

Authorship Patterns and Collaborative Research Output in IEEE/ACM Transactions on Networking during 1998-2017

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Abstract:

The bibliometrics is a research method used for the quantitative measuring the production and dissemination of scholarly scientific communication. This method is fast emerging in the field of Library and Information Science. This study has explored that the scientometric techniques were applied to analyze the authorship trend and research output in the online Journal of IEEE/ACM Transactions on Networking from 1998 to 2017. A total of 2535 articles and 8360 authors in the journal were examined by years ascertain authorship patterns, author productivity, Degree of collaboration and Law of bibliometrics.

Keywords: *Authorship patterns, author productivity, Degree of collaboration, bibliometrics and scientometrics*

Introduction:

The Scientometrics studies are one of the most basic research methods of publication on science and engineering technology. It is one of the subfields of Bibliometric¹. Haitun² treats 'Scientometrics' as scientific disciplines, which performs reproducible measurements of scientific activity and reveal its objective quantitative regularities. According to him, Scientometric methods include statistical and thesaurus purposes, and indicators as to the number of authorship pattern, term etc. Scientometrics is used to measure scientific activities mainly by producing statistics on scientific research publication. Scientometrics is the study dealing with the quantitative aspects of written communication which helps in the measurement of the published knowledge by analyzing literature, the interrelationship among different branches of knowledge, Productivity, authorship pattern, Degree of collaboration pattern of collection building. The written research- mainly in the form of publications in a peer-reviewed journal and their uses.

Literature Review:

Nutan Gaud, Singh and Bhoopendra Singh (2019)³ has an analysis authorship pattern and a collaboration coefficient of library professional's competency publications research from 1999-2018 from Scopus database. The study reveals that a total number of published articles during the period of study was 433 and out of 171 articles published by single authors. In this study, Collaboration Coefficient is 0.47, and Modified Collaboration Coefficient is 0.54 and Collaboration Index is 2.80.

Yadav, Singh and Verma (2019)⁴ evaluated the Authorship and Collaboration Pattern in SRELS Journal of Information Management during 2008-2017. In this study, out of 578 articles, 196 articles are by a single author, and the 386 research articles are by collaborative authors. In the study, the average collaboration index is 1.86, the average collaboration coefficient is 0.36, and average Degree of collaboration is 0.66. The average relative growth rate is 0.32, and the average doubling time is 3.40 during 2008-2017.

Mondal and Jana (2018)⁵ viewed the authorship pattern and collaboration trend in Indian LIS journals during 2012-2017. In this research 900 articles are published in 96 issues of three leading journals like Annals of Library and Information Studies (ALIS), DESIDOC Journal of Library & Information Technology (DJLIT) and SRELS Journal of Information Management (SRELS) during 2012-2017. The study observed that the maximum 432 articles (48 %) were written by two-authored with the average citation of 2.18. The average Collaborative Index (CI) and the Collaborative Coefficient (CC) indicate the trend towards a dominance of collaborative authorship in LIS publications.

Richa Narzary and Murugan (2017)⁶ examined the authorship pattern and collaboration in ETRI journal with total articles of 936 collected from the Web of Science database during 2010-2016. The result showed that the average number of authors per paper is 3.6, and Productivity per author 0.27. The Degree of collaboration is 0.98. The multi-authored publications are higher and predominant than single authorship. The study reveals that Kim J is the most productive author contributing 58 (6.2%) of articles in ETRI journals.

Senthilkumar and Muthukrishnan (2017)⁷ has focused collaborative research and authorship pattern of research papers published in the journal of thoracic oncology during 2006 and 2015 from the web of science database. The study reveals that a total of 96669 authors has contributed the 13888 articles, and the average number of authors per paper is 6.7. The multi-authored papers 12373 (89.10%) dominate single-authored research publications are 1515 (10.90%). The Degree of collaboration is 0.89, Time Series Analysis of Single Authored Publications $Y_c = 226.2$ and collaborative publication trends also increasing gradually $Y_c = 2817.82$.

