Application of Bradford's Law on Pakistan Journal of Psychological Research

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Bradford's Law states that articles on a given subject are distributed over journals according to specific mathematical function, where a large number of articles are scattered in fewer highly productive journals. The purpose of this study was to apply the accepted formulations of Bradford's Law to citations used by the authors of the Pakistan Journal of Psychological Research to find out the list of core journals cited. Pakistan Journal of Psychological Research has been published since 1986 by National Institute of Psychology, Quaid-i-Azam University, Islamabad, Pakistan. This study examined 251 articles published in the Journal from 1986 to 2012. The data consisted of 6890 citations used by the authors. A ranked list of the cited journals was formed for the application of Egghe's formulation of Bradford's Law of scattering. Findings showed that journals were the most preferred source for citations in this study. Most of the cited journals were published in the United States. The rate of authors' and journals' self-citations was very low. A ranked list of the journals was prepared and Journal of Applied Psychology was found to be the most cited journal. The study identified 24 core journals after the application of Bradford's Law. Pakistan Journal of Psychological Research is the only journal of Pakistan found in the list of core journals. This law was found fit to the citations of the Journal.

Keyword. Bradford's law, citation analysis, Pakistan Journal of Psychological Research

Researchers utilize numerous resources for conducting research in their fields. They explore periodical and non periodical literature

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including journals, conference papers, and textbooks for their reviewing of literature. There are some standard journals, which are frequently used by the researchers for their publishing and referring. This bibliometric study intends to recognize the number of these core journals in a subject. Citation analysis is the commonly used bibliometric method and it is one of the techniques that identify the source of a given statement and key documents. This method is used to determine the impact of a publication by counting the number of times it has been cited by other authors. According to Moed (2005), citation analysis includes the application of different indicators such as impact, influence, and quality of scholarly work provided in references cited in the bibliographies of research publications. Sylvia (1998) has found the citation analysis as an unobtrusive method for the evaluation of journal collection in libraries. She examined bibliographic citations of student's research papers using this method. She posited that subscription of some journals, which were not used by the students, should be cancelled and funds of these journals may be allocated for the subscription of other journals. Many researchers have conducted studies to analyze the citations used in journals and dissertations. Journals of psychology remained the main focus of researchers for citation analysis. White and White (1977) performed citation analysis on 57 journals of psychology. Everett and Pecotich (1993) carried out citation analysis of journals for ranking their importance and showing the inter-relationships of the journals of psychology published by the American Psychological Association (APA).

The aim of the present study is to use the accepted formulations of Bradford's law to identify core journals of psychology. The notion of core journals was given by Samuel Clement Bradford, when he formulated Bradford's law of scattering in 1934 (see Kawatra, 2000). There are some journals on any subject that are frequently cited by researchers. These journals are referred to as *core journals* as they have close relationship with that specific subject. Pakistan Journal of Psychological Research (PJPR) was selected for this study. PJPR is one of the foremost research journals of social science in Pakistan. The content of this journal includes researches on educational, social, management, and developmental areas of psychology. This journal has great importance among the psychologists and researchers as the articles of this journal deal with the psychological knowledge application in understanding the problems of both national and international importance. This Journal has been selected for the study because it is one of the fewer Pakistani national journals that are ranked in 'X' category by Higher Education Commission (HEC,

2016) and the journal maintains and assures the quality of research published in it. PJPR is published biannually by the National Institute of Psychology, Quaid-i-Azam University, Islamabad, Pakistan since 1986. All of the 27 volumes, published from 1986 to 2012 were included in the study. A total of 6890 references cited by 251 articles of PJPR were selected for the analysis.

