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APPLICATION OF LOTKA'S LAW TO THE RESEARCH PUBLICATIONS OF ALAGAPPA AND BHARATHIDASAN UNIVERSITIES: A COMPARATIVE STUDY

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Abstract

This paper deals with the comparative study of author productivity based on Lotka's law to the research publications of Alagappa and Bharathidasan Universities. The data for the study collected from Web of Science (WOS) database during the period of 2009 to 2018. Straight counting method applied to author productivity for both universities. A total of 1726 research publications from Alagappa University similarly 2778 research publications from Bharathidasan University contributed during the span of study period. Majority of the author productivity tested using Lotka's law by applying Kolmogorov-Smirnov (K-S) goodness-of-fit test. The result shows the author productivity of Lotka's law was convinced the data set with maximum difference (D) value 0.044 for Alagappa University and 0.148 for Bharathidasan University less than that of critical value.

Keywords: Lotka's Law, Alagappa University, Bharathidasan, University, Research Publication,

Kolmogorov-Smirnov (K-S) Goodness- of-fit test.

Introduction

In the year 1969 Bibliometrics and Scientometrics have been introduced. Bibliometrics used to deal with more general information where as scientometrics used to measure scholarly communication. Bibliometrics is a quantitative technique which used to evaluate the research publications of the literature. Bibliometric analysis is an innovation of national system which to find the knowledge output of science and technology.¹ It helps to know about the growth of literature, country, language, authorship pattern, collaboration, and core journal etc. Individual characteristics such as, age, gender, educational qualification, funding, institution, organization are the large number of factors which influenced scientific productivity of the research publications.²

The bibliometric analysis would be helpful to understand about the publications of research carried out by the faculties of Alagappa and Bharathidasan Universities. The study aims to identify the growth of research publications in Alagappa and Bharathidasan Universities which in South Tamilnadu, India taken in to consideration for the present study to analysis the research output of publications. The research outputs analysed the year wise distribution of authorship pattern. Lotka's laws have also been tested.

Review of Literature

Manthiramoorthi, Saravanakumar and Thirumagal (2019)³ conducted a study about Lotka's law and pattern of author productivity of information literacy research output. The data extracted from Web of Science (WOS) database from 2008 -2017. The objectives of the study is to identify Lotka's law using Kolmogorov-Smirnov test (K-S) goodness of fit test. The result shows that the data set of information literacy research output fit to the Lotka's law.

Khanna, et.al. (2017)⁴ analysed the research output of physics and astronomy of Guru Nanak Dev University during 2006 – 2015. The data extracted from Scopus database. The study reveals the year wise research productivity, collaboration, collaborating institutions, most prolific authors, preferred journals and number of citation received by the university during the study period. The result of the analyses denoted that 652 papers published in physics and astronomy. 7.01% is the average

impact per paper of the university publications. 27.45% of publications were collaborative with international collaboration where as 68.71% publications were collaborative with national collaboration.

Navaneethakrishnan (2014)⁸ explained about the authorship patterns and degree of collaboration of SriLankan scientific publications in social sciences and humanities. The dataset downloaded from SCOPUS during the period of 1960 – 2012. A total of 1795 records of publications authored by 3521 authors. The result shows that majority of the publication contributed by multiple authors and there is an increasing trend in the degrees of collaboration over the study span.

Tamilselvan, Sivakumar and Sevukan (2013)⁵ investigated a study to test the validity of Lotka's law to the literature published by faculties of National Institute of Technology in India. In order to verify the observed distribution of author productivity Kolmogorov-Smirnov (K-S) goodness of fit test applied to know the estimated distribution. The findings of the study shows that the value of maximum difference (D) value 0.015 is less than the critical value 0.24 which resulted that the data of the literature produced by NIT faculties fit to the Lotka's law.

Objectives

The main objectives of this study are to:

1. Analyse the year-wise distribution of authorship pattern of Alagappa and Bharathidasan Universities publications.
2. To determine the degree of collaboration of the research publications.
3. To test the Lotka's law of author productivity.

