

Citation Analysis in Doctoral Dissertations in Physics: A Quantitative Study

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Abstract: The present study is based on 30691 citations, appended in the 163 theses in physics submitted to Andhra University, Visakhapatnam for the award of Doctoral Degree during the period 1942-2002. It has been carried out Bibliographic Form-wise distribution of citations, Subject wise distribution of citations, language wise distribution of citations, country wise distribution of citations, country wise distribution of journal citations, average number of author for citation. The Physics researchers referred mostly journal source rather than other sources. Most of the publications cited by the physics researchers were published by developed countries and all the citations were published in English language only.

Keywords: Bibliometric Study, Citation Analysis, Quantitative Study, Physics Theses, Citation Techniques. Bibliometric Methods.

Introduction

Citation analysis is one aspect of Bibliometrics which deals with the study of literature use patterns. It can bring out useful information pertaining to authorship patterns in different disciplines and in different periods, the relative use of literature and different kinds of documents such as books, periodicals reports, theses, patents, standards etc., the rate of obsolescence of documents ranked list of periodicals based on their productivity research productivity in a country, in a language and in a particular subject, by a particular author or scientist or organization etc. The findings and conclusions drawn from such studies, as

evinced from the review of previous Bibliometric Studies are helpful solving many of the problems specific to collection management and general management issues like space management, budget management, customization of information services to users etc.

Bibliometrics

Bibliometrics is an emerging thrust research area of Library and information Science. It is the application of mathematical and statistical method for measuring quantitative and qualitative changes in the production of literature in a given area of specialization. Bibliometric studies are used to identify the pattern of publication, authorship and citation analysis with the hope that such regularities can give an insight into the dynamics of the area under consideration. The basic aims of Bibliometric Studies are to assist the users in locating the existing information.

Citation Analysis

Citation analysis is the most popular technique used in Bibliometrics. Citation studies are useful in elucidating the development of library services in research. Meaningful acquisition becomes possible when the quantum of citation from a particular (journal) or other sources is assessed by the librarians and information managers. Citation analysis makes easy in weeding out redundant material. Citations can bring-out useful information like authorship pattern in different disciplines, the relative use of different kinds of documents as

books, periodicals, reports, theses, patents, standards etc.

Review of Literature

Rangra and others in (1972) studied the coverage of Indian literature on chemistry and chemical technology excluding metallurgy in referativinyi Zhunal-Khimiya, based on the literature reported in Indian science abstracts, and found that only 31 per cent of the literature has been covered in the journal.

Grefrath (1974) analyzed the citations appended to 308 journals articles in the field of chemistry published in 1963. The results showed that theoretical articles had a longer lifetime than articles on practical aspects.

Dewitt and others in (1980) studied the use of citations as a tool for studying the sociology of chemical research and the feasibility and accuracy of using automatically general data.

Anand (1981) studied the citing pattern of Indian chemists by analyzing the citations in the journal of the Indian Chemical Society for the year 1979. The authorship pattern revealed that papers with two authors were maximum in number according for 50.87 per cent, followed by papers with three authors (31.22%), and single authored papers accounted for 8.52 per cent. The bibliographic form-wise distribution of citations showed that journals accounted for 88.56 per cent of total citations and self-citations accounted for 11.26 per cent.

Lal and Panda (1999), based on 20 doctoral theses in plant pathology submitted to Rajendra Agricultural University, Bihar, India from 1980-

1993, gives result of a citation analysis of references used. The applicability of 2 formulations (verbal and graphical) of Bradford's Law of Scatter was tested in 3 separate parameters to avoid arbitrary scattering. The conformation of the verbal and graphic formulations was found to be very close. Suggests that at a practical level, application of the Bradford distribution may provide a means for selecting those journals dealing with a given subject that are the most productive in terms of the number of relevant articles.

Nalini (2003) carried a bibliometric study and analyzed 31 articles on occupational health related problems studied in India and published in journals (most Indian but some in foreign journals) during the year 2000. Examines the institutions originating the articles: the major subject area covered was found to be that of health consequences of chemical and textile workers. Average length of articles, number of authors and the time span and number of citations are also analyzed.