In bibliometric studies, Bradford's Law deals with journals' productivity and examination of concentration of articles in a subject area within a set of scholarly journals. Bradford's Law of distribution or scattering indicated that large number of articles are scattered in fewer journals and a large number of journals have proportionally fewer articles. The distribution of articles can be distinct in some approximate ratio $1:n:n^2$ …. This law states that documents on a given subject are scattered according to a definite mathematical function. Bradford has prepared a list of journals used in the bibliographies on Applied Geophysics and Lubrication and arranged them in decreasing order. He identified three groups of journals ranked by their productivity. The first group had the smallest number of highly productive journals called the core zone and the second group had a comparatively large number of *moderately productive journals*. The third group was called the *low productive zone* and had a large number of low productive journals. Roughly proportion of the journals in these three groups would be $1: n: n^2$ …, where n is called the Bradford multiplier (Birger & Jeppe, 2005).

Applicability of Bradford's law was examined by researchers using citations of journals and dissertations of different subjects. Sudhier (2010) applied Bradford's Law to the physics literature used by Indian Institute of Science for their doctoral theses. He found the law fit for the data set. Similarly, Banateppanvar, Birdar, and Kannappanavar (2013) applied Bradford's Law of Scattering to the journals of Botany cited by the doctoral students of Kuvempu University of India in their theses. He found the pattern of journal use of the researchers to be perfect with Bradford's Law of Scattering. Bradford's Law of Scattering was also found fit to the study of The Electronic Library Journal during the years 2003-2009 (Jena, Swain, & Sahu, 2012). Zafrunnisha (2012) has applied this law on the citations of doctoral thesis of psychology. She identified the Bradford's zone and productivity of the journals cited in the doctoral thesis and found that dispersion of journal titles in psychology does not satisfy the Bradford's Law of Scattering. Bradford's Law of scattering was applied for the identification of the core journals in many subject areas. Krishnamoorthy, Ramakrishnan, and Devi (2009) have applied this law for the identification of core journals in the field

of diabetes. They found United States, the largest contributor of diabetes literature and the research productivity of diabetes conforms to Bradford's law. Venable et al. (2014) has identified the core journals of pediatric neurosurgery by using the formulations of Bradford Law. Keeping this successful application of Bradford's Law for identification of core journals in a given field, the leading journal in the field of psychology in Pakistan, PJPR was selected to apply the law to citations of its articles to find out the scattering of cited sources. Moreover, PJPR is one of the quality Pakistani research journals that is recognized by HEC.

This study will be significant for research scholars and faculty members of the field of psychology. They can be able to recognize the core journals cited by the authors of PJPR for their further consultation. This study will also be substantial for the library managers, as they can evaluate their collection of journals. They can set priorities among journal subscription by identifying the core list of journals.

Objectives of the Study

This study has been conducted to serve the following objectives.

1. Analyze the type and number of cited documents.
2. Find out the journal's and authors' self-citations.
3. Identify the journals mostly used by the authors of PJPR.
4. Recognize the group of core journals with respect to use by the authors of PJPR
5. Check the appropriateness of the accepted formulations of the Bradford's Law of Scattering.

Method

The articles of PJPR were selected for the current study. There were 251articles published from 1986 to 2012. The citations were drawn from reference list of each article. The citations of each article were assessed to compile data. MS Excel worksheets were used for the data entry. Bibliographic details of references were observed. Citations of books, conferences, workshops, journals, theses, and dissertation were recorded in different rows. Sum of all cited journals was calculated at the end.

All journals cited in PJPR were arranged in descending order of their number of citations per journal. These journals were divided into three equal groups with equal number of citations. A table was formed for number of journals and their number of citations with the percentage. The relationship of journals in each group was created. By

putting the mean value of the Bradford multiplier in this relationship, a linear geometric expression $1: n : n^2$ was tested. Percentage error was calculated to check the appropriateness of Bradford's expression for the cited journals of the PJPR. In the next step, appropriateness of graphical formulation was tested. The natural log values of the cumulative number of journals were calculated. A graph of the log values of the cumulative number of journals with the cumulative number of citations was plotted

