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Correlation of Authorship Pattern, Lotka's Law and Collaborative Measures on Research Publications of Anna University: A Bibliometric Study

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Abstract

This paper presents the analysis of authorship pattern and collaborative measures of 5318 research publications of Anna University and indexed in Web of Science (WoS) database during the period of 2014. 2018. The analysis indicates that multi authored papers are dominated in the dataset and the average author per paper is 4.01. The collaborative measures consist of collaborative index, degree of collaboration, collaborative coefficient and moderate coefficient. Overall value of collaborative index (4.06), degree of collaboration (0.99), collaborative coefficient (0.67) and there is no change in the value of moderate coefficient. The distribution of author productivity of the research publications follows the Lotka's law.

Keywords: Bibliometrics, Correlation, Authorship pattern, Lotka's law, Collaborative Measures, Anna University

Introduction

In bibliometric studies, authorship trend and collaborative measures plays a vital role in the development of the scholarly communication. The authorship pattern mainly deals with the kinds of authors, degree of collaboration and collaborative research work with other authors. The authorship patterns are in the form of single and multiple authored publications. It is one of the important parameters to analysis their collaborative index, degree of collaboration, collaborative coefficient, moderate coefficient and the distribution of author productivity. This collaborative measure helps to know about the research activities of national and international authors.

Macrina¹ stated that collaboration is inevitable in natural sciences and multi disciplinary areas to make significant advances and breakthroughs. Collaboration in research is said that two or more researchers work together to solve a scientific problem, discover new things, exchange of ideas, thoughts and information in the form of physical and mental efforts. Price² was the first who observed the authorship pattern based on sampling of chemical abstracts for the period of 1910-1960. It states that multi authored papers are steadily increasing simultaneous reduction in single authored papers.

The present study is a bibliometric analysis based on the research publications of Anna University for the period of 2014 to 2018. The objectives of the study to analyse the authorship pattern, collaborative measures and examine the applicability of Lotka's law to the research publications. Data downloaded from the Web of Science bibliographical database on 29.10.2019 and extracted data analysed and interpreted using Ms excel and SPSS.

Review of Literature

Patil and Kanekar³ studied the authorship pattern and collaborative research in Astrophysics. A total of 411 articles extracted during the study period of 2008 to 2017. The findings of the study reveal that 67.6% of articles contributed by multi authored. 0.67 is the overall degree of collaboration. The collaboration index is 5.18 in 2008 which increased as 8.22 in 2017. There is a steady increase in the collaborative coefficient for the study period. Del Zanna, Giulio considers as the most prolific author with 15 publications. **Kanekar and Azeza**⁴ have examined the authorship pattern and authors collaborative research in rain water harvesting during the period of 2007 to 2016. A total of 959 articles extracted from SCOPUS database. The result shows that 91.5% of multi authored articles are dominant in the publications. The overall degree of collaboration is 0.91, collaboration index increased from 2.7 to 3.59 for the study period. There is a gradual increase in the collaborative coefficient from 0.64 to 0.68. 3.01 is the average number of authors per paper and 0.26 is the average productivity per author. Mahmoud S.H. was contributed 7 publications and consider as the most prolific author of the publications. **Nishavathi and Jeysankar**⁵ conducted a bibliometric study on chromosome anomalies research output during the year 2007 to 2016. The study analyse 35912 citations extracted from PubMed bibliographical database. The results of the study indicates the growth of publication output, degree of collaboration, most prolific author, collaborative author and co authorship network.

Objectives

1. To analyse the nature of authorship pattern on research publications of Anna University.
2. To determine the collaborative measures such as collaborative index, degree of collaboration, collaborative co efficient and moderate co efficient.
3. To examine the applicability of Lotka's law on the research publications of Anna University.

Hypotheses

1. There is a moderate positive correlation between the publications and multi authored.
2. There is a moderate negative correlation between the publications and single authored.
3. There is a moderate positive correlation between the single and multi authored.

4. The distribution of author productivity of the research publications follows the Lotka's law.

Methodology

Web of Science (WoS) database used to download data for the present study from 2014 to 2018. The database searched as Address =("Anna University") used to extract data from Web of Science database. Total of 5381 publications retrieved based on Anna University during the study period. Straight count method used to analyse collaborative authors. Bibliometric study parameters such as collaborative coefficient measured by the method suggested by Ajiferuke.⁶ Subramanyam (1983)⁷ formula used to determined the degree of collaboration. Pao (1985)⁸ followed various steps to calculate the parameters n and c to examine authors productivity in Lotka's law $x^n y=c$. In order to verify the goodness of fit compare the values of the observed and expected distribution of publications at 0.05 level of significance as per the Kolmogorov-Smirnov goodness of fit test suggested by Tamilselvan (2013)⁹. Software's like Bibexcel, SPSS and Microsoft Excel also used for further analysis of the records.