Methodology

Citation analysis is one aspect of Bibliometrics which deals with the study of literature use patterns. It can bring out useful information pertaining to authorship patterns in different disciplines and in different periods, the relative use of literature and different kinds of documents.

Objectives

The main objective of the any citation analysis is to provide useful information to the scholars in searching of literature and to help the library administration in selection relevant source. The main objectives of the present study are:

- § To trace out the information sources cited by researchers in the field of physics i.e bibliographic form wise distribution of citations in physics.
- § To examine the subject wise distributions of citations in physics
- § To identify the language wise distribution of citations in physics
- § To know the country wise distribution of citations
- § To trace out the country wise distribution of journal citations
- § To identify the average number of author for citations

Hypothesis-2: The literature of Physics is scattered over a wide range of subject.

Hypothesis-3: English is the predominant language in which the physics literature is published.

Hypothesis-4: Major portion of the Physics Literature is published in developed countries.

Hypothesis-5: Compared to individual research collaborative research is predominant in the field of Physics.

Results and Discussions

Bibliographic form-wise Distribution of Citations in Physics

Scope

The study is based on 30691 citations, cited in the 163 theses of physics submitted to Andhra University, Visakhapatnam for the award of doctoral degree during the period 1942-2002.

The various sources of information used by researchers in the field of Physics are studied by analysing the citations according to their bibliographic form subject and country of origin. 14 Bibliographic forms of documents appended to the 163 theses covered in the study.

Hypotheses

Hypothesis-1: Journals are the most preferred vehicles of scholarly communication and academic advancement in the sciences.

The distribution of citations among different bibliographic forms in Physics is presented in the following Table.

Table – 1: Bibliographic Form-Wise Distribution of Citations in Physics

Sl No	Type of Document	Number of Citations	Percentage	Cumulative Number	Cumulative Percentage
1.	Journals	24759	80.67	24759	80.67
2.	Books	2533	8.25	27292	88.92
3.	Conference Proceedings	1458	4.75	28750	93.67
4.	Manuals	594	1.94	29344	95.61
5.	Memories	650	2.12	29994	97.73
6.	Monographs	334	1.09	30328	98.82
7.	Others	115	0.37	30443	99.19
8.	Patents	99	0.32	30542	99.51
9.	Reports	58	0.19	30600	99.70
10.	Reference Books	36	0.12	30636	99.82
11.	Standards	25	0.08	30661	99.90
12.	Theses	13	0.04	30674	99.94

13.	Unpublished	13	0.04	30687	99.98
14.	Unidentified	4	0.02	30691	100.00

Bibliographic form wise distribution of citations in Physics theses is shown in Table-1. It may be observed from the table that the citations to journals completely topped the list with 24759 (80%) citations. The rest of the citations together accounted only for 20 percent. Among them Books with 2533 citation stood first (8.25%) followed by Reports with 1458 (4.75%) citations stood in the third place.

Analysis of data indicates the importance of journals to the researchers and also their dependence on journals rather than other forms of information sources. This may be due to the fact that the journals are primary sources of latest

research information mostly required by the researchers.

Subject wise Distribution of Citations in Physics

Citations cited by researchers might have been scattered over a wide range of subjects that are considered to be the outgrowth of basic physics. Subject-wise analysis of total citations appended to the theses in Physics shows the distribution of citations among various subject specialisation and associated disciplines. This shows the outgrowth of specialisations from a basic discipline on one hand and interdisciplinary nature of the literature on the other hand. The subject-wise distribution of citations in Physics is shown in Table-2