Methodology

The present study focussed to test the Lotka's law of author productivity to the research publications of Alagappa and Bharathidasan Universities during 2009 – 2018. The data for this study collected from Web of Science (WOS) database (updated in 15.09.2019). Search term “Alagappa University” and “Bharathidasan University” used to search in the address field. The downloaded data which include 1726 research publications appeared in Alagappa University and 2278 research

publications in Bharathidasan University. To test the author productivity of Lotka's law by using Kolmogorov-Smirnov (K-S) goodness-of-fit test. The data analysed by using the softwares such as SOFA, Bibexcel and MS excel.

Analysis and Interpretation

Degree of Collaboration

The degree of collaboration is 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 of time. The formula suggested by Subramanyam⁷ is used to analysed the degree of collaboration of this study. It is expressed as;

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

N_m = Number of multi-authored research papers in the discipline published during a year.

N_s = Number of single authored research papers in the discipline published during a year.

Authorship Pattern of Alagappa University

It could be noted that more than five authors contributed 428 (24.78%) of publications ranked as first followed by three authors published 341 (19.75%) publications ranked as second, 329 (19.06%) publications contributed by four authors ranked as third. Five authors contributed 312 (18.07%) and 306 (17.72%) by two authors ranked as fourth and fifth. Majority of the publications contributed by multiple authored (99.42%) and (0.58%) contributed by single authored.

Table 1 reveals that the value of the degree of collaboration 0.95 in the year 2009 and 1.00 in the year 2018. The overall value of degree of collaboration 0.99. It was observed that there is an increasing trend over the year and the highest was recorded as 1.00 in the year 2012, 2014, 2016 to 2018 and lowest was recorded as 0.95 in 2009.

Table 1: Year wise Distribution of Authorship Pattern of Alagappa University

Year	Single	Two	Three	Four	Five	> Five	Total	DC	%
2009	3	9	16	13	9	12	62	0.95	3.59
2010	2	24	15	16	17	25	99	0.98	5.74
2011	2	22	40	34	19	34	151	0.99	8.75
2012	0	27	37	26	40	21	151	1	8.75
2013	1	35	48	44	27	22	177	0.99	10.25
2014	0	40	44	37	27	28	176	1	10.2
2015	1	36	41	49	36	31	194	0.99	11.24
2016	0	43	34	43	46	52	218	1	12.63
2017	0	40	31	35	42	79	227	1	13.15
2018	1	30	35	32	49	124	271	1	15.7
Total	10	306	341	329	312	428	1726	0.99	100

Note. DC = Degree of Collaboration % = Percentage

Authorship Pattern of Bharathidasan University

From the below table, it could be stated that more than five authors contributed 753 (27.10%) of publications ranked as first followed by three authors published 565 (20.33%) publications ranked as second, 536 (19.29%) publications contributed by four authors ranked as third. Five authors contributed 456 (16.14%) and 435 (15.65%) by two authors ranked as fourth and fifth. Majority of the publications contributed by multiple authored (98.81%) and (0.19%) contributed by single authored.

Table 2 indicates that the value of the degree of collaboration 0.96 in the year 2009 and 0.99 in the year 2018. The overall value of degree of collaboration 0.99. It was observed that there are some fluctuations over the study period and the highest was recorded as 0.99 in most of the years except 2010 and 2012 and lowest was recorded as 0.96 in 2009.

Table 2: Year wise Distribution of Authorship Pattern of Bharathidasan University

Year	Single	Two	Three	Four	Five	> Five	Total	DC	%
2009	8	43	46	33	21	37	188	0.96	6.77
2010	3	46	44	35	33	37	198	0.98	7.13
2011	2	45	58	63	63	59	290	0.99	10.44
2012	4	45	60	49	40	63	261	0.98	9.4
2013	3	55	61	45	31	84	279	0.99	10.04
2014	3	59	49	67	50	91	319	0.99	11.48
2015	2	45	67	63	46	92	315	0.99	11.34
2016	4	34	74	61	45	98	316	0.99	11.38
2017	2	31	54	59	61	86	293	0.99	10.55
2018	2	32	52	61	66	106	319	0.99	11.48
Total	33	435	565	536	456	753	2778	0.99	100

Note. DC = Degree of Collaboration % = Percentage

Productivity of Authors Based on Lotka's Law

In 1926, Alfred J. Lotka derived a formula to calculate the frequency distribution of scientific productivity of authors. It is mathematically represented as $y = CXx^n$. Pao (1985) suggested the non parametric Kolmogorov Smirnov (K-S) goodness of fit test to find out the critical value. From the above mentioned formula the value of n, c, c.v and D calculated.⁶