Objectives of the Study

The primary objectives of this study are:

1. To find out Per Capita Authorship analysis
2. To find out distributions of authorship pattern and publication counts
4. To find out Degree of collaboration - year-wise Distribution
5. To find out Single Author publications – Trend Analysis
6. To find out Multiple Author publications – Trend Analysis
7. To determine the Productivity of authors based on Lotka's Law
8. To determine the exponential growth of Price's Fundamental Law of Science

Scope of the Journal IEEE/ACM Transactions on Networking:

The Journal of IEEE/ACM Transactions on Networking⁸ is one of the foremost research journals in the communication and networking field. It is Published the bimonthly online Electronic Journal. It is published cosponsored by the IEEE Communications Society, IEEE computer society and the ACM (Association for Computing Machinery). This journal covers the subject like network architecture and design, communication protocols, network software, network technologies, network services applications and network operation management. The scope of this journal includes all topics on communication and Networking. The present study aims to explore the scientometric techniques used to find out the authorship and collaboration of research output in the Journal IEEE/ACM Transactions on networking selected twenty years published article period between 1998-2017.

Methodology:

From the online journal IEEE/ACM Transactions on Networking the data for the study is collected from the period 1998 to 2017. The total 2535 articles and the required information like authorship pattern, year-wise research productivity are noted. These data were organized, tabulated analyzed by using simple arithmetic and statistical methods.

Data Analysis:

1. Per Capita Authorship Analysis

Table 1
Per Capita Authorship Analysis

S. No.	Year	No. of Authors	No. of Papers	Authorship
1	1998	177	68	0.38
2	1999	177	72	0.41

3	2000	174	65	0.37
4	2001	187	65	0.35
5	2002	194	65	0.34
6	2003	208	76	0.37
7	2004	244	89	0.37
8	2005	295	106	0.36
9	2006	313	107	0.34
10	2007	370	124	0.34
11	2008	319	113	0.35
12	2009	458	151	0.33
13	2010	480	150	0.31
14	2011	463	141	0.3
15	2012	520	149	0.29
16	2013	536	147	0.27
17	2014	541	148	0.27
18	2015	528	147	0.28
19	2016	1054	280	0.27
20	2017	1122	272	0.24
	Total	8360	2535	30.32

This analysis shows that 8360 authors have contributed 2535 articles during the period between 1998 and 2017.

The per capita authorship is

$$= \text{Total Number of articles} / \text{Total Number of authors}$$

$$= 2535 / 8360 = 0.32$$

The per capita publication works out to 0.32

Table 1 reveals that the per capita authorship ranged from 0.24 to 0.41. The per capita authorship in the years 1999 was 0.41, which decreased to 0.24 in the year 2017. This analysis showed when the number of authors increased the number of publications also increased. Which is shown in Figure 1.

