

## APPLICATION OF BIBLIOMETRIC LAWS IN DOCTORAL THESES OF LIBRARY AND INFORMATION SCIENCE SUBMITTED TO THE UNIVERSITIES OF NORTHEAST INDIA

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Bibliometrics primarily concentrates on a mechanism adopted for quantitative analysis of the data through statistical means. The present paper investigates the validity of Lotka's Law to authorship distribution and Zipf's law of word occurrence in Doctoral Theses of Library and Information Science in the Universities of North East India. The collected data for the period from 2006 to 2015 for the present study were compiled systematically for analysis. A total number of 12707 citations were identified and tabulated in 8 different criteria to analyze and draw findings. The result suggests that author productivity distribution in Lotka's Law is not relevant to Doctoral Theses in the field of Library and Information Science in the Universities of North East India.

**Keywords:** Bibliometrics, Citations, Authorship Pattern, Research output, Lotka's Law, Zipf's Law

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### INTRODUCTION

Bibliometric studies are applied to every branch of study with a simple mechanism of counting to determine the growth of discipline and Library and Information Science is no exception to this. The data collection followed by scientific selection from the authentic source is very important in such studies as, four basic components such as the form of publication, authorship pattern, year and place of publication are determined to ascertain the growth of knowledge dimension in the given field of study. It is a viable means to know the development of the available information resources which form the basis of potential teaching source, value-added learning and research materials for the faculties, students, and research scholars. It, further, leads to sustainable growth in research and development of the subject. Bibliometrics, an inter-disciplinary character, has been recognized globally as a discipline and it is a fast-developing area in information science as it involves a process of critical

scrutinization of the properties and behavior of information.

The present study is limited to 83 doctoral theses in Library and Information Science of North East India for the period from 2006 to 2015 of 4 universities such as, Gauhati University, Manipur University, Mizoram University, and North Eastern Hill University. As the study is limited to the year 2015, Assam University and Tripura University were not included under the purview of the study as till 2015 there was no research output leading to Ph.D. by that time.

### **LAWS OF BIBLIOMETRICS**

During 1920s and 1930s, three basic bibliometric studies namely Lotka's Law, Bradford's Law, and Zipf's Law were published, where Lotka's Law concentrates on the distribution of scientific papers (Potter, 1988) among authors while, Bradford's Law on the scattering of papers on a given subject in scientific journals (Potter, 1988) and Zipf's Law works on the distribution of words in a text (Potter, 1988). These three laws may be invariably explained as below:

#### **Lotka's Law of Scientific Productivity**

This law relates to the authors publishing in a certain discipline where the Law depicts the publication frequency by authors in a given field of study. It states that "... the number (of authors) making  $n$  contributions is about  $1/n^2$  of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent". The general formula shows that,  $XnY = C$  where,

$X$  is the number of publications,

$Y$  the relative frequency of authors with  $X$  publications and,

$n$  and  $C$  are constants depending on the specific field (Potter, 1988; De, 2009, p.75; Hertz, 2010, p.560-573; Jose, 2012).

#### **Bradford's Law of Scattering**

It is related to the distribution of publications and it stands as an accepted guideline to librarians in ascertaining the number of core journals in a field of study. It depicts that the journals in a single field can be separated into three zones, each containing the same number of articles:

- i. The first zone, where a core of journals on the subject, relatively few in number, that produces approximately one-third of all the articles,
- ii. The second zone, containing the same number of articles as the first, but with a greater number of journals, and
- iii. The third zone which contains the same number of articles as the second, but still covers greater number of journals.

The mathematical relationship of the number of journals in the core to the first zone is a constant  $n$  and to the second zone, the relationship is  $n^2$ . Bradford expressed this relationship as  $1:n:n^2$  (Potter, 1988; De, 2009, p.75; Hertz, 2010, p.560-573; Jose, 2012).

#### **Zipf's Law of Word Occurrence**

The law denotes to a ranking of Word Frequency which is often used to predict the frequency of its use within a text. The Law states that in a relatively lengthy text if you "list the words occurring within that text in order of decreasing frequency, the rank of a word on that list multiplied by its frequency will equal a

constant. The equation for this relationship is:  $r \times f = k$  where  $r$  is the rank of the word,  $f$  is the frequency, and  $k$  is the constant". (Potter, 1988; De, 2009, p.75; Hertz, 2010, p.560-573; Jose, 2012).