The formulation of Egghe and Rousseau (1990) was used for checking the fitness of the Bradford's Law. Egghe and Rousseau stated Bradford's Law for the bibliographies in Applied Geophysics and Lubrication that if journals are subdivided into p groups in such a way that each group of journals contains the same numbers y_0 of papers in this bibliography, then there exists $r_0$journals, the second has r_0k journals, the third has r_0k^2 journals and so on, until the last (p^{th}) group, contains r_0k^{p-1} journals. They used the following formulation.

$$r_0 = T (k-1) / (k^p-1) \qquad (1)$$

Where, r_0 is for journals of first zone; T is total number of journals; and k is Bradford multiplier. Following equation was used for calculating the k value.

$$k = (e^\gamma xY_m)^{1/p} \qquad (2)$$

Where e^γ is Euler's number (1.781), Y_m is the highest number of citations by the journal of rank one and p is the number of Bradford's zones.

Analysis and Results

The analysis and findings of the data collected from the 6890 citations of the 251 articles of the PJPR is given below:

Types of Cited Documents

A total of 6890 citations were used in the 251 articles of PJPR. Different types of cited documents were divided into seven categories of books; conferences and workshops; journals; theses and dissertations, websites, reports and surveys; newspapers and magazines; and others. The category 'others' includes unpublished manuscripts of research projects and research instruments, newsletters, and papers presented in annual meetings and national seminars. The category "dissertations and theses' include the entire theses cited in PJPR articles including the thesis and dissertations of the Dissertation Abstract International.
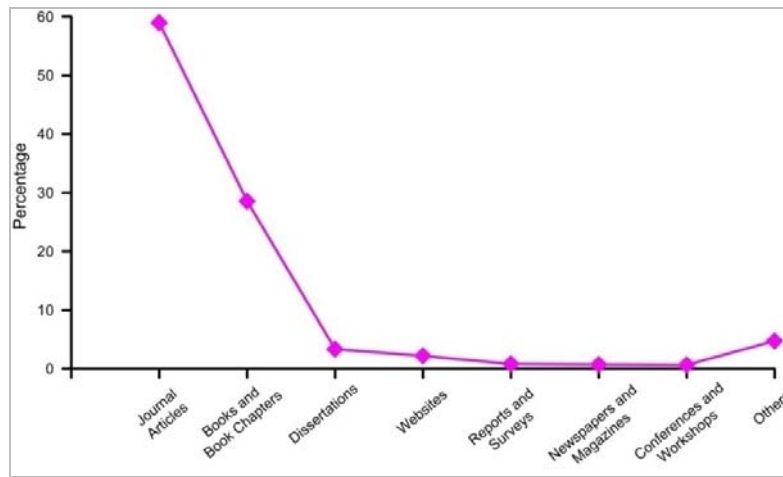
Figure 1. Types of cited sources

Figure 1 indicates the outcome of analysis of different types of documents cited by the PJPR article. The result shows that journals are the most cited sources with 4063 (58.97%) citations followed by books and book chapters with the 1967 (28.55%). Two hundred and thirty one (3.35%) cited sources are theses and dissertations and 151 (2.19%) citations are taken from websites. Reports, newspapers and magazines, and conferences and workshops constituted less than 1% of the citations.

Journal and Authors' Self-citations

The findings reveal that 62(2.35%) of the citations are the authors' self-citations and only 65(0.94%) of citations were cited from the same journal that is PJPR.

Journal Citations

There were 1053 journals from which 4063 citations were cited in all of the issues of PJPR. The ranked list of top 73 cited journals with the number of citations is given in Table 1, which reveals that based on the citations, 39 ranks are created of these 73 top journals. These 73 journals are cited 10 or more times by the articles of the PJPR. Journal of Applied Psychology is ranked first with 126 citations, followed by Child Development with the 114 citations, and Journal of Personality and Social Psychology with 97 citations. The top five journals are published in United States. Wiley-Blackwell is the adopted publisher with 16 journals followed by the APA with 11 journals. Ten journals are cited from each of Elsevier and SAGE

publications. PJPR is ranked seventh with 65 citations. There are only two journals from Pakistan in this list; the first was PJPR with 65 citation counts and the other was Pakistan Journal of Psychology with 29 citation counts. The top 73 journals which are ranked among the 39 most used journals provided 53.7% of the total citations (4063).