Analysis and Interpretation

Table 1: Authorship Pattern in Research Publications of Anna University

Year	Single	Two	Three	Four	Five	>Five	No. of Multiple Authors	Total No. of Multiple Authors	TP
2014	18 (38.29%)	262 (16.65%)	247 (19.40%)	173 (18.68%)	111 (19.07%)	145 (15.81%)	938	3713	956
2015	8 (17.02%)	311 (19.77%)	291 (22.85%)	170 (18.35%)	119 (20.44%)	157 (17.12%)	1048	4200	1056
2016	3 (6.38%)	333 (21.16%)	261 (20.50%)	192 (20.73%)	118 (20.27%)	174 (18.97%)	1078	4436	1081
2017	9 (19.14%)	318 (20.21%)	246 (19.32%)	196 (21.16%)	110 (18.90%)	204 (22.24%)	1074	4467	1083
2018	9 (19.14%)	349 (22.18%)	228 (17.91%)	195 (21.05%)	124 (21.30%)	237 (25.84%)	1133	4783	1142
Total	47	1573	1273	926	582	917	5271	21599	5318
%	0.884	29.579	23.938	17.413	10.944	17.243	99.116		

Table 1 shows the authorship pattern in research publications of Anna University for the

period of 2014 to 2018. The single author contribution 0.88% followed by two authors published 29.57% of publications three authors share 23.93% four authors contributed 17.41% five authors contribution 10.94% whereas more than five authors contributed 17.24% in the total publications.

Hence, it concluded that multi authored contributed 99.11% of publications in the research whereas 0.88% contributed by single authored. So the average author per paper 4.01.

Hypothesis 1

There is a moderate positive correlation between the publications and multi-authored.

Table 2: Correlation between the Publications and Muti-Authorred

		Publications	Multi-Authorred
Publications	Pearson Correlation	1	0.998**
	Sig. (2-tailed)		0.000
	N	5	5
Multi-Authorred	Pearson Correlation	0.998**	1
	Sig. (2-tailed)	0.000	
	N	5	5

**Level of Significant at 0.05 (2-tailed)

There is a strong positive correlation between the publications and multi-authored ($r=0.998$, $df=4$, $p>0.05$). Hence, it concluded that null hypothesis accepted and indicates that there is a moderate positive correlation between the publications and multi authored.

Hypothesis 2

There is a moderate negative correlation between the publications and single authored.

Table 3: Correlation between the Publications and Single Authored

		Publications	Single Authored
Publications	Pearson Correlation	1	-0.724**
	Sig. (2-tailed)		0.000
	N	5	5
Single Authored	Pearson Correlation	-0.724**	1
	Sig. (2-tailed)	0.000	
	N	5	5

**Level of Significant at 0.05 (2-tailed)

There is a moderate negative correlation between the publications and single authored ($r=-$

0.724, df=4, p<0.05). Hence, it concluded that null hypothesis accepted and indicates that there is a moderate negative correlation between the publications and single authored.

Hypothesis 3

There is a moderate positive correlation between the single and multi-authored.

Table 4: Correlation between the Publications and Single Authored

		Single Authored	Multi-Authored
Single Authored	Pearson Correlation	1	-0.759**
	Sig. (2-tailed)		0.000
	N	5	5
Multi-Authored	Pearson Correlation	-0.759**	1
	Sig. (2-tailed)	0.000	
	N	5	5

**Level of Significant at 0.05 (2-tailed)

There is a strong negative correlation between the single and multi authored (r=-0.759, df=4, p<0.05). Hence, it concluded that null hypothesis rejected and alternative hypothesis accepted and indicates that there is a strong negative correlation between the single and multi authored.

Collaboration Index (CI)

This is defined as (Lawani, 1980).¹⁰ this index gives mean number of authors per paper. It has no upper limit and cannot express as a percentage. The Collaboration Index (CI) is the simplest index presently used to explore the literature, which is to be interpreted the mean number of authors per paper and the formula is given below

$$CI = \frac{\sum_{j=1}^A jf_j}{N}$$

Hence, j is the number of co-authored papers appearing in a discipline; N is the total number of papers in the discipline over the same time interval, and k is the greatest number of authors per paper in a discipline.