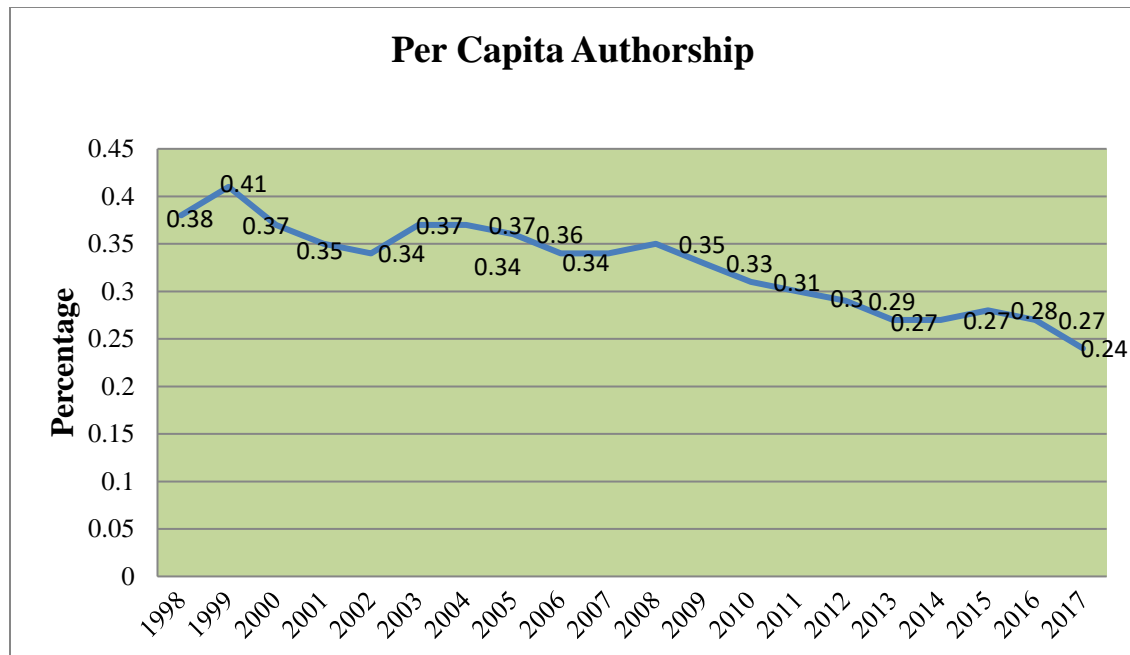


Figure 1: Per Capita Authorship

2. Authorship Pattern of Contributions

Table 2: Authorship Pattern of Contributions

Year	Single	Two	Three	Four	Five +	Total
1998	6	40	16	5	1	68
1999	8	31	25	8	0	72
2000	3	27	25	8	2	65
2001	4	23	23	11	4	65
2002	6	18	23	12	6	65
2003	2	36	23	12	3	76
2004	7	35	30	10	7	89
2005	5	43	35	18	5	106
2006	4	37	37	22	7	107
2007	3	48	41	20	12	124
2008	7	41	38	22	5	113
2009	5	48	56	27	15	151
2010	6	43	47	32	22	150
2011	2	31	59	30	19	141
2012	0	35	49	39	26	149
2013	1	38	36	35	37	147
2014	2	36	38	34	38	148

2015	3	34	43	28	39	147
2016	8	58	75	64	75	280
2017	9	42	53	69	99	272
Total	91	744	772	506	422	2535
%	3.59	29.3	30.5	20	16.7	100
Mean	4.55	37.2	38.6	25.3	21.1	127
SD	2.48	8.81	14.4	17	25.5	59.4
CV	54.5	23.7	37.4	67	121	46.9

In this study, the extent of contribution conducted by individuals in collaboration with each other identified. The number of authors mentioned in the articles was counted and analyzed. Table 2 presents the Distribution of research publications based on the number of authors. The table-2 shows three –authored papers rank first in the order, which shares 30.5% of the total contribution. The year-wise analysis shows that the performance of three author papers is better in almost all years except 1998, Two-authored publication taking 29.3 % of the total contribution. The year-wise analysis reveals that the two author contribution has shown an increasing trend in the years 2007, 2009 and 2016.

The Four author contributions take third place in order with a sharing of 20% of the total publication during the study period. In this case research publications, is more than 60 only in 2016 and 2017. All the remaining years have recorded less than 60. It confirms the prediction of de solla price that team research is a common trend in scientific activities. The five and above author contributions share 16.7% over the study period that comes in the fourth category. Single author papers attain the last place with only 3.59 % during the study period. Figure 2 shows scientists intended to take collaborative participation in research activities. It determines the single-author papers have a declining trend (3.59%), and thereby, collective contributions have increased performance in scientific research activities.

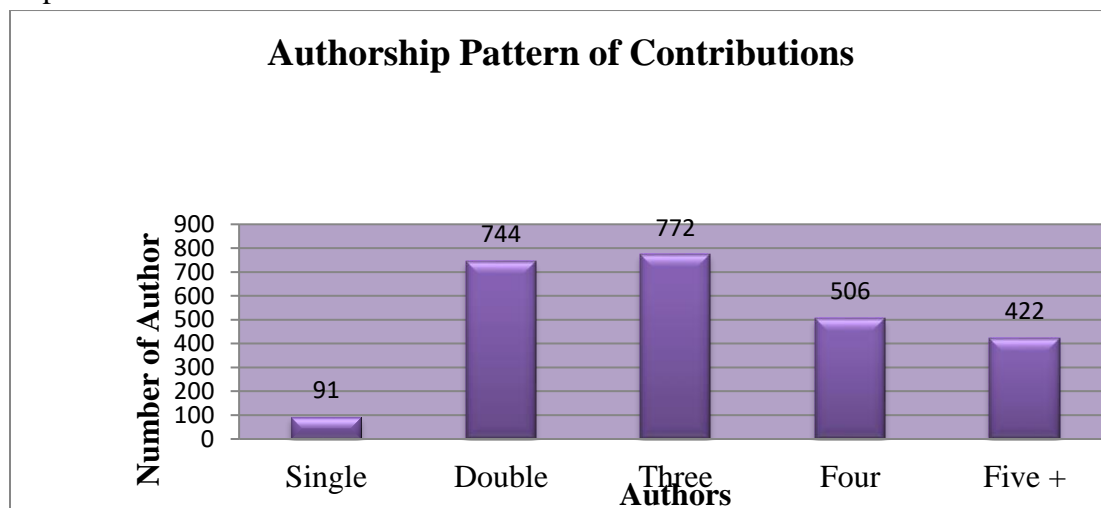


Figure 2: Authorship Pattern of Contributions

3 Distributions of Authorship and Publication Counts

Table 3: Distribution of Authorship and Publication Counts

Number of Authors	Count	Percentage
Single	91	3.59
Double	744	29.35
Three	772	30.46
Four	506	19.96
Five	228	8.99
Six	112	4.42
Seven	55	2.17
Eight	19	0.75
Nine	5	0.19
Ten	1	0.04
Twelve	1	0.04
Twenty Three	1	0.04
Total	2535	100

