

Citation Analysis of Ph.D. Theses in Electronics and Communication Engineering

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Abstract: *The present study investigates the distribution of citations from the perspective of bibliographic forms by analyzing a total of 22,878 citations drawn from 178 doctoral theses submitted in the field of Electronics and Communication Engineering to K L University, Guntur, Andhra Pradesh, India, during the period 2015–2024. The study examines the distribution of citations based on the type and nature of bibliographic sources, while also considering several critical factors such as journal rank, journal productivity, etc. The study reveals that journals are the most preferred sources of information for research scholars in electronics and communications engineering since they contributed the highest number of citations. There are 10698 journal article citations cited by contributors in electronics and communications engineering are scattered in 1975 journal titles. Among the 'IEEE Transactions on Antennas and Propagation' occupies first ranks for being cited more number times with 6.25 percent of total citations.*

Key words: Citation, Ph.D. theses, Electronics, Communication Engineering

1. Introduction

Electronics and Communication Engineering (ECE) is a specialized branch of engineering that focuses on the design, analysis, and application of electronic circuits, devices, communication systems, signal processing, network protocols, fibre-optic technologies, and telecommunication systems. The discipline integrates the fundamental principles of electrical engineering with concepts from computer science, including programming, and communication theory to develop innovative and efficient solutions for a wide range of industrial, scientific, and technological applications.

At present librarians are facing many problems due to the rising costs of journals every year, ever increasing demands of the reading community for getting new periodical and diminishing budgetary provisions to meet the user requirements it is becoming necessary for them to identify core journals in different disciplines in order to procure useful journals within the given financial resources for providing effective service to the users in the library.

Citation analysis, which is one of the areas of bibliometrics, can be used for identifying the core journals and for knowing the characteristic features of the discipline such as authorship pattern, scatter of literature in different information sources and in different subjects, etc. Gross and Gorss (1927) used for the first time this citation analysis as a tool for identifying the core journals in a subject based on counting the citations given at the end of each paper from a group of primary journals. Afterwards, a number of such studies were carried out on citations in dissertations/theses, books, journals, conference proceedings and reviewing journals.

2. Objectives

The objectives of the present study are:

- 1) To analyze the distribution pattern of citations across different bibliographic forms in the field of Electronics and Communication Engineering;
- 2) To examine the authorship pattern;
- 3) To identify the core journals
- 4) To assess the productivity of journals;
- 5) To examine the applicability of Bradford's Law of Scattering to the pattern of journals used by researchers in Electronics and Communication Engineering;

3. Hypotheses

The following hypotheses have been formulated for testing:

- 1) Journals are the most frequently cited sources of information by researchers in electronics and communication engineering and its sub-fields.
- 2) There is no statistically significant difference between books and journal articles with respect to the authorship pattern of cited sources in Electronics and Communication Engineering and its selected sub-fields.
- 3) There is no statistically significant difference in the productivity of journal citations among Electronics and Communication Engineering and its selected sub-fields.
- 4) There is no statistically significant difference in the distribution of journal citations across Bradford Zones among Electronics and Communication Engineering and its selected sub-fields.
- 5) Researchers in electronics and communication engineering depend more on current literature than on older literature.

4. Materials and Methodology

The present study is confined to a citation analysis of citations in doctoral theses submitted in the field of Electronics and Communication Engineering. The study is based on data collected from 178 doctoral theses submitted to Koneru Lakshmaiah University during the period 2015–

2024. A total of 22,878 citations were extracted from these theses, with an average of 129 citations per thesis.

All references appended to the selected theses were carefully examined to analyze various bibliometric aspects such as authorship pattern, bibliographic forms, year-wise distribution of publications, journal titles, and country-wise distribution of publications. The collected data were recorded on standard reference cards (12.5 × 7.5 cm) and supplemented with journal-related information obtained from Ulrich's International Periodicals Directory. Subsequently, the compiled data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for interpretation and presentation of results.

5. Data Analysis

Analysing data of the available sample is one of the major and important works in research. Different software is available to analyse the data in the field of bibliometrics. In this study, M.S. Excel is considered a tool of analysis using different formulae. Analysis of the same are discussed below:

Year wise distribution of theses

Year-wise distribution of Ph.D. theses in Electronics and Communication Engineering is shown in Table 1.