### **SIGNIFICANCE AND SCOPE OF THE STUDY**

Developing need-based information sources have imminent in the library in view of shrinking budget allocation, varied needs of information sources, a multiplicity of primary and secondary sources of information for research. Hence, statistical measures became indispensable to measure the information needs of the users and this precipitated to carry out Bibliometric studies both in international and national level in Social Science research in general and Library and Information Science in particular, and the results of such studies have been tested with various Bibliometric laws. The present study is, however, limited to the research evaluation of 83 doctoral theses in Library and Information Science of North East India from 2006 to 2015 of 4 universities such as, (i) Gauhati University, (ii) Manipur University, (iii) Mizoram University, and (iv) North Eastern Hill University and will confine with Lotka's Law of Scientific Productivity and Zipf's Law of Word Occurrence. As the study is limited to the year 2015, Assam University and Tripura University were not included under the purview of the study as till 2015 there was no research output leading to Ph.D. by that time. The purpose of the present study is to ascertain the type of information need and use pattern of the scholars in Library and Information Science of the universities under study.

### **REVIEW OF LITERATURE**

Kumar and Senthil Kumar (2019) in their study of 6,363 papers published by 2,719 authors during 2013-2017 in Web of Science (WoS) Database applied Lotka's Inverse Square ( $n=2$ ) method and general power method ( $n=2$ ) to test the applicability of the law. They also added a Chi-Square test and Kolmogorov-Smirnov (K-S) test to measure the viability of the law. The authors deduced that the productivity distribution is inappropriate when Lotka's law was applied in generalized form as well as its original form on the data set. Suguna (2017) while analysing 2478 Ph.D. theses in Humanities accepted between 1950 and 2012 in five Universities of Kerala deduced 84.4% of the Theses do not have tables and more than a quarter of them have 1-3 appendices and no references were found in 22.5% of the Theses. He also found out that chapter end references were seen in 39% and less than 100 entries in the bibliography were in 37.4% of Theses. With regard to the result almost 3/5<sup>th</sup> of Ph.D. theses used Chicago Style manual. Dorta et al. (2015) in their study of 120 randomly selected highly productive authors from the CSIC Research Centre (Spain) in four different subjects deduced that the ratio between production and impact dimensions is a normalized measure of the citation potential at the level of individual authors. They further viewed that, this ratio decreases between-group variance in relation to the within-group variance in a higher proportion than the rest of the indicators analyzed and this result in the selection and promotion process within interdisciplinary institutions as it allows comparisons of authors based on their scientific research. The authors suggested different

measures of the citation potential for author based on a proportion of the dimensions. The study of PubMed by Jeyasekar and Saravanan (2015) disclosed the exponential growth of forensic literature. It revealed that relative growth rate fell from 0.83 to 0.17 during 2002 and 2013 and while, the mean collaborative index came to 3.5, the mean degree of collaboration formed 0.89, and the mean collaborative coefficient was 0.6119. Further, they inferred that the mean modified collaborative coefficient was 0.6121 during the period of study. The authors also created Cluster map of co-words.

Singh and Bebi (2014) in a study of 52,378 citations out of 260 theses inferred that, the scholars have given priority to 9,997 journal articles belonging to 934 journals published from 31 countries. The authors further found out that Books also contribute the highest number of citations. Meyer et al. (2009) used citation analysis to identify the most influential publications. They verified characteristics of social simulations such as its multi-disciplinary nature. They also performed a co-citation analysis for visualizing the intellectual structure of social simulation and its development. They found that books represent the dominant publication outlet in this period. They also found that even at the early stage, social simulation appears to emerge as a multi-disciplinary field drawing upon publications from wide range of disciplines such as economics and evolutionary biology. Their studies revealed that, *Economic & Political Weekly* from India is the most-cited journal. Bhat and Sampath Kumar (2008) studied a citation analysis of research articles from scholarly electronic journals published during