From the figure 3 it is indicated that out of 2535 papers, three authored research papers found to be the highest with 772 (30.42%) papers, followed by two authored publications with 744 (29.35%). Whenever the number of authors increases, there is a decline in the contribution. This study also shows that a single-authored paper ranked in 6th position with 91 articles (3.59%). The inference is that the multi-authored publications found to be more than single-author contributions.

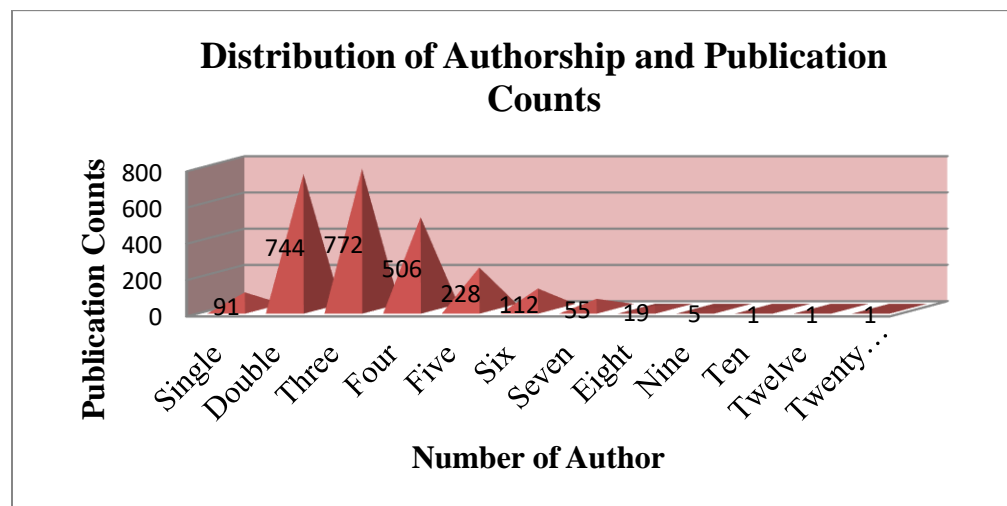


Figure 3: Distribution of Authorship and Publication Counts

4. Degree of Collaboration - Year wise Distribution**Table 4:Degree of Collaboration - Year wise Distribution**

Year	Single Author	Collaborative Authorship	Degree of Collaboration
1998	6	62	0.91
1999	8	64	0.88
2000	3	62	0.95
2001	4	61	0.94
2002	6	59	0.91
2003	2	74	0.97
2004	7	82	0.92
2005	5	101	0.95
2006	4	103	0.96
2007	3	121	0.98
2008	7	106	0.94
2009	5	146	0.97
2010	6	144	0.96
2011	2	139	0.98
2012	0	149	1
2013	1	146	0.99
2014	2	146	0.98
2015	3	144	0.98
2016	8	272	0.97
2017	9	263	0.97
	91	2444	0.96

In this context, the researcher aims at analyzing the Degree of collaboration on article publications by scientists of "IEEE/ACM Transactions on Networking". The above table 4 reveals that the Degree of collaboration has shown an increasing trend during the study period. It indicates that the high level of prevalence of collaborative research in the field of Networking. In the year 1998, Degree of collaboration is 0.91 %. which is increased to 0.97 % in 2017. There was a decreasing trend in the single-authored papers and an increasing trend in multi-authored articles. The result, evidenced in the application of Subramaniam's ⁹ formula corroborated the results obtained in this investigation through regression analysis. It is showed in Figure 4.