Table 1: Year-wise distribution of Ph.D. theses in Electronics and Communication Engineering

S. No	Year	Number of Theses	Percentage
1	2015	2	1.12
2	2016	2	1.12
3	2017	6	3.37
4	2018	12	6.74
5	2019	22	12.36
6	2020	32	17.98
7	2021	27	15.17
8	2022	16	8.99
9	2023	48	26.97
10	2024	11	6.18
Total		178	100.00

Table 1 reveals that a total of 178 doctoral theses were awarded in Electronics and Communication Engineering during the period 2015–2024. Among these, the highest number of theses, 48 (26.97%), were awarded in the year 2023, followed by 32 (17.98%) in 2020 and 27 (15.17%) in 2021. Further, 22 (12.36%) theses were awarded in 2019, while 16 (8.99%) were awarded in 2022. A total of 12 (6.74%) theses were awarded in 2018 and 11 (6.18%) in 2024. The lowest number of theses, 2 (1.12%) each, were awarded during the years 2015 and 2016. The data indicate a gradual increase in the number of doctoral degrees awarded, with a significant rise observed during the years 2020–2023.

Branch-wise distribution of Theses

Table 2 shows the branch-wise distribution of theses submitted, the number of citations appended and the average number of citations per thesis.

Table 2: Branch -wise distribution of Theses

Name of the Branch	Number of Theses	Number of citations appended	Average number of Citations per Theses
Antennas and Wave Propagation	42	5281	125.74
Artificial Intelligence and Data Science	41	5288	128.96
Digital Image and Digital Signal Processing	44	5624	127.82
Wireless Communications	51	6685	131.08
Electronics and Communication Engineering (Total)	178	22, 878	128.53

It is evident from Table 2 that a total of 22,878 citations were appended in 178 doctoral theses in the field of Electronics and Communication Engineering, with an average of 128.53 citations per thesis. Out of the 178 theses, 51 theses belong to the area of Wireless Communications, contributing 6685 citations, with an average of 131.08 citations per thesis. This is followed by Digital image and signal processing, which accounted for 44 theses with 5,624 citations and an average of 127.82 citations per thesis, the field of Artificial Intelligence and Data Science contributed 41 theses with 5,288 citations and an average of 128.96 citations per thesis, and the field of antennas and wave propagations contributed 42 theses with 5, 281 citations and an average of 128.96 citations per thesis.

Research Supervisor wise distribution of theses

Table 3 presents the distribution of doctoral theses in Electronics and Communication Engineering according to the research supervisors.

Table 3: Distribution of doctoral theses in Electronics and Communication Engineering according to the research supervisors

S. No	Name of the Research Supervisor	Number of Theses	Percentage
1	Dr. Habibulla Khan	14	7.865169
2	Dr. B. T. P. Madhav	10	5.617978
3	Dr. D. Venkata Ratnam	9	5.05618
4	Dr. I. Govardhani	8	4.494382
5	Dr. P.V. V. Kishore	7	3.932584
6	Dr.K. Sarat Kumar	7	3.932584
7	Dr.V. Rajesh	6	3.370787
8	Dr. K. Kumar Naik	6	3.370787
9	Dr. Kakarla Hari Kishore	5	2.808989
10	Dr. M. Sivaganga Prasad	5	2.808989
11	Dr. P. Pardhasaradhi	5	2.808989
12	Dr. A.S.C.S. Sastry	5	2.808989
13	Dr. Fazal Noorbasha	4	2.247191
14	Dr. M. Sridhar	4	2.247191
15	Dr. Md Zia Ur Rahman	4	2.247191
16	Dr.K.S. Ramesh	4	2.247191
25	9 research supervisors with 3 theses	27	15.16854
33	8 research supervisors with 2 theses	16	8.988764

65	32 Research Supervisors with 1 thesis	32	17.97753
Total		178	100.00

It is evident from Table 3, Out of the total 178 theses, the highest number of theses (14) were submitted under the guidance of Dr. Habibulla Khan, followed by Dr. B.T.P. Madhav with 10 theses, and Dr. D. Venkata Ratnam with 9 theses. These supervisors secured the first, second, and third ranks respectively in terms of research guidance.

The supervisor-wise analysis provides valuable insights into the research productivity, academic involvement, and guidance patterns of faculty members in the field of Electronics and Communication Engineering. It also reflects the active participation and contribution of research supervisors toward the development of doctoral research in the discipline.

Nature of Guideship

Table 3.4 presents the distribution of doctoral theses in Electronics and Communication Engineering according to the nature of guideship. The table highlights the pattern of supervision adopted for guiding research scholars, such as single guideship and joint or co-guideship. The analysis helps in understanding the extent of collaborative supervision and the role of research guides in doctoral research. It also reflects the academic cooperation and interdisciplinary involvement in guiding research work within the field of Electronics and Communication Engineering.

Table 4: Distribution of doctoral theses in Electronics and Communication Engineering according to the nature of guideship

S. No	Nature of Guideship	Number of guides	No. PhD's Awarded
1	Sole Guideship	56	169
2	Co-Guideship	9	9
Total		65	178

It is evident from Table 4 that a total of 65 research supervisors were identified during the study period. Out of these, 56 were sole research supervisors under whose guidance 169 theses were awarded, with an average of 4.8 theses guided per supervisor. The remaining 9 research supervisors were associated with co-guideship, under which 9 theses were awarded.