2000-2006. The results of the study revealed that, 81.49% of articles published in selected 9 electronic journals constitute web references and out of 25,730 references, 56.54 % of references are print journal references while 43.52% of them are web references. They found that majority of articles having web references are from ARIADANE (93.24%) followed by *Cybermetrics: International Journal of Scientometrics, Informetrics, and Bibliometrics* (89.47%) and *D-LIB Magazine* (89.19%). Saichev et al. (2008) study on the theory of Zipf's law and power laws, driven by the mechanism of proportional growth. Their study includes the origin and conditions of the validity of Zipf's law using the terminology of firm's asset values and the intimate connection between Zipf's and Gilbrat's laws, underlie Zipf's law in diverse scientific areas.

Vallmitjana and Sabate (2008) in a study of 4203 citations out of 46 doctoral theses covered during 1665 to 2003 at InstitutQuimic de Sarria (IQS) found that the most frequently used documents were scientific papers which constitute 79% of the citations. They also found that 33 journals met 50% out of the information needs and the age of 50% of the citations was not older than 9 years. A study by Casserly and Bird (2003) to 500 citations of various internet sources published in various library and information science journals between 1999 and 2000 revealed that majority contained partial bibliographic information without year. Further, most of the URLs pointed to content pages with ".edu" or ".org" domains are excluded. More than half i.e. 56.4% of the citations were permanent, 81.4 % were available on the Web and thus, searching the

Internet Archive increased the availability rate to 89.2 %. Chen and Leimkuhler (1986) studied a common functional relationship among Lotka's law, Bradford's law and Zipf's law. In their paper, the proof takes explicit account of the sequences of observed values of the variables by means of an index. Their study resulted in a more realistic and precise formulation of each law.

### **STATEMENT OF THE PROBLEM**

The problems associated with the present study are mentioned below:

- 1) Inappropriate use of Bibliometric indices in the bibliography.
- 2) Unscientific arrangement of bibliography in the dissertation.
- 3) Excessive use of short-form with regard to Author.
- 4) Inappropriate recording of bibliography components like author, year, place, publisher, etc.
- 5) A large number of spelling mistakes in the Bibliography.

### **OBJECTIVES OF THE STUDY**

The objectives of the present study are to:

- 1) Ascertain year of establishment of the universities including the total number of research outputs;
- 2) Find out the authorship pattern and collaborative research in Library and Information Science;
- 3) Examine the validity of Lotka's Law of Scientific Productivity;
- 4) Test the data with Zipf's Law of Word Occurrence; and

- 5) Study the Chronological Distribution of Documents

### **METHODOLOGY**

The present study contains a total of 12707 citations out of 83 Ph.D. theses from the Department of Library and Information Science of 4 Universities of North East India as discussed. The bibliographical references cited at the end of each thesis are taken as the source of data for the study. The data were collected by visiting each University and used hard as well as soft copy of the theses. The 12707 citations data received are tabulated into 8 different criteria for analysis with the retrieved documents of 1,01,656 data. The Microsoft-excel was used to draw the statistical inferences of the data.

### **DATA ANALYSIS AND FINDINGS**

#### **Research Output of selected LIS Departments in North East India**

The establishment of every institution results in the quality as well as quantity of research output and therefore, highlighting about the year of establishment of the department of library and information science in North East India is essential along with the award of Ph.D. in the discipline. Table-1 reveals the year of establishment and the number of Ph.D. awardees till 2015. It reflects the establishment of the department of library and information science where, Gauhati University is the first university to commence the department in 1966 followed by North Eastern Hill University (NEHU) in 1985, Manipur University in 1986, Mizoram University in 2002 and Assam University in 2009. The table further reflects that, the total numbers of Ph.D. awardees from each university.