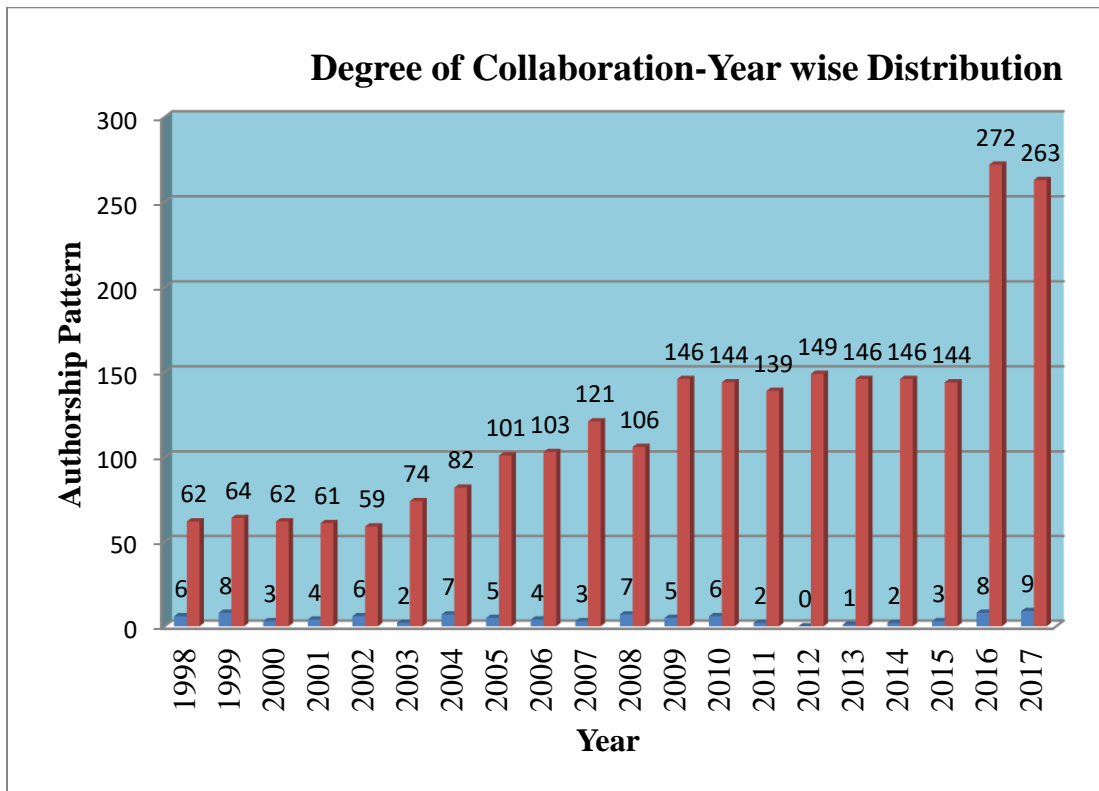


Figure 4: Degree of Collaboration – Year wise Distribution

5. Single Author publications – Trend Analysis

Table 5: Single Author Publications – Trend Analysis

Year	Single Author Contribution	Count	Percentage
1998	6	68	8.82
1999	8	72	11.11
2000	3	65	4.62
2001	4	65	6.15
2002	6	65	9.23
2003	2	76	2.63
2004	7	89	7.87
2005	5	106	4.72
2006	4	107	3.74
2007	3	124	2.42
2008	7	113	6.19
2009	5	151	3.31
2010	6	150	4
2011	2	141	1.42

2012	0	149	0
2013	1	147	0.68
2014	2	148	1.35
2015	3	147	2.04
2016	8	280	2.86
2017	9	272	3.31
Total	91	2535	3.59

The study explained the single author publications determined the trend analysis from during the period 1998-2017. From the table.5, it is showed that research publication of single-author contributions to the journal over the period has a fluctuation trend. In the second year of the journal, it recorded a maximum of 11.11% of articles contributed by single authors out of the total of 72 contributions. Figure 5 shows the individual author contribution was not in 2012.