Table 1

Ranked List of Cited Journals

S/N	Journal	Rank	No. of Citations	Publisher	Country
1	Journal of Applied Psychology	1	126	APA	USA
2	Child Development	2	114	Wiley-BW	USA
3	Journal of Personality and Social Psychology	3	97	APA	USA
4	Psychological Bulletin	4	73	APA	USA
5	Developmental Psychology	5	69	APA	USA
6	Journal of Educational Psychology	6	66	APA	USA
7	Pakistan Journal of Psychological Research	7	65	NIP-QAU	Pakistan
8	Personality and Individual Differences	8	58	Elsevier	England
9	British Journal of Psychiatry	9	55	Royal College of Psychiatrists	England
10	Journal of Marriage and Family	9	55	Wiley-BW	USA
11	Journal of Adolescence	10	53	Elsevier	USA
12	Sex Roles: A journal of Research	10	53	Springer	USA
13	Journal of Vocational Behavior	11	52	Elsevier	USA
14	American Psychologist	12	48	APA	USA
15	Journal of Consulting and Clinical Psychology	13	45	APA	USA

Continued…

S/N	Journal	Rank	No. of Citations	Publisher	Country
16	Psychological Reports	14	44	Ammons Scientifics	USA
17	Journal of Child Psychology and Psychiatry	15	42	Wiley-BW	England
18	Journal of Youth and Adolescence	16	39	Springer	USA
19	Journal of Social Psychology	17	38	Taylor & Francis	USA
20	Journal of Counseling Psychology	18	36	APA	USA
21	Journal of American Academy of child and Adolescent Psychiatry	19	35	Elsevier	USA
22	Journal of Cross-Cultural Psychology	19	35	SAGE	USA
23	Journal of Adolescent Research	20	33	SAGE	USA
24	Journal of Social Issues	21	32	Wiley-BW	USA
25	Journal of Abnormal Psychology	22	31	APA	USA
26	Human Relations	23	30	SAGE	England
27	Pakistan Journal of Psychology	24	29	ICP-UOK	Pakistan
28	American Journal of Psychiatry	25	27	American Psychiatric Association	USA
29	International Journal of Eating Disorders	26	25	Wiley-BW	USA
30	Journal of Occupational and Organizational Psychology	26	25	Wiley-BW	USA
31	Journal of Personality	26	25	Wiley-BW	USA
32	Psychological Medicine	26	25	Cambridge University Press	USA
33	British Journal of Educational Psychology	27	23	Wiley-BW	England
34	International Journal of Psychology	27	23	Wiley-BW	France
35	Personality and Social psychology Bulletin	28	22	SAGE	USA

Continued…

S/N	Journal	Rank	No. of Citations	Publisher	Country
36	JAMA Psychiatry	29	21	American Medical Association	USA
37	Psychological Review	29	21	APA	USA
38	Journal of Personality Assessment	30	20	Taylor & Francis	USA
39	Personnel Psychology	30	20	Wiley-BW	USA
40	Academy of Management Journal	31	18	Academy of Management	USA
41	Educational and Psychological Measurement	31	18	SAGE Publications	USA
42	Merrill-Palmer Quarterly	31	18	Wayne State University Press	USA
43	Contemporary Educational Psychology	32	17	Elsevier	USA
44	Journal of Psychology	32	17	Taylor & Francis	USA
45	Administrative Science Quarterly	33	16	SAGE	USA
46	Journal of Abnormal Child Psychology	33	16	Springer	USA
47	Academy of Management Review	34	15	Academy of Management	USA
48	Acta Psychiatrica Scandinavica	34	15	Wiley-BW	England
49	American Sociological Review	34	15	SAGE Publications	USA
50	Child Abuse & Neglect	34	15	Elsevier	USA
51	Journal of Applied Social Psychology	34	15	Wiley-BW	USA
52	Review of Educational Research	34	15	SAGE Publications	USA
53	Journal of Clinical Psychology	35	14	Wiley-BW	USA
54	Perceptual and Motor Skills	35	14	Ammons Scientifics	USA
55	American Journal of Orthopsychiatry	36	13	APA	USA