**Table 1: Year of establishment and institution wise award of Ph.D. of the DLIS\***

Sl. No.	Name of the University	Year of Estd. of the Dept.	No. of Ph.Ds. Awarded as on 2015	% **
1	Gauhati University	1966	39	46.99 or 47
2	North-Eastern Hill University (NEHU)	1985	15	18.07 or 18
3	Manipur University	1986	17	20.48 or 20
4	Mizoram University	2002	12	14.46 or 14
5	Assam University	2009	0	-
		Total	83	100

\*DLIS- Department of Library and Information Science

\*\* >.5 has been rounded to the next digit, <.5 has been rounded to the previous digit

Analysis of the Table 1 regarding the institution wise contribution of research leading to Ph.D. during the period under coverage depicts that Gauhati University stands at the apex i.e., 39 (47%) in awarding Ph.D. degree out of 83 in total followed by Manipur University with 17 (20%), North-Eastern Hill University (NEHU) with 15 (18%) and Mizoram University with 12 (14%). As, Assam University was established in 2009, it could not produce any research output leading to Ph.D.

### Authorship Pattern

Authors contribute potentially in the domain of research though articles are available in both print and electronic form. The author may be single, joint, triple, et.al. etc. Evaluation of all 12707 citations covered under study could identify 9835 (77.39%) authors while 2870 (22.58%) were unidentified. The total number of 9835 authors categorized into Single author, Joint authors, three authors, etc. without author (links alone) and organization as an author placed in Table 2

**Table 2: Authorship Pattern**

Sl. No.	Author(s)	No. of Authors	%	Cumulative Frequencies	Cumulative %
1	Single	6073	48	6073	48
2	Joint	2056	16	8129	64
3	Three	374	3	8503	67
4	Others	366	3	8869	70
5	Organization	751	6	9620	76
6	Without Author (links alone)	217	2	9837	78
7	Unidentified	2870	22	12707	100
	Total	12707	100		

While making an analysis of the authorship pattern placed in Table-2, the study revealed that the contribution of articles by a single author is significantly more which comes to 6073 (48%), followed by joint authors i.e. 2056 that form 16%, 751 number of organization as an author's (6%) respectively. This further revealed that among 6 groups, single author, joint authors, and organizations as an author, rank First, Second and Third position respectively while three authors, et.al., and without author (links alone) are insignificant. This may be due to the fact that the

contribution of either articles or book chapters by many individuals is lacking bringing out research publications.

### Application of Lotka's Law of Scientific Productivity

Lotka's law is widely employed to measure the scientific productivity of an author. Lotka claimed that a large proportion of the literature is produced by a small number of authors. The application of Lotka's Law of Scientific productivity for the present study has been reflected in Table-3.

**Table 3: Lotka's Law of Scientific Productivity**

Sl. No.	Type of Author	No. of Articles	Citation Frequency	%	Cumulative Frequencies	Cumulative %
1.	One time	2072	2072	48.55	2072	48.55
2.	Two times	399	798	18.7	2870	67.25
3.	Three times	121	363	8.5	3233	75.75
4.	Four times	58	232	5.43	3465	81.18
5.	Five times	23	115	2.7	3580	83.88
6.	Six times	18	108	2.53	3688	86.41
7.	Seven times	9	63	1.48	3751	87.89
8.	Eight times	14	112	2.62	3863	90.51
9.	Nine times	9	81	1.9	3944	92.41
10.	Ten times	6	60	1.4	4004	93.81
11.	Eleven times	2	22	0.51	4026	94.32
12.	Twelve times	3	36	0.84	4062	95.16
13.	Thirteen times	3	39	0.91	4101	96.07
14.	Fifteen times	1	15	0.35	4116	96.42
15.	Seventeen times	1	17	0.4	4133	96.82
16.	Twenty-one times	2	42	1	4175	97.82
17.	Twenty-six times	1	26	0.61	4201	98.43
18.	Twenty-eight times	1	28	0.66	4229	99.09
19.	Thirty nine times	1	39	0.91	4268	100
	<b>Total</b>	<b>2744</b>	<b>4268</b>	<b>100</b>		