Table 3: Distribution of Author Productivity Based on Lotka's Law of Alagappa University

x	y	X	Y	X ²	XY	yx / $\sum y x$	$\sum(y x / \sum y x)$	1/x ⁿ	f = C($\sum 1/x^n$)	Σ	D
1	22	0	1.342	0	0	0.138	0.138	1	0.22	0.22	-0.083
2	18	0.301	1.255	0.091	0.378	0.113	0.25	0.633	0.139	0.359	-0.109
3	15	0.477	1.176	0.228	0.561	0.094	0.344	0.485	0.107	0.466	-0.122
3	14	0.477	1.146	0.228	0.547	0.088	0.431	0.485	0.107	0.573	-0.141
2	13	0.301	1.114	0.091	0.335	0.081	0.513	0.633	0.139	0.712	-0.199
4	12	0.602	1.079	0.362	0.65	0.075	0.588	0.401	0.088	0.8	-0.213
14	11	1.146	1.041	1.314	1.194	0.069	0.656	0.176	0.039	0.839	-0.183
13	10	1.114	1	1.241	1.114	0.063	0.719	0.184	0.041	0.879	-0.161
53	9	1.724	0.954	2.973	1.645	0.056	0.775	0.073	0.016	0.896	-0.121
48	8	1.681	0.903	2.827	1.518	0.05	0.825	0.078	0.017	0.913	-0.088
109	7	2.037	0.845	4.151	1.722	0.044	0.869	0.045	0.01	0.923	-0.054
176	6	2.246	0.778	5.042	1.747	0.038	0.906	0.033	0.007	0.93	-0.024
311	5	2.493	0.699	6.214	1.742	0.031	0.938	0.023	0.005	0.935	0.003
329	4	2.517	0.602	6.336	1.516	0.025	0.963	0.022	0.005	0.94	0.023
341	3	2.533	0.477	6.415	1.208	0.019	0.981	0.021	0.005	0.945	0.037
307	2	2.487	0.301	6.186	0.749	0.013	0.994	0.023	0.005	0.95	0.044
10	1	1	0	1	0	0.006	1	0.219	0.048	0.998	0.002
1726	160	23.14	14.71	44.7	16.63	1	11.89	4.54	1	13.28	

Note. n= 0.66; c = 0.22; c.v. = 0.286; D = 0.44

To validate the Lotka's law, above mentioned calculation done to find the value of n, c, c.v and D to test whether the dataset fits to the Lotka's law. Table 3 shows the author productivity distribution of Alagappa University. The calculated values of n=0.66 and c=0.22. The critical value is 0.286 and the value of maximum difference (D) between the observed and expected frequency is 0.44. Therefore it is clear that D value is less than that of critical value which resulted in convincing the author productivity of Lotka's law to the research publications of Alagappa University.

Table 4: Distribution of Author Productivity Based on Lotka's Law of Bharathidasan University