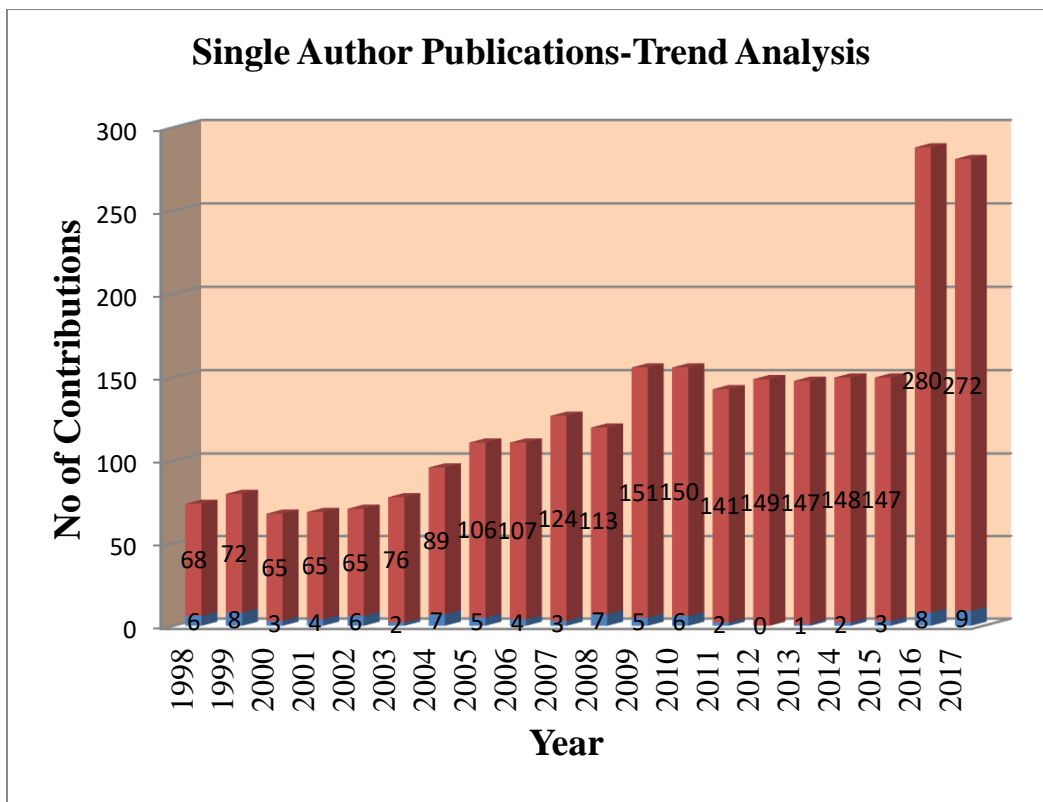


Figure 5: Single Author Publications – Trend Analysis

6. Multiple Author Publications – Trend Analysis**Table 6: Multiple Author Publications – Trend Analysis**

Year	Multiple Author Contribution	Count	Percentage
1998	62	68	91.18
1999	64	72	88.89
2000	62	65	95.38
2001	61	65	93.85
2002	59	65	90.77
2003	74	76	97.37
2004	82	89	92.13
2005	101	106	95.28
2006	103	107	96.26
2007	121	124	97.58
2008	106	113	93.81
2009	146	151	96.69
2010	144	150	96
2011	139	141	98.58
2012	149	149	100
2013	146	147	99.32
2014	146	148	98.65
2015	144	147	97.96
2016	272	280	97.14
2017	263	272	96.69
Total	2444	2535	96.41

The analysis explained the multiple-author publications determined the trend analysis from during the period 1998-2017. Research publication of multiple author contributions to the journal over the period has an increasing trend. Table 6 shows the collaborative author trend during the study period. In the year 1998, the contribution of collaborative authors was 91.18%. Since then it has shown the progress of increasing trend from the year 2012. It fulfils hundred per cent contributions from the beginning of the study period. Hence, the majority of the research contributions to the Journal "IEEE/ACM Transactions on Networking" are by multiple authors over the period. Which shown in the chart in Figure 6