Table 4: Authorship Pattern and Collaborative Index

Year	Single	Two	Three	Four	Five	>Five	TP	CI
2014	18	262	247	173	111	145	956	3.90

		(38.29%)	(16.65%)	(19.40%)	(18.68%)	(19.07%)	(15.81%)		
2015	8	311	291	170	119	157		1056	3.98
		(17.02%)	(19.77%)	(22.85%)	(18.35%)	(20.44%)	(17.12%)		
2016	3 (6.38%)	333	261	192	118	174		1081	4.10
		(21.16%)	(20.50%)	(20.73%)	(20.27%)	(18.97%)			
2017	9	318	246	196	110	204		1083	4.13
		(19.14%)	(20.21%)	(19.32%)	(21.16%)	(18.90%)	(22.24%)		
2018	9	349	228	195	124	237		1142	4.19
		(19.14%)	(22.18%)	(17.91%)	(21.05%)	(21.30%)	(25.84%)		
Total	47	1573	1273	926	582	917		5318	4.06

From the above table it indicates the authorship pattern and collaborative index in research publications of Anna University for 2014 to 2018. The collaborative index increased from 3.90 in 2014 to 2018 as 4.19. The overall value of the collaborative index is 4.06.

Degree of Collaboration

The Degree of Collaboration (DC) The Degree of collaboration, defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period. The formula suggested by Subramanyam is used. The formula expressed as

$$C = \frac{N_m}{N_m + N_s}$$

Hence,

“C” is the degree of collaboration in a discipline.

N_m is the number of Multi-authored papers in the discipline published during a year.

N_s is the number of Single-authored papers in the discipline published during same year. From the above mentioned formula the degree of collaboration is determined.

Table 5: Degree of Collaboration (DC) in Research Publications of Anna University

Year	Single	Two	Three	Four	Five	>Five	TP	DC
2014	18 (38.29%)	262 (16.65%)	247 (19.40%)	173 (18.68%)	111 (19.07%)	145 (15.81%)	956	0.98
2015	8 (17.02%)	311 (19.77%)	291 (22.85%)	170 (18.35%)	119 (20.44%)	157 (17.12%)	1056	0.99
2016	3 (6.38%)	333	261	192	118	174	1081	1.00

		(21.16%)	(20.50%)	(20.73%)	(20.27%)	(18.97%)		
2017	9 (19.14%)	318 (20.21%)	246 (19.32%)	196 (21.16%)	110 (18.90%)	204 (22.24%)	1083	0.99
2018	9 (19.14%)	349 (22.18%)	228 (17.91%)	195 (21.05%)	124 (21.30%)	237 (25.84%)	1142	0.99
Total	47	1573	1273	926	582	917	5318	0.99

Table 5 reveals the degree of collaboration in the research publications of Anna University. There is a steady increased trend from 0.98 in 2014 to 1.00 in 2016 and slight decreased trend in 2017 to 2018 as 0.99. The overall value of degree of collaboration in the research publications of Anna University for the study period is 0.99. This indicates that there is a constant trend in the collaborative publications.

Collaborative Coefficient

The Collaborative Co-efficient (CC) makes possible to draw a comparison between different sub disciplines. So in order to make a relevant comparison, consider the collaboration co-efficient among different countries have been examined by making use of Collaborative Co-efficient (CC) suggested by Ajiferuke (1988). Collaboration Coefficient is a number between 0 and 1. The more it is bigger than 0.5 the better is the collaboration rate among the authors. When it is near 0, it means that authors have a weak collaboration. The formula is given below used to calculating CC.

$$CC = 1 - \left[\sum_{j=1}^k (1/j)F_j/N \right]$$

Hence,

F_j = the number of authored papers.

N = total number of research published; and k = the greatest number of authors per paper.