S/N	Journal	Rank	No. of Citations	Publisher	Country
56	Journal of Social and Clinical Psychology	36	13	Guilford Press	USA
57	Social Science and Medicine	36	13	Elsevier	England
58	Career Development Quarterly	37	12	American Counseling Association	USA
59	Family Process	37	12	Wiley-BW	USA
60	International Journal of Social Psychiatry	37	12	SAGE Publications	England
61	Journal of College Student Development	37	12	The John Hopkins Uni. Press	USA
62	Journals of Gerontology	37	12	Oxford University Press	USA
63	Psychological Studies	37	12	-	India
64	European Journal of Social Psychology	38	11	Mouton Publishers	Netherland
65	Journal of Organizational Behavior	38	11	Wiley-BW	England
66	Journal of Psychosomatic Research	38	11	Elsevier	England
67	Journal of Research in Personality	38	11	Elsevier	USA
68	Psychological Science	38	11	SAGE	USA
69	Anxiety, Stress and Coping	39	10	Taylor & Francis	England
70	Applied Psychology: An International Review	39	10	Wiley-BW	England
71	Comprehensive Psychiatry	39	10	Elsevier	USA
72	International Journal of Aging and Human Development	39	10	SAGE Publications	USA
73	Journal of Nervous and Mental Disease	39	10	Lippincott Williams	USA

Application of Bradford's Law

Bradford's Law has been used to identify the group of core journals. Egghe and Rousseau (1990) used the following formula for appropriateness of Bradford's Law:

$r_0 = T (k-1) / (k^p-1)$

Where, r_0 is for journals of first zone; T is total number of journals; and k is Bradford multiplier. Egghe and Rousseau (1990) has used following formula for calculating the value of k.

$k = (e^\gamma x Y_m)^{1/p}$

Where e^γ is Euler's number (1.781), Y_m is the highest number of citations by the journal of rank one and p is the number of Bradford's zones. The value of p is assumed 3 for this study. By putting these values, the calculated value of k is 6.07.

Table 2

Scattering of Journals and Citations over Bradford Zones

Zones	No. of Journals	Journals Percentage	No. of citations	Citations Percentage	Multiplier
1	24	2.28%	1363	33.55%	-
2	145	13.83%	1421	34.97%	6.07
3	884	83.98%	1279	31.48%	6.07
Total	1053	100	4063	100	6.07 (Mean)

Number of journals in the first zone are 24, calculated by using formula (1) for identifying the number of journals in the other two zones. Number of journals in other two zones is identified accordingly. The number of citations calculated according to this distribution is shown in Table 2. It shows that number of journals contributing citations to each zone increases by a Bradford multiplier of 6.07. The data indicates that first zone holding 24 journals contribute 1363 citations, 145 journals of second zone contribute 1421 citations, and third zone comprising 884 journals contribute 1279 citations. Detailed calculations are given in Appendix-1.