Table – 2: Subject-Wise Distribution of Citations in Physics

Sl. No.	Subject	Number of Citations	Per-centage	Cumulative Number	Cumulative Percentage
1.	Nuclear Physics	9447	30.78	9447	30.78
2.	Ionosphere	5414	17.64	14861	48.42
3.	Spectroscopy	3484	11.35	18345	59.77
4.	Ultrasonics	1592	5.19	19937	64.96
5.	Dielectrics	1286	4.19	21223	69.15
6.	Pure Physics	693	2.26	21916	71.41
7.	Magnetic Hydrodynamics	623	2.03	22539	73.44
8.	Material Science	583	1.90	23122	75.34
9.	Ultrasonic vibrations	576	1.88	23498	77.22
10.	Geophysics	486	1.58	23984	78.80
11.	Acceleration in Resonance Phenomena	456	1.49	24440	80.29
12.	Transient Magnetism of Earth	385	1.25	24825	81.54
13.	Acceleration in Resonance Accelerators	378	1.23	25203	82.77
14.	Electric Measurements	348	1.13	25551	83.90
15.	Electromagnetic Phenomena	335	1.09	25886	84.99
16.	Vibrations	322	1.05	26208	86.04
17.	Applied Mathematics	309	1.01	26517	87.05
18.	Nuclear Structure	308	1.00	26825	88.05
19.	Dielectric Phenomena	265	0.86	27090	88.14
20.	Fundamental Particles	259	0.84	27349	88.99

21.	Electronics	256	0.83	27605	89.91
22.	Magnetism	250	0.81	27855	90.60
23.	Mathematical Physics	248	0.81	28103	91.42
24.	Pyroelectricity and piezoelectricity	243	0.79	28346	92.20
25.	Geology	242	0.79	28588	93.0
26.	Molecular structure	239	0.78	28827	93.79
27.	Mathematics	199	0.65	28827	94.44
28.	Physical structure of Matter	190	0.62	29026	95.50
29.	Aeronomy and space physics	164	0.53	29380	95.58
30.	Magnetic fields and waves	161	0.52	29541	96.10
31.	Heat Reaction	160	0.52	29701	96.62
32.	Thin	137	0.45	29838	97.08
33.	Hydrodynamics	126	0.41	29964	97.49
34.	Analysis of physics	106	0.35	30070	97.86
35.	Electric Dipole	105	0.34	30175	98.18
36.	Synchronous	84	0.27	30259	98.44
37.	X-Ray spectroscopy	78	0.25	30337	98.69
38.	Thermal Effects of currents	76	0.25	30413	98.94
39.	Magnetic Resource	69	0.22	30482	99.16
40.	Electric city	67	0.22	30549	99.38
41.	Vibratise in Air column	64	0.21	30613	99.58
42.	Solid State Physics	45	0.15	30658	99.73
43.	Atomic structure	33	0.11	30691	100.00

The subject wise distribution of citations in Physics is shown in Table-2. It is observed from the table that the cited references in Physics are scattered among 43 subjects. Among them 'Nuclear Physics' stands in the first place with 9447 (31%) citations. The second and third places are occupied by 'Ionosphere' with 5414 (17%) citations and 'Spectroscopy' with 3484 (11%) citations respectively. 'Ultrasonics' and 'Dielectrics' stood at fourth and fifth places with 1592 (5%) and 1286 (4%) respectively.

Language wise Distribution of Citations

It is a known fact that the scientific literature is published in different languages of the world. In

other words, the scientific findings are communicated through a variety of languages known to researchers. Their preferences for language medium mostly depend on the language of the source document in which they would like to publish their research findings. There are other reasons like the availability of literature in a particular language researcher's knowledge of foreign languages and the availability of translation facilities. The language wise distribution of the citations cited by the researchers reveals the predominant language in which most of the citations cited are published. Table-3 presents the language wise distribution of citations in Physics. The distribution of physics literature among 15 languages shows its international nature.

Table -3: Language-wise distribution of citations in physics

Sl No	Language	Number of Citations	Percentage	Cumulative Number	Cumulative Percentage
1	English	28135	91.69	28135	91.83
2	German	1032	3.36	29167	95.18
3	Japanese	615	2.00	29782	97.18
4	French	252	0.82	30034	98.01
5	Russian	166	0.54	30200	98.55
6	Swedish	116	0.37	30316	98.92
7	Danish	147	0.47	30463	99.34
8	Italian	107	0.34	30570	99.72
9	Chainese	68	0.22	30638	99.94
10	Other (6 Languages) (Polish, Portugese, Brazil, Belgium, Nepal, Finland) 14+12+10+8+5+4	53	0.17		100.00
	Total	30691		30691	100.00

Languages wise analysis of citations data in the above table reveals clear cut domination of citations in English Language accounting for 91.69 percent of the total citations in Physics. Languages other than English, such as German, Japanese, French, Russian, Swedish, Swiss, Italian, Chinese cover only, 3.36 percent, 2.00 percent, 0.82 percent, 0.54 percent, 0.37 percent 0.47 percent, 0.34 percent, 0.22 percent citations respectively. Rest of the languages like Polish, Portugese, Belzium, Brazil, Nepalese and Finland together

grouped under others category account for only 0.17 percent of the total citations.