x	y	X	Y	X ²	XY	yx / $\sum y x$	$\sum(y x / \sum y x)$	1/ x ⁿ	f = C($\sum 1/ x^n$)	Σ	D
1	99	0	1.996	0	0	0.174	0.174	1	0.087	0.087	0.086
1	81	0	1.908	0	0	0.142	0.316	1	0.087	0.174	0.142
1	53	0	1.724	0	0	0.093	0.409	1	0.087	0.261	0.148
1	37	0	1.568	0	0	0.065	0.474	1	0.087	0.348	0.125
1	29	0	1.462	0	0	0.051	0.525	1	0.087	0.435	0.089
1	27	0	1.431	0	0	0.047	0.572	1	0.087	0.522	0.05
1	25	0	1.398	0	0	0.044	0.616	1	0.087	0.609	0.007
1	24	0	1.38	0	0	0.042	0.658	1	0.087	0.696	-0.038
2	21	0.301	1.322	0.091	0.398	0.037	0.695	0.448	0.039	0.735	-0.04
1	20	0	1.301	0	0	0.035	0.73	1	0.087	0.822	-0.092
1	18	0	1.255	0	0	0.032	0.761	1	0.087	0.909	-0.148
3	16	0.477	1.204	0.228	0.575	0.028	0.789	0.28	0.024	0.934	-0.144
3	15	0.477	1.176	0.228	0.561	0.026	0.816	0.28	0.024	0.958	-0.142
5	14	0.699	1.146	0.489	0.801	0.025	0.84	0.155	0.013	0.971	-0.131
5	13	0.699	1.114	0.489	0.779	0.023	0.863	0.155	0.013	0.985	-0.122
12	12	1.079	1.079	1.165	1.165	0.021	0.884	0.056	0.005	0.99	-0.105
22	11	1.342	1.041	1.802	1.398	0.019	0.904	0.028	0.002	0.992	-0.089
30	10	1.477	1	2.182	1.477	0.018	0.921	0.019	0.002	0.994	-0.073
61	9	1.785	0.954	3.187	1.704	0.016	0.937	0.008	0.001	0.994	-0.058
117	8	2.068	0.903	4.277	1.868	0.014	0.951	0.004	0	0.995	-0.044
199	7	2.299	0.845	5.285	1.943	0.012	0.963	0.002	0	0.995	-0.032
284	6	2.453	0.778	6.019	1.909	0.011	0.974	0.001	0	0.995	-0.021
456	5	2.659	0.699	7.07	1.859	0.009	0.982	0.001	0	0.995	-0.013
536	4	2.729	0.602	7.448	1.643	0.007	0.989	0.001	0	0.995	-0.006
564	3	2.751	0.477	7.57	1.313	0.005	0.995	0.001	0	0.995	-0.001
436	2	2.639	0.301	6.967	0.795	0.004	0.998	0.001	0	0.995	0.003
33	1	1.519	0	2.306	0	0.002	1	0.017	0.002	0.997	0.003
2778	570	27.46	30.07	56.8	20.19	1	20.74	11.46	1	21.38	

Note. n= 1.66; c = 0.087; c.v. = 0.23; D = 0.148

According to the research publications of Bharathidasan University, Table 4 indicates the author productivity based on Lotka's law. The calculated values of n=1.66 and c=0.087 respectively. The critical value is 0.23 and the value of maximum difference (D) between the observed and expected frequency is 0.148. Therefore it is clear that D value is less than that of critical value which resulted in convincing the author productivity of Lotka's law to the research publications of Bharathidasan University.

Hence, it concluded that both universities research publications convincing the author productivity of Lotka's law.

Conclusion

This study has explored the comparative study of research publications of Alagappa and Bharathidasan Universities. The study indicates that the total of 1726 research publications from Alagappa and 2778 research publications from Bharathidasan Universities published during the span of 10 years from 2009 to 2018. Authorship pattern of Alagappa University shows that majority of the publications contributed by multiple authored (99.42%) and (0.58%) contributed by single authored. The degree of collaboration 0.95 in the year 2009 and 1.00 in the year 2018. The overall value of degree of collaboration 0.99. It was observed that there are some fluctuations over the year and the highest was recorded as 1.00 in the year 2012, 2014, 2016 to 2018 and lowest was recorded as 0.95 in 2009. Bharathidasan University authorship pattern of the publications indicates that the majority of the publications contributed by multiple authored (98.81%) and (0.19%) contributed by single authored. The value of the degree of collaboration 0.96 in the year 2009 and 0.99 in the year 2018. The overall value of degree of collaboration 0.99. It was observed that there are some fluctuations over the study period and the highest was recorded as 0.99 in most of the years except 2010 and 2012 and lowest was recorded as 0.96 in 2009. The Straight counting method used to test the Lotka's law. Kolmogorov-Smirnov (K-S) goodness-of-fit test applied in both datasets. The author productivity based on Lotka's law of Alagappa University shows the calculated values of $n=0.66$ and $c=0.22$ respectively. The critical value is 0.286 and the value of maximum difference (D) between the observed and expected frequency is 0.44. Therefore, it is clear that D value is less than that of critical value which resulted in convincing the author productivity of Lotka's law to the research publications of Alagappa University. According to the author productivity of Lotka's law of Bharathidasan University

revealed that the calculated values of $n=1.66$ and $c=0.087$ respectively. The critical value is 0.23 and the value of maximum difference (D) between the observed and expected frequency is 0.148. Hence, it is concluded that D value is less than that of critical value which resulted in convincing the author productivity of Lotka's law to the research publications of Bharathidasan University.

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