Bibliographic Forms

The distribution of citations as per the different bibliographic forms in the literature of electronics and communication engineering is presented in Table 5.

Table 5: Bibliographic form-wise sharing of cited citations

S. No	Types of Bibliographic Forms	Number of Citations	Percentage
1	Journal articles	10,698	46.76
2	Conference papers	5,372	23.48
3	Books	3,380	14.77
4	Reports/Govt. publications	1,189	5.20
5	Databases	1,098	4.80
6	Reference sources	514	2.25
7	Theses/Dissertations	331	1.45

8	Weeklies/magazines	205	0.89
9	Un-identified	91	0.40
Total		22,878	100.00

It is evident from the Table 5 that journals contribute the highest number of citations, accounting for 10,698 (46.76%) of the total citations in electronics and communication engineering. Conference proceedings papers secured the second highest number of citations, accounting for 5,372 (23.48%) of the total citations, followed by books 3,380 (14.77%), reports/government publication 1,189 (5.20%), databases 1,098 (4.80%), reference sources 514 (2.25%), theses/dissertations 331 (1.45%) and weeklies/magazines 205 (0.89%) of total citations. The remaining 91 (0.40%) of the total citations are not identified. Hence, it can be concluded that journals constitute the mostly cited sources of information among researchers in the field of electronics and communication engineering.

Authorship pattern of books

The distribution of book citations based on the authorship pattern in electronics and communication engineering is shown in Table 6.

Table 6: Authorship pattern of books

S. No	Authorship pattern	Number of Citations	Percentage
1	One author	1554	45.98
2	Two authors	1045	30.92
3	Three authors	507	15.00
4	More than three authors	274	8.10
Total		3380	100.00

Table 6 reveals that out of a total of 3,380 book citations, 1,554 (45.98%) were contributed by single authors, 1,045 (30.92%) by two authors, 507 (15.00%) by three authors, and 274 (8.10%) by more than three authors. While single-authored books constitute the largest individual category, the combined contribution of multiple-authored books amounts to 1,826 citations (54.02%), this exceeds that of single-authored books. Therefore, it may be concluded that multiple-authored books are cited more frequently than single-authored books in the field of electronics and communication engineering research, indicating a greater reliance on collaborative scholarly works.

Authorship pattern of journal articles

The distribution of journal article citations based on the authorship pattern in electronics and communication engineering is shown in Table 7.

Table 7: Authorship pattern of journal articles

Number of authors	Number of Citations	Percentage
One author	1025	9.58
Two authors	2644	24.72
Three authors	2916	27.26
Four authors	1957	18.29
Five authors	1095	10.24
Six authors	635	5.94
Seven authors	243	2.27
Eight authors	102	0.95
Nine authors	46	0.43
Ten authors	10	0.09
Eleven authors	13	0.12

Twelve authors	8	0.07
Fifteen authors	3	0.03
Nineteen authors	1	0.01
Total	10,698	100.00

Table 7 indicate that out of 10,698 journal article citations in electronics and communication engineering, 1,025 (9.58%) citations were contributed by single authors, 2,644 (24.72%) by two authors, 2,916 (27.26%) by three authors, 1,957 (18.29%) by four authors, 1,095 (10.24%) by five authors, 635 (5.94%) by six authors, 243 (2.27%) by seven authors, 102 (0.95%) by eight authors, 46 (0.43%) by nine authors, 10 (0.09%) by ten authors, 13 (0.12%) by eleven authors, 8 (0.07%) by twelve authors, 3 (0.03%) by fifteen authors, and 1 (0.01%) by nineteen authors. The highest proportion of

citations was contributed by three author journal articles (27.26%), followed by two author articles (24.72%) and four author articles (18.29%). Collectively, multiple authored journal articles account for 9,673 citations (90.42%), whereas single authored articles account for only 1,025 citations (9.58%). Therefore, it can be concluded that multiple authored journal articles dominate the citation pattern in Electronics and Communication Engineering, reflecting the collaborative nature of research in the discipline.

Rank List of Highly Cited Journals in ECE

The ranking of highly cited journals in Electronics and Communication Engineering is shown in Table 8.