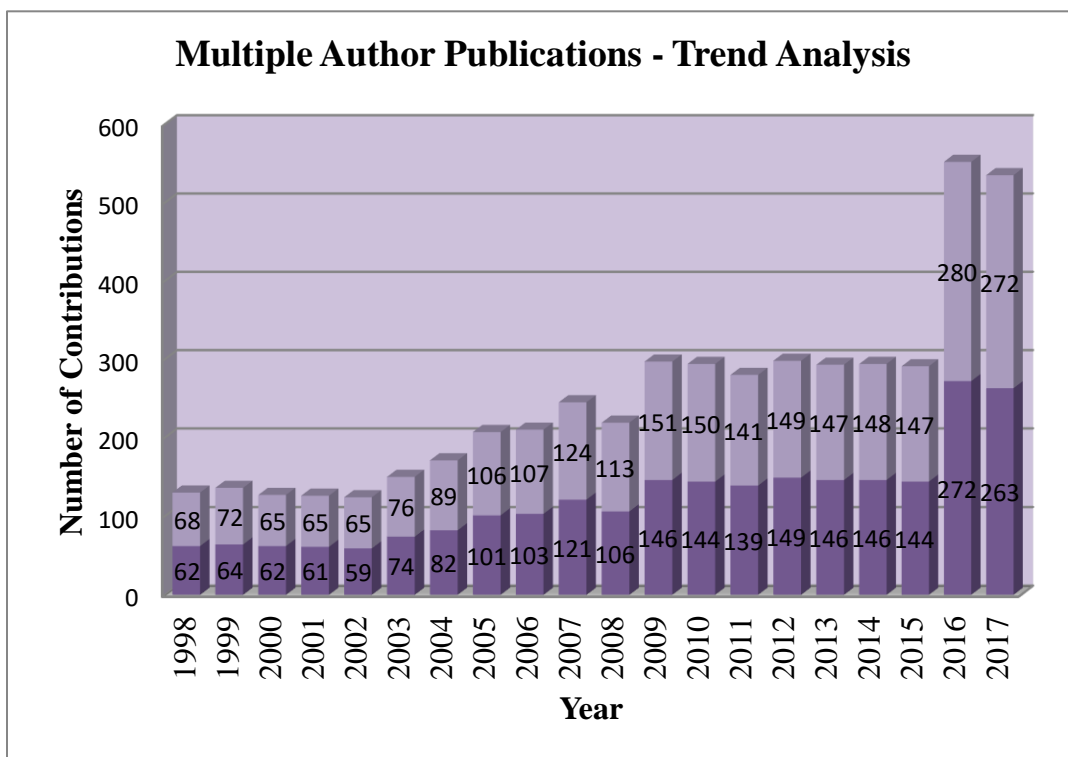


Figure 6: Multiple Author Publications – Trend Analysis

7. Productivity of Authors Based on Lotka’s Law

Table 7: Productivity of Authors Based on Lotka’s Law

No. of Publications	Observed No of Author With n(an) or F	Observed % of Authors 100* (an/al)	Expected No of Authors (an=al/n ²) P	Expected % of Author Predicate by Lotka 100/n ²	(F-P) ² /P
1	3264	100	3264	100	0
2	656	20.09	816	25	31.37
3	271	8.3	362.63	11.11	23.15
4	148	4.53	204	6.25	15.37
5	79	2.42	130.56	4	20.36
6	50	1.53	90.41	2.77	18.06
7	42	1.29	66.59	2.04	9.08
8	29	0.89	50.92	1.56	9.44
9	18	0.55	40.15	1.23	12.22
10	6	0.18	32.64	1	21.74
11	9	0.28	27.09	0.83	12.08

12	6	0.18	22.52	0.69	12.12
13	11	0.34	19.26	0.59	3.54
14	4	0.01	16.65	0.51	9.61
15	1	0.31	14.36	0.44	12.43
16	3	0.09	12.73	0.39	7.44
17	2	0.06	11.42	0.35	7.77
18	2	0.06	10.12	0.31	6.52
19	1	0.03	9.14	0.28	7.25
20	3	0.09	8.16	0.25	3.26
21	1	0.03	7.51	0.23	5.64
22	5	0.15	6.85	0.21	0.49
23	2	0.06	6.2	0.19	2.85
29	1	0.03	0.47	0.12	0.59
30	1	0.03	3.6	0.11	1.87
32	1	0.03	2.93	0.09	1.27
36	1	0.03	2.61	0.08	0.99
50	1	0.03	1.31	0.04	0.07
	4618			X2	256.58

It is appropriate to examine and analyze the implications of Lotka's Law about author productivity on the publication of articles. Lotka's Law stated the "frequency of publication by authors in a given field ". The table shows "The number of authors making "n" contribution is about $1/n^2$ of those making one; the proportion of all contributors that make a single contribution is about 60 per cent" (Lotka 1926)¹⁰. which means that among all the authors in a given field, 60 % had just one publication, and 15 % will have two contributions ($1/2^2 \times 60$). 7 % of authors had three research papers ($1/3^2 \times 60$), and so on. As per Lotka's Law of scientific Productivity, only 6% of the authors in a field will produce more than ten articles. From the table, it is observed that the single paper contributed authors constitute 70.68% of the total authors. Only 0.05% of authors have provided more than ten contributions. Table-7 obeys Lotka's Law of scientific Productivity.