Maximum numbers of authors contributed single articles, i.e. 2072 (48.55%). This is followed by the authors who contributed two

times, i.e. 399 (18.7%), authors who have contributed three times contributed 121 (8.5%) of the total articles, authors who contributed four

times 58 (5.43%) articles, author who contributed five times 23 (2.7%) articles, author who contributed six times 18 (2.53%), the authors who contributed seven and Nine times remains the same in number i.e. 9 (1.48%) and (1.9%), authors who contributed eight times 14 (2.62%), authors who contributed ten times 6 (1.4%), the authors who contributed eleven times and twenty-one times remain the same number that is 2 (0.51%) and (1%) respectively. The authors who contributed twelve times and thirteen times remains the same number, that is 3 (0.84%) and (0.91%) and the authors who contributed fifteen times, seventeen times, twenty-six times, twenty-eight times and thirty-nine times remains the same number, that is 1 (0.35%), (0.4%), (0.61%), (0.66%) and (0.91%) respectively. The total citation frequency i.e. 4268 is from 2744 number of authors has been spelled in the type of author i.e. one time two times, three times, etc. and up to thirty-nine times.

Lotka's Law of Scientific Productivity that focusses on the frequency of publication by authors in a given field states that "... the number (of authors) making  $n$  contributions is about  $1/n^2$  of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent". Moreover, the frequency distributions of the author productivity did not match the generalized Lotka's Law (Potter, 1988; De, 2009, p.75; Hertz, 2010, p.560-573; Jose, 2012).

The table 3 represents the author productivity data for Lotka's law. Of the 4268 total author names, 2072 (48.55%) produced one article with 2072 citation frequency, 399 (18.7%) produced two articles with 798 citation frequency, 121

(8.5%) produced three articles with 363 citation frequency, 58 (5.43%) produced four articles with 232 citation frequency, 23 (2.7%) produced five articles with 115 citation frequency, 18 (2.53%) produced six articles with 108 citation frequency, 9 (0.72%) and 9 (1.9%) produced seven articles and nine articles with 63 and 81 citation frequency respectively. 14 (2.62%) produced eight articles with 112 citation frequency, 6 (1.4%) produced ten articles with 60 citation frequency, 2 (0.51%) and 2 (1%) produced eleven and twenty-one with 22 and 42 citation frequency, 3 (0.84%) and 3 (0.91%) produced twelve and thirteen articles with 36 and 39 citation frequency, 1 (0.35%), 1(0.4%), 1 (0.61%), 1 (0.66%) and 1 (0.91%) produced fifteen, seventeen, twenty-six, twenty-eight and thirty nine articles with 15, 17, 26, 28 and 39 citation frequency respectively.

### Application of Zipf's Law of Word Occurrence

The Law in a relatively lengthy text establishes that in the list of words occurring within that text in decreasing frequency, the rank of a word on that list is multiplied by its frequency which will equal a constant. The equation for this relationship can be formulated as  $r \times f = k$  where  $r$  is the rank of the word,  $f$  is the frequency, and  $k$  is the constant (Potter, 1988; De, 2009, p.75; Hertz, 2010, p.560-573; Jose, 2012). While taking into consideration, words with more than 500 in frequency are listed in Table-4.

Table 4 represents words occurrence of Zipf's law. The word 'Library' secured 1<sup>st</sup> position in ranking order with 3409 frequency. The word 'Information' with 2852 frequency, 'Libraries' 1425 frequency, 'New' 1408 frequency followed by 'India' with 1377 frequency, which constitutes 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>. and 5<sup>th</sup> in ranking order. The equation



**Table 4: Zipf's Law of Scientific Productivity**

Sl. No.	Rank (r)	Word	Frequency (f)	$r \times f = k$ (expected constant)
1	1	Library	3409	3409
2	2	Information	2852	5704
3	3	Libraries	1425	4275
4	4	New	1408	5632
5	5	India	1377	6885
6	6	Science	1070	6420
7	7	Search	1041	7287
8	8	University	949	7592
9	9	Journal	919	8271
10	10	Education	827	8270
11	11	Era	792	8712
12	12	Retrieve	659	7908
13	13	Access	620	8060
14	14	Research	571	7994
15	15	Source	554	8310
16	16	National	547	8752
17	17	Management	536	9112
18	18	Development	534	9612
19	19	Service	533	10127
20	20	Technology	524	10480
21	21	Librarian	503	10563

for relationship i.e.  $r \times f = k$  where  $r$  is the rank of the word,  $f$  is the frequency, and  $k$  is the constant, it is found that rank and frequency of words in Table-4 are not always related and multiplication of them is not equal constant. Therefore, Zipf's Law did not match with the findings.