Table 8: Rank List of Highly Cited Journals in ECE

S. No	Name of the Journal	Citations		Cumulative	
		No	%	No	%
1.	IEEE transactions on antennas and propagation	669	6.253505	669	6.253505
2.	IEEE Antennas and Wireless Propagation Letters	564	5.272013	1233	11.52552
3.	IEEE Access	366	3.4212	1599	14.94672
4.	Microwave and optical technology letters	221	2.065807	1820	17.01253
5.	IEEE transactions on microwave theory and techniques	171	1.59843	1991	18.61095
6.	IEEE Antennas and Propagation Magazine	162	1.514302	2153	20.12526
7.	Electronics Letters	160	1.495607	2313	21.62086
8.	Progress in electromagnetic research	157	1.467564	2470	23.08843
9.	IEEE Transactions on Circuits and Systems	122	1.1404	2592	24.22883
10.	Journal of Geophysical Research: Space Physics	111	1.037577	2703	25.2664
11.	Other Journals	7995	74.7336	10698	100

It is evident from table 8 that the 10698 journal article citations cited by contributors in electronics and communications engineering are scattered in 1975 journal titles. Among the ‘*IEEE Transactions on Antennas and Propagation*’ occupies first ranks for being cited more number times with 6.25 percent of total citations, followed by ‘*IEEE Antennas and Wireless Propagation Letters*’ (5.27%), ‘*IEEE Access*’ (3.42%), ‘*Microwave and Optical*

Technology’ (2.07%), and ‘*IEEE Transactions on Microwave Theory and Techniques*’ (1.60%).

Productivity of Journals

The productivity of cited journals in electronics and communication engineering is shown in Table 9.

Table 4.26

Table 9: Productivity of Journals in Electronics and Communication Engineering

S. No	Percentage of Citations	No. of Citations	No. of Journals covered	Percentage of Journals	Average Productivity of articles
1	0 – 25%	2703	10	0.51	270.3
2	26 – 50%	2646	44	2.23	60.14
3	51 – 75%	2677	212	10.73	12.63
4	76 – 100%	2677	1709	86.83	1.57
Total		10698	1975	100.00	5.42

Table 9 shows that, in the electronics and communication engineering, the first 25% of citations are contributed by the first 10 journals, thus signifying their high rate of productivity. The average rate of productivity of journals in the first group is 270.3 citations, followed by 60.14 article citations in the second group, 12.63 article citations in the third group, and only 1.57 article citations in the last group.

This clearly demonstrates that a significant concentration of citations is confined to a small core set of 10 journals.

Bradford Zones for Electronics and Communication Engineering

Table 10 shows that the distribution of journal article citations according to the Bradford Law of Scattering in the Electronics and Communication Engineering.

Table 10: Bradford Zones for Electronics and Communication Engineering

Zones	Citations	Journals	Journal Percentage	Cumulative		
				No. of citations	No. of Journals	Journal Percentage
I (Core)	3598	20	1.01	3598	20	1.01
II	3529	128	6.48	7127	148	7.49
III	3571	1827	92.51	10698	1975	100

Table 10 presents the distribution of journal citations according to Bradford's Law of Scattering in the field of Electronics and Communication Engineering. The total journal article citations (10,698) were divided into three Bradford zones, and each contributing approximately one-third of the total citations.

The Core Zone (Zone I) consists of 20 journals, which together contributed 3,598 citations (33.63%), indicating that a very small number of highly productive journals account for a substantial proportion of the literature cited by researchers.

6. Conclusions

An analysis of 22,878 citations appended in 178 Ph.D. theses in electronics and communication engineering reveals the following conclusions:

- Out of 178 theses, the highest number of theses (14) were submitted under the guidance of Dr. Habibulla Khan, followed by Dr. B.T.P. Madhav with 10 theses, and Dr. D. Venkata Ratnam with 9 theses. These supervisors secured the first, second, and third ranks respectively in terms of research guidance.
- There are 65 research supervisors were identified during the study period. Out of these, 56 were sole research supervisors under whose guidance 169 theses were awarded, and the remaining 9 research supervisors were associated with co-guideship, under which 9 theses were awarded.
- Journals appear to be the most preferred sources of information for research scholars in electronics and communications engineering since they contributed the highest number of citation (46.76%).
- Out of 3,380 book citations, 1,554 (45.98%) citations were contributed by single authors, and 1,826 (54.02%) citations contributed by multiple authors. Multiple-authored books are cited more frequently than single-authored books in the field of electronics and communication engineering research, indicating a greater reliance on collaborative scholarly works.
- Out of 10,698 journal article citations in electronics and communication engineering, 1,025 (9.58%) citations were contributed by single authors, and 9673 (90.42%) citations contributed by multiple authors. Multiple authored journal articles dominate the citation pattern in Electronics and Communication Engineering, reflecting the collaborative nature of research in the discipline.
- There are 10698 journal article citations cited by contributors in electronics and communications engineering are scattered in 1975 journal titles. Among the '*IEEE Transactions on Antennas and Propagation*' occupies first ranks for being cited more number times with 6.25 percent of total citations.
- The Core Zone (Zone I) consists of 20 journals, which together contributed 3,598 citations (33.63%), indicating that a very small number of highly productive journals account for a substantial proportion of the literature cited by researchers. The results clearly identify a small nucleus of highly cited journals surrounded by a large number of less frequently cited journals, confirming the general applicability of Bradford's Law to the journal

citation pattern in Electronics and Communication Engineering.

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