publications being published in other sources. The affiliation field was alone

considered and there may be a possibility of non-inclusion of Anna University contributions in the affiliation name by the authors. The study shows that there exists substantial research production and steady growth in publications among academics of Anna University and domination of collaborative research among Anna University. The research productivity can also be seen in other languages too besides English. Journals are a major source of publications in Anna University research. It seems majority of the articles carries Inappropriate Keywords both in singular and plural forms. The use of proper keywords and singular form will increase the citation of articles and as well as 'h' Index of the authors.

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