### Chronological Distribution of Documents

The chronological distributions of documents cited by the scholars in their thesis have been depicted in table 5. This is also one of the major components of the study to determine the research value of a journal including the obsolescence of literature in a given field of study. The total periods commencing from 1807 to 2015 have been split into 22 groups with a gap of 10 years in between each showing the citation frequency and the percentage there of including the cumulative frequencies and its percentage.

**Table 5: Chronological Distribution of Documents**

Sl. No.	Year (10 yrs Gap)	Publications	%	Cumulative Publications	Cumulative %
1.	1807	1	0.01	1	0.01
2.	1808-1817	0	-	1	0.01
3.	1818-1827	4	0.04	5	0.05
4.	1828-1837	0	-	5	0.05
5.	1838-1847	7	0.08	12	0.13
6.	1848-1857	1	0.01	13	0.14
7.	1858-1867	1	0.01	14	0.15
8.	1868-1877	5	0.05	19	0.2
9.	1878-1887	5	0.05	24	0.25
10.	1888-1897	8	0.09	32	0.34
11.	1898-1907	0	-	32	0.34
12.	1908-1917	13	0.15	45	0.49
13.	1918-1927	27	0.31	72	0.8
14.	1928-1937	27	0.31	99	1.11
15.	1938-1947	56	0.66	155	1.77
16.	1948-1957	77	0.9	232	2.67
17.	1958-1967	213	2.51	445	5.18
18.	1968-1977	479	5.7	924	10.88
19.	1978-1987	754	8.91	1678	19.79
20.	1988-1997	1589	18.8	3267	38.59
21.	1998-2007	3776	44.61	7043	83.2
22.	2008-2015	1421	16.8	8464	100
<b>Total</b>		<b>8464</b>	<b>100</b>		

The analysis of the chronological distributions of the documents placed in table 5 shows that in between 1998-2007 there is a highest citation rate i.e. 3776 (44.61%) out of 8464 followed by 1589 citations (18.8%) in between 1988-1997 and 1421 citations (16.8%) during 2008-2015 and thus keeps 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> respectively. It is surprising to know that the number of citations increased from 77 (0.9%) to 213 (2.51%) during 1948-1967 and chronologically it went on exceeding the number of citations till 1987. Again, it could be pointed out that a period of 1808-1817, 1828-1837 and 1898-1907 have no citation frequency for the study, which may be due to the fact that either the research output during the period is negligible or the documents are not available in the library or may not be having any research value of the articles either in books or journals. Chronological Distribution of Documents placed in Table-5 can be assumed that the research importance increases in the light of the present trends which are visible from the present study.

### CONCLUSION

The Bibliometric studies are widely used not only to evaluate research performances but also to generate information which is employed by the experts in a given field of research. Bibliometric analysis has been assumed for different reasons and ending up with various perspective, placing objectives, and defining future strategy. The institution-wise contribution of research leading to Ph.D. during the period under coverage visualized that, Gauhati University stands at the apex i.e., 39 (47%) in conferring Ph.D. degree out of 83 in total. The contributions of articles by single author are significantly more which

comes to 6073 (47.8%). The author productivity data for Lotka's law out of 4268 total authors, 2072 (48.55%) produced one article with 2072 citation frequency each, besides the frequency distributions of the author, productivity did not match the generalized Lotka's Law. In the occurrence of the word of Zipf's law, the word 'Library' secured 1<sup>st</sup> position in ranking order with 3409 frequency. From the analysis, it could be found that rank and frequency of words are not always related and multiplication of them is not equal constant and therefore, words occurrence of Zipf's Law did not match the generalized Law. Chronological Distribution of Documents deduced that there is a high citation rate i.e. 3776 (44.61%) out of 8464 in between 1998-2007 followed by 1589 citations (18.8%) in between 1988-1997 and 1421 citations (16.8%) during 2008-2015 and thus keeps 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> respectively.

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