Country wise Distribution of Citations

The scientific literature in the field of Physics is being published by many countries Geographical distribution of literature cited by researchers in a subject field indicate the research output of a particular country in that subject. The research productivity of the country reflects its scientific progress and development.

Table-4: Country wise distribution of citations in Physics

Sl. No.	Name of the Country	Number of Citations	Percentage	Cumulative Number	Cumulative Percentage
1.	US	15110	49.23	15110	49.23
2.	U.K.	5930	19.32	21040	68.55
3.	India	3799	12.38	24839	80.93
4.	Netherlands	1910	6.22	26749	87.15
5.	German	1257	4.10	28006	91.25
6.	Japan	859	2.80	28865	94.05
7.	France	402	1.31	29267	95.36
8.	Sweden	268	0.87	29535	96.23
9.	Denmark	243	0.79	29778	97.02
10.	Russia	193	0.63	29971	97.65
11.	Italy	184	0.60	30155	98.25
12.	Switzerland	173	0.56	303281	98.81
13.	Australia	132	0.43	30460	99.24
14.	Unidentified	84	0.27	30544	99.51

15.	Chaina	76	0.25	30620	99.76
16.	Poland	18	0.06	30638	99.82
17.	Ireland	14	0.05	30652	99.87
18.	Portugal	12	0.04	30691	100.00
19.	Canada	10	3.9	30691	100.00
20.	Brazil	6			
21.	Belgium	4			
22.	Finland	4			
23.	Nepal	3			

A geographic analysis of citations presented in the above table furnishes information on the range of countries active in the field of Physics and their relative contribution. It also presents country wise distribution of core journals in Physics. While USA takes the top position with its contribution of 49 percent (15110) journals, the UK is second on the list of countries with 5930 (19%). India and Netherlands stood in third and forth place with 3799 (12%) and 1910 (6.22%) citations

respectively. The fifth place was occupied by Germany with 1257 (4.10%) contributions. Japan France, Sweden, Denmark, Russia, Italy, Switzerland, Australia have also contributed literature in physics comprising 0.43 to 2.80 percent of the total citations. Contributions from Portugal, Canada, Brazil, Belgium, Finland and Nepal together contributing to less than 0.05% of citations are grouped under 'others' category.

Table – 5: Country Wise Distribution of Citations to Journals in Physics

Sl. No.	Name of the Country	Number of Citations	Percentage	Cumulative Number	Cumulative Percentage
1.	U.S.	12576	50.79	12576	50.79
2.	UK	5152	20.81	17728	71.60
3.	Netherlands	1711	6.91	19439	78.51
4.	India	1683	6.80	21122	85.31
5.	Germany	1194	4.82	22316	90.13
6.	Japan	819	3.31	23135	93.44
7.	France	371	1.50	23506	94.94
8.	Sweden	264	1.07	23770	96.01
9.	Denmark	227	0.92	23997	96.93
10.	Italy	174	0.70	24171	97.63
11.	Russia	173	0.70	24344	98.33
12.	Switzerland	161	0.65	24505	98.98
13.	Australia	118	0.48	24623	99.46
14.	Chaina	64	0.26	24687	99.72
15.	Unidentified	18	0.07	24705	99.79
16.	Ireland	14	0.06	24719	99.85
17.	Portugal	12	0.05	24731	99.90
18.	Poland	28	0.11	24759	100.00
19.	Canada				
20.	Brazil				
21.	Nepal				
22.	Finland				

Table-5 reveals the geographical distribution of citations to journals cited by the researchers in Physics. It shows the relative research contribution

of different countries in the discipline of Physics. While USA takes the top position with its contribution covering 50 percent (12576) citations, UK occupied the second place on the list of

countries contributing to 5152 (20.81%) citations. Netherlands stands third with 1711 (6.91%) citations followed by India in the fourth place with 1683 (6.80%) journal citations. Germany's contribution accounts for 1194 (4.82%) citations. Next place is occupied by Japan with 819 (3.31%) citations. The analysis reveals that the research scholars in physics depend mostly on literature published from USA and UK. Others group comprises contributions from Poland, Canada, Brazil, Nepal & Finland together with (28) citations. Countries contributing to less than 0.05 percent of citations are grouped under 'others' category.