Table 3

Distribution of Journals Cited in PJPR

Rank	No. of Journals	Cumulative No. of journals	No. of citations	Total no. of citations	Cumulative No. of citations	Log N	% of citations	% of total journal
1	1	1	126	126	126	4.84	3.10	0.095
2	1	2	114	114	240	0.69	2.81	0.095
3	1	3	97	97	337	1.10	2.39	0.095
4	1	4	73	73	410	1.39	1.80	0.095

Continued…

Rank	No. of Journals	Cumulative No. of journals	No. of citations	Total no. of citations	Cumulative No. of citations	Log N	% of citations	% of total journal
5	1	5	69	69	479	1.61	1.70	0.095
6	1	6	66	66	545	1.79	1.62	0.095
7	1	7	65	65	610	1.95	1.60	0.095
8	1	8	58	58	668	2.08	1.43	0.095
9	2	10	55	110	778	2.30	2.71	0.190
10	2	12	53	106	884	2.48	2.61	0.190
11	1	13	52	52	936	2.56	1.28	0.095
12	1	14	48	48	984	2.64	1.18	0.095
13	1	15	45	45	1029	2.71	1.11	0.095
14	1	16	44	44	1073	2.77	1.08	0.095
15	1	17	42	42	1115	2.83	1.03	0.095
16	1	18	39	39	1154	2.89	0.96	0.095
17	1	19	38	38	1192	2.94	0.94	0.095
18	1	20	36	36	1228	3.00	0.89	0.095
19	2	22	35	70	1298	3.09	1.72	0.190
20	1	23	33	33	1331	3.14	0.81	0.095
21	1	24	32	32	1363	3.18	0.79	0.095
22	1	25	31	31	1394	3.22	0.76	0.095
23	1	26	30	30	1424	3.26	0.74	0.095
24	1	27	29	29	1453	3.30	0.71	0.095
25	1	28	27	27	1480	3.33	0.66	0.095
26	4	32	25	100	1580	3.47	2.46	0.380
27	2	34	23	46	1626	3.53	1.13	0.190
28	1	35	2	22	1648	3.56	0.54	0.095
29	2	37	21	42	1690	3.61	1.03	0.190
30	2	39	20	40	1730	3.66	0.98	0.190
31	3	42	8	54	1784	3.74	1.33	0.285
32	2	44	17	34	1818	3.78	0.84	0.190
33	2	46	16	32	1850	3.83	0.79	0.190
34	6	52	15	90	1940	3.95	2.22	0.570
35	2	54	14	28	1968	3.99	0.69	0.190
36	3	57	13	39	2007	4.04	0.96	0.285
37	6	63	12	72	2079	4.14	1.77	0.570

Continued…

Rank	No. of Journals	Cumulative No. of journals	No. of citations	Total no. of citations	Cumulative No. of citations	Log N	% of citations	% of total journal
38	5	68	11	55	2134	4.22	1.35	0.475
39	5	73	10	50	2184	4.29	1.23	0.475
40	12	85	9	108	2292	4.44	2.66	1.140
41	9	94	8	72	2364	4.54	1.77	0.855
42	20	114	7	140	2504	4.74	3.45	1.899
43	21	135	6	126	2630	4.91	3.10	1.994
44	18	153	5	90	2720	5.03	2.22	1.709
45	41	194	4	164	2884	5.27	4.04	3.894
46	72	266	3	216	3100	5.58	5.32	6.838
47	176	442	2	352	3452	6.09	8.66	16.714
48	611	1053	1	611	4063	6.96	15.04	58.025