Table 6: Collaborative Coefficient (CC) in Research Publications of Anna University

Year	Single	Two	Three	Four	Five	>Five	TP	CC
2014	18 (38.29%)	262 (16.65%)	247 (19.40%)	173 (18.68%)	111 (19.07%)	145 (15.81%)	956	0.64
2015	8 (17.02%)	311 (19.77%)	291 (22.85%)	170 (18.35%)	119 (20.44%)	157 (17.12%)	1056	0.67
2016	3 (6.38%)	333 (21.16%)	261 (20.50%)	192 (20.73%)	118 (20.27%)	174 (18.97%)	1081	0.68

2017	9 (19.14%)	318 (20.21%)	246 (19.32%)	196 (21.16%)	110 (18.90%)	204 (22.24%)	1083	0.68
2018	9 (19.14%)	349 (22.18%)	228 (17.91%)	195 (21.05%)	124 (21.30%)	237 (25.84%)	1142	0.68
Total	47	1573	1273	926	582	917	5318	0.67

Table 6 indicates the collaborative coefficient in the research publications. The collaborative coefficient has increased from 0.64 in 2014 to 0.68 in 2018. It shows that there is a strong collaborative rate among the authors. Overall collaborative coefficient value is 0.67. Hence, it concluded that the research publications of Anna University authorship pattern had a strong collaborative coefficient.

Moderate Collaboration

$$MC = \frac{A}{A-1} \left\{ \frac{\sum_{j=1}^A (1j) f_j}{N} \right\}$$

Table 7: Moderate Coefficient (MC) in Research Publications of Anna University

Year	Single	Two	Three	Four	Five	>Five	TP	MC
2014	18 (38.29%)	262 (16.65%)	247 (19.40%)	173 (18.68%)	111 (19.07%)	145 (15.81%)	956	0.64
2015	8 (17.02%)	311 (19.77%)	291 (22.85%)	170 (18.35%)	119 (20.44%)	157 (17.12%)	1056	0.67
2016	3 (6.38%)	333 (21.16%)	261 (20.50%)	192 (20.73%)	118 (20.27%)	174 (18.97%)	1081	0.68
2017	9 (19.14%)	318 (20.21%)	246 (19.32%)	196 (21.16%)	110 (18.90%)	204 (22.24%)	1083	0.68
2018	9 (19.14%)	349 (22.18%)	228 (17.91%)	195 (21.05%)	124 (21.30%)	237 (25.84%)	1142	0.68
Total	47	1573	1273	926	582	917	5318	0.67

Table 7 shows the Moderate Collaboration (MC), there is no variation in the Moderate

Collaboration. It values from 0.64 in 2014 and 0.68 in 2018. There is a constant trend found in moderate collaboration.

Table 8: Distribution of Author Productivity Based on Lotka's Law

x	y	X	Y	X2	XY	YX	Syx	1/x ⁿ	c*1/x ⁿ	Ckdf	Diff
1	83	0.000	1.919	0.000	0.000	0.081	0.081	1.000	0.597	0.597	-0.516
1	58	0.000	1.763	0.000	0.000	0.057	0.138	1.000	0.597	1.194	-1.056
2	55	0.301	1.740	0.091	0.524	0.054	0.191	0.354	0.211	1.405	-1.214
1	48	0.000	1.681	0.000	0.000	0.047	0.238	1.000	0.597	2.002	-1.764
1	45	0.000	1.653	0.000	0.000	0.044	0.282	1.000	0.597	2.599	-2.317
1	42	0.000	1.623	0.000	0.000	0.041	0.323	1.000	0.597	3.196	-2.873
1	41	0.000	1.613	0.000	0.000	0.040	0.363	1.000	0.597	3.793	-3.430
1	40	0.000	1.602	0.000	0.000	0.039	0.402	1.000	0.597	4.390	-3.988
1	38	0.000	1.580	0.000	0.000	0.037	0.439	1.000	0.597	4.987	-4.548
2	37	0.301	1.568	0.091	0.472	0.036	0.475	0.354	0.211	5.198	-4.723
1	34	0.000	1.531	0.000	0.000	0.033	0.508	1.000	0.597	5.795	-5.287
1	33	0.000	1.519	0.000	0.000	0.032	0.540	1.000	0.597	6.392	-5.852
3	32	0.477	1.505	0.228	0.718	0.031	0.572	0.192	0.115	6.507	-5.935
2	30	0.301	1.477	0.091	0.445	0.029	0.601	0.354	0.211	6.718	-6.117
1	29	0.000	1.462	0.000	0.000	0.028	0.629	1.000	0.597	7.315	-6.686
3	28	0.477	1.447	0.228	0.690	0.027	0.657	0.192	0.115	7.430	-6.773
1	27	0.000	1.431	0.000	0.000	0.026	0.683	1.000	0.597	8.027	-7.344
4	25	0.602	1.398	0.362	0.842	0.024	0.707	0.125	0.075	8.102	-7.394
1	24	0.000	1.380	0.000	0.000	0.023	0.731	1.000	0.597	8.699	-7.968
2	23	0.301	1.362	0.091	0.410	0.022	0.753	0.354	0.211	8.910	-8.157
5	22	0.699	1.342	0.489	0.938	0.021	0.775	0.089	0.053	8.963	-8.188
1	21	0.000	1.322	0.000	0.000	0.020	0.795	1.000	0.597	9.560	-8.765
4	20	0.602	1.301	0.362	0.783	0.020	0.815	0.125	0.075	9.635	-8.820
3	19	0.477	1.279	0.228	0.610	0.019	0.833	0.192	0.115	9.750	-8.916