Average Number of Authors per Citation in Physics (Journals, Books, Conference Proceedings Monographs, Manuals & Reference Books)

The growth in the proportion of both collaborative papers and the number of authors in a discipline depends to some extent on the type of research. The average number of authors per citation denotes estimation of the extent of collaboration in a discipline. The average number of authors per citation in Physics.

Table-6: Average Number of Authors per citation in Physics

Year	No. of Citations	No. of Authors	Average No. of Authors
Upto 1869	212	315	1.49
1870-79	12	15	1.25
1880-89	39	41	1.05
1890-99	20	22	1.10
1900-09	115	126	1.10
1910-19	124	144	1.16
1920-29	601	815	1.36
1930-39	2040	2916	1.43
1940-49	1978	2998	1.52
1950-59	7706	13061	1.69
1960-69	8114	15298	1.89
1970-79	4615	10043	2.18
1980-89	1481	3613	2.44
1990-99	362	1002	2.77
2000-2001	1	2	2.00
Total	27420	50411	1.84

The above table presents the average number of authors per citation in Physics. The average number fluctuates somewhat in the beginning but later showed a marked increase. The highest author ratio is 2.77 in the years from 1990-99 and the average number of author per citations for the period is 1.84.

Findings

Validation of Hypotheses:

Based on the testing of the validity of the hypotheses formulated, the researcher arrived at the following conclusions: It is evident from the citation analysis conducted in the present study that journals are the most preferred vehicles of scholarly communication and academic advancement in Physics.

The second hypotheses states that the literature of Physics is scattered over a wide range of subjects. This statement is found to be true in the case of Physics, since the literature of Physics is scattered over 43 subjects. The applied aspect of Physics in Mathematics, Geophysics and Engineering shows the interdisciplinary nature of research in the field.

The third hypotheses states that the literature of Physics is published predominantly in English language. It is found to be true since a very high percentage of the literature cited in Physics theses is published mainly in English language. It shows the international nature of Physics literature and its global use.

The fourth hypotheses states that major portion of the literature of Physics is published in developed countries. It is found to be valid, since the findings show that most of the literature cited in Physics is mainly published in developed countries like USA, and UK where Research and Development are considered to be priority areas of concern.

The fifth hypotheses states that compared to solo research, collaborative research is predominant in the field of Physics. This statement is found to be valid from 1960 onwards, from which period the shift in emphasis from single authored works to multi-authored works has been noticed. There is significant increase in the works of multiple authors during the last forty years indicating increasing collaborative research in Physics.

Conclusion

Citation analysis, as is well known, has been used or proposed for a wide variety of applications. Since, citations allow a quantitative and computer manipulation of data, citation analysis became easy

and more popular. In addition to the general purposes cited by many authors, after having obtained the core journal's list, these journal, can be considered for rapid and wide secondary service treatment to provide current awareness services. Moreover citation analysis helps in identifying a list of non-physics journals which have proved to be of use and which are not easily obtained by other methods.

Citation ranking is an attractive concept. This will be of best use for those libraries working in a well-defined subject area. Citation analysis is however, a useful technique for examining journals in general, mapping fields in these journals or literature as a whole or of a particular country. In spite of the limitations of the technique of citation analysis, because of its many interpretations, it remains interesting.

Information input is crucial for conducting the research activity in any field of knowledge. Scientist's approach to information varies based on the various stages of research activity. Their current needs for information are usually coupled with retrospective information needs. A well high universal finding of many surveys of the literature habits of scientists is that the frequently used of all sources of information are periodicals and typically they account for well over half of all their reading. The same has been traced in the present study. In addition to journals, other sources occasionally referred by scientists include books, conference proceedings, reports, theses, standards and patents. Each of these documents has a specific role to play in the dissemination of research information.

It is hoped that this study would provide some insight into literature use pattern in Physics of Indian researchers in Physics.

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