The calculated percentage error is 0.091%, which is negligible. This study identified 24 journals as the core journals that were most cited by the authors of PJPR. Table 3 indicates the distribution of journals cited by the authors of PJPR. It shows list of journals by decreasing the frequencies of citations, cumulative citations, and log of cumulative citations. The graph of the cumulative number of citations with the log N of the cumulative number of journals is shown in Figure 2. This graph is called Bradford Bibliograph (Brooks, 1969). Cumulative number of citations is plotted on vertical axis, while logarithm of cumulative number of journals is on horizontal axis. On this Bradford bibliograph, the points of core journals lays on the initial curved part of the graph and indicates that less number of journals is cited more times, while there are more journals that are cited least. It directs that least productive journals inclined to be cited less number of times. This validates earlier researches (Banateppanvar et al. 2013; Krishnamoorthy et al. 2009; Sudhier, 2010) by showing the small number of journals in the core nucleus of the large journal collection.
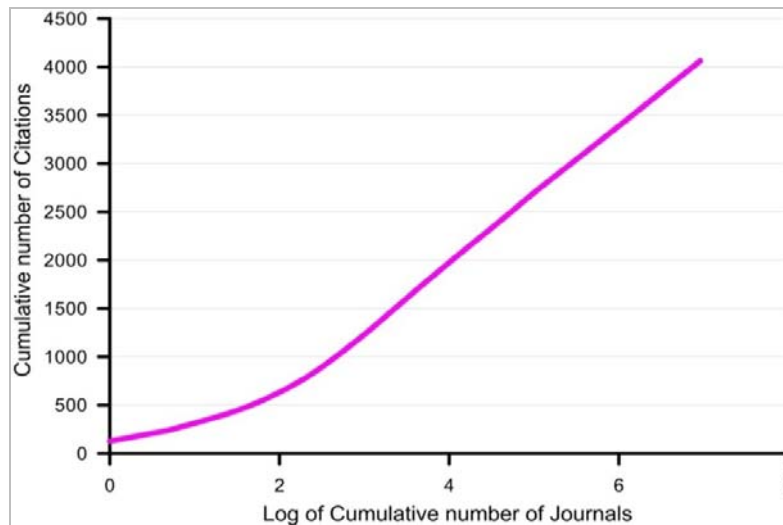
Figure 2. Bradford plot of journal distribution.

Concluding Discussion

Finding of this study shows that the authors of PJPR have cited journals literature, books, thesis, newspapers, and magazines. It indicates that researchers of the PJPR give preference to journals for citations. Both national and international journals are cited by them, but most of the cited journals were foreign published. The excessive use of the journals in citations may be due to the availability, suitability, validity, and reliability of the current and relevant information published in journals. Citations from books and other sources; theses and dissertations; newspapers; magazines; seminar and workshops were very low. Most of other citation studies have also revealed that journals are the most preferred source for citations (Fagbola, 2012; Fasae, 2011; Mubeen, 1996). Researchers of psychology give preference to journal literature for citations (Vanleeuwen, 2013; Zafrunnisha, 2012).

There was less use of authors' self-citation and journals' self-citation in the articles of PJPR. This may be due to the nature of researchers that they do not prefer to do research work as extension of previous work. Authors had mostly cited the journal's literature published in United States. Top five cited journals are published from United States. Zafrunnisha and Pullareddy (2009) have also observed the same findings that authors of the psychology mostly cited journals

of United States. Journal of Applied Psychology, one of the journals published by American Psychological Association is the most cited journal by the authors of PJPR. Journal of Applied Psychology was also the top cited journal of the doctoral students of IIMA (Kumar & Dora, 2011). Foreign journals are mostly used in citations that reflect the trust of authors with the quality of these journals.

The study identified a group of 24 core journals, while other journals were least cited journals. There were 611 journals that have been cited only once. Bradford's Law was found fit and proved true to the cited journals of the PJPR.

This study will be very beneficial for the research scholars and the library professionals, as they may identify the core journals of the field of psychology. Following recommendations are proposed:

1. Quality of the local journals should be improved so that researchers also cite the articles of the local journals. Quality can be improved by revising the review process for publication.
2. Articles of these journals should be made available online so that researchers access them freely.
3. Journals should be indexed in international databases so that articles can be visible by interested community.

This research study may provide expedient framework to the following areas of research in future.

1. Citation Analysis of other psychology journals should also be conducted. It will give the information about different types of literature used for citations, which could be adopted by researchers.
2. Leftover issues of PJPR may be studied to find out the core cited journals and associate the results of current study.

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