5	18	0.699	1.255	0.489	0.877	0.018	0.851	0.089	0.053	9.803	-8.952
7	17	0.845	1.230	0.714	1.040	0.017	0.867	0.054	0.032	9.835	-8.968
7	16	0.845	1.204	0.714	1.018	0.016	0.883	0.054	0.032	9.867	-8.985
4	15	0.602	1.176	0.362	0.708	0.015	0.898	0.125	0.075	9.942	-9.045
11	14	1.041	1.146	1.084	1.194	0.014	0.911	0.027	0.016	9.958	-9.047
13	13	1.114	1.114	1.241	1.241	0.013	0.924	0.021	0.013	9.971	-9.047
14	12	1.146	1.079	1.314	1.237	0.012	0.936	0.019	0.011	9.983	-9.047
24	11	1.380	1.041	1.905	1.437	0.011	0.946	0.009	0.005	9.988	-9.041
39	10	1.591	1.000	2.531	1.591	0.010	0.956	0.004	0.002	9.990	-9.034
67	9	1.826	0.954	3.335	1.743	0.009	0.965	0.002	0.001	9.991	-9.026
109	8	2.037	0.903	4.151	1.840	0.008	0.973	0.001	0.001	9.992	-9.019
201	7	2.303	0.845	5.305	1.946	0.007	0.980	0.000	0.000	9.992	-9.012
372	6	2.571	0.778	6.608	2.000	0.006	0.985	0.000	0.000	9.992	-9.007
582	5	2.765	0.699	7.645	1.933	0.005	0.990	0.000	0.000	9.992	-9.002
926	4	2.967	0.602	8.801	1.786	0.004	0.994	0.000	0.000	9.992	-8.998
1273	3	3.105	0.477	9.640	1.481	0.003	0.997	0.000	0.000	9.992	-8.995
1573	2	3.197	0.301	10.219	0.962	0.002	0.999	0.000	0.000	9.992	-8.993
47	1	1.672	0.000	2.796	0.000	0.001	1.000	0.003	0.002	9.994	-8.994
5318	1025	36.245	52.307	71.112	30.467	1.000		16.740	9.994	320.431	

C = 0.059; **n = 1.50;** **cv = 0.254;** **D = -0.516**

The calculated critical value is 0.254 and the maximum difference between the observed and expected value is -0.516. Therefore, it is observed that the difference value is -0.516 is less than that of critical value which indicates that Lotka's law fit to the data set of Anna University research publications.

Hypothesis 4

The distribution of author productivity of the research publications follows the Lotka's law.

The calculated critical value 0.254 is greater than that of maximum difference value -0.516. Hence, the null hypothesis is accepted and concluded that the distribution of author productivity of research publications follow Lotka's law.

Conclusion

In this study, the analysis of authorship pattern and collaborative measure of Anna University research publications from 2014 to 2018 is presented. It is observed from the study that multi authored contributed 99.11% of total publications whereas 0.88% contributed by single authored and the average author per paper is 4.01. The result of the correlation shows that there is a strong positive correlation between the publications and multi authored and moderate negative correlation between the publications and single authored. Strong negative correlation between the single and multi authored. According to the collaborative measure, collaborative index increased from 3.90 to 4.19 from 2014 to 2018. The degrees of collaboration increased from 0.98 to 1.00 and slight decreased trend in 2017 to 2018 as 0.99. There is a strong collaborative coefficient with the authorship pattern and no change in the moderate coefficient. The distribution of author productivity of the research publications follows the Lotka's law.

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