8. Price's fundamental Law of science

Table 8: Price's Fundamental Law of Science

S. No.	Year	No. of Papers	No. of Authors	Exponential Growth Yt1/Yt0
1	1998	68	177	
2	1999	72	177	1
3	2000	65	174	0.98
4	2001	65	187	1.07
5	2002	65	194	1.04
6	2003	76	208	1.07
7	2004	89	244	1.17
8	2005	106	295	1.21
9	2006	107	313	1.06
10	2007	124	370	1.18
11	2008	113	319	0.86
12	2009	151	458	1.44
13	2010	150	480	1.05
14	2011	141	463	0.96
15	2012	149	520	1.12
16	2013	147	536	1.03
17	2014	148	541	1.01
18	2015	147	528	0.98
19	2016	280	1054	1.99
20	2017	272	1122	1.06

Price's 11 celebrated lectures on "Little Science and Big Science" reviewed some earlier works by Francis Galton, Cattell and Lotka. And presented a notable "Feeling that most of the great scientists are still with us and that the greater part of scientific work produced within living memory, within the span of the present generation of scientists".

But once the mathematical nature of the model he considered is understood, the awe, if any, disappears. He thinks an exponential time trend as the appropriate model to fit for data on many scientists. He calls this principle of exponential growth as the "Fundamental law of any analysis of science".

Let y_t = number of scientists during a period t . (t maybe just 1 year or a span of say, 30 or 45, years).

$$y_t = e^{a'+b't} \text{-----} 1$$

$$\log y_t = a' + b't$$

Let $a' = \log a$ and $b' = \log b$.

Then $\log y_t = \log a + t \log b$

$$\text{ory}_t = a \cdot b^t \text{-----} 2$$

In (2) if $b > 1$ the exponential curve is rising over time (+ve growth) and if $b < 1$, the curve is falling (-ve growth). (2) may also be written as

$$y_t = y_0 * b^t \text{ (Since } t=0, y_0 = a = \text{number of scientists in the beginning).}$$

$$\text{or } y_t = y_{t-1} * b$$

Since $b > 1$, number of scientists during any period t is greater than those existing in particular period in the past.

Table 8 shows the exponential growth of authors/scientists from 1998 to 2017. The price formula of the fundamental Law of science $y_t = e^{a+bt}$ is applied here. Table 8 indicated that the value of b is higher than one maximum in the years, except 2000, 2008, 2011, 2015 and hence the present study accepts Price's fundamental Law of science.

Findings:

The analysis examined and discovered the following significant findings and conclusions.

- It is identified that the per capita authorship ranged from 0.24 to 0.41. The per capita authorship in the years 1999 was 0.41 which decreased to 0.24 in the year 2017
- It is proved from the analysis that single-author papers have a declining trend and thereby, collective contributions have increased performance in scientific research activities.
- Out of 2535 papers, three authored contributions found to be the highest with 772 (30.42%) papers, followed by two authored articles with 744 (29.35%).
- The average Degree of author collaboration in the IEEE/ACM Transactions on Networking is 0.96
- The trend analysis of authorship pattern reveals that single-authored publications show fluctuation trend from 1998 to 2017. In the year 1999 of the journal, it had recorded a maximum of 11.11% of articles contributed by single authors studied out of the total 72 contribution.
- The trend analysis of authorship pattern reveals that the collaborative author trend for the duration of the study period in the year 1998, the contribution of collaborative authors was 91.18%. Since then it has shown a progressive trend from the year 2012, and the contributions were with a maximum hundred per cent right from the beginning of the study period.
- It is observed that the single paper contributed authors constitute 70.68% of the total authors. So obeys the author productivity based on Lotka's Law.
- The exponential growth, based on fundamental price law brings out the following facts: The analyzed data regarding growth on a number of scientists the value of b is less than 1 during for the period of the years 2000, 2008, 2011 and 2015, except further all year greater than value 1. Price's Fundamental Law of Science forms a predominant basis in this study.

Conclusion:

The present study established some general inferences on the basic bibliometric attributes like authorship, a research collaboration of the networking literature. In summary, it may be concluded that the findings of the study would certainly provide the-state-of-the-art of networking research, thus helping researchers and policymakers. The IEEE/ACM Transactions on Networking is one of the most extensive journals that appear in the IEEE society. This study has proven to be useful a tool in the assessment of research publication of scientists in Engineering and technology. From the study, it is clear that the majority of joint authorship and high collaboration in Journal of IEEE/ACM Transactions on Networking which reveals that team research is predominant during the study.

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