Citation Analysis of Network Security Literature Output During 2002 to 2012

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ABSTRACT

Over 8051 articles were downloaded from the data base of Web of knowledge in the periods of 2002 -2011. Totally 25,249 authors were contributed in the area of network security in 8051 documents and its average number of authors per articles is 3.13. Collaborative productivity is highest compare than single author's productivity.

INTRODUCTION

Citation analysis is a valuable area of research. "Citation analysis" refers to references in one text to another text, with information on where that text can be found. Citation analysis is useful for understanding subject relationships, author effectiveness, publication trends, and so on.

Objectives of the Study

➢ To study the year wise distribution of articles;
➢ To study the citation pattern of articles
➢ To study the bibliographical forms of documents
➢ To study the authorship pattern
➢ To study the age of citations of taken sample
➢ To determine ranked list of journals based on citation scores
➢ To determine Lotka's law of authorship patterns.

DATA AND METHODOLOGY

The necessary data were collected from the SCI, SSCI and ACHI which are available on the Web of Science (WoS). A total of 8051 downloaded records were analyzed by using the Histcite software.

Table 1: Year wise analysis of Network security research outputs

S. No	Year	Recs	Cum. recs	TCS	Average citations/ article	Cum. CS
1	2002	316 (3.9)	316	5384	17.04	5384
2	2003	426 (5.3)	742	5742	13.48	11126
3	2004	648 (8.0)	1390	6704	10.35	17830
4	2005	778 (9.7)	2168	7356	9.46	25186
5	2006	916 (11.4)	3084	6992	7.63	32178
6	2007	747 (9.3)	3831	6119	8.19	38297
7	2008	807 (10)	4638	4502	5.58	42799
8	2009	989 (12.3)	5627	4146	4.19	46945
9	2010	1101 (13.7)	6728	2315	2.10	49260
10	2011	1323 (16.4)	8051	804	0.61	50064
	Total	8051		50064	78.63 (7.87)	

Out of the total 8051 articles the maximum numbers of articles are reported to have been published in the year 2011 (1323 articles; 16.4%) while the least number of articles have been published in the year 2002 (316 articles; 3.9 %). On an average, network security has accommodated 805 articles per year, average citation per year value is 5006.4 and average citation per article is 6.22. The publication strength has gradually increased, but year wise citation scores has not increased.
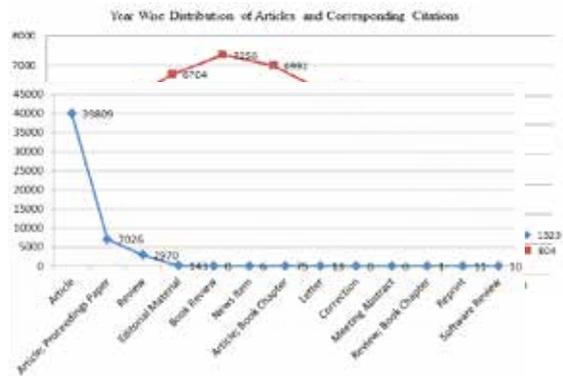

Fig. 2: Bibliographic forms and citations

Table 2: Bibliographical forms of documents

S. No	Bibliographical forms	Pub. Recs	No. of citations & %	Cum. citations	Cum. Citations & %
1	Article	6033 (75.0)	39809 (79.52)	39809	79.52
2	Article; Proceedings Paper	1701 (21.1)	7026 (14.03)	46835	93.55
3	Review	136 (1.8)	2970(5.93)	49805	99.48
4	Editorial Material	111 (1.4)	143(0.29)	49948	99.77
5	Others (9 types)	70 (0.641)	116 (1.23)	50065	100
	Total	8051	50064		

Table 2 depicts the distribution of bibliographical forms of citations. It is observed the citations of journal (39809) form are the most predominant form followed by Proceeding papers (7026), Review (2970) and Editorial materials (143). The rest forms which are news item, reprint and software review were found less citation values. Figure 2 also depicts that the values of concerned bibliographic form and citations scores.

Table 3: Authorship pattern of network security output

Authorship pattern	No. of article	Rank	No of authors	Rank	% of articles	% of authors
Single	1046	4	1046	7	12.99	4.14
Double	2174	2	4348	3	27.0	17.22
Triple	2215	1	6645	1	27.51	26.32
Four	1352	3	5408	2	16.79	21.42
Five	684	5	3420	4	8.50	13.55
Six	315	6	1890	5	3.91	7.49
Seven	108	7	756	8	1.34	2.99
Eight	45	9	360	9	0.56	1.43

Nine	34	10	306	10	0.42	1.21
10 & above	78	8	1070	6	0.97	4.24
	8051		25249			
DC	0.958					

Table 3 indicates that majority of authors preferred to publish their research results in three authorship mode (27.51%) followed by two authorship mode (27.0%), four authorship mode (16.79 %) and individual authorship mode (12.99 %) while, articles published by more than three authors (7 articles; 2.9%) were quite negligible. The DC of authors can be calculated as DC = 1046 / (1046 + 24203) = 0.958. As DC value exceeds 0.5 and tends to 1, it is deduced that multi-authored citations occupy the prominent position and the research is based on team research rather than non-collaborative authors.

Table 4: Ranking of authors in network security research output

S. No	Name of contributor	No. of output	Rank	H -index	TCS	TLCR
1	Kim S	41 (0.5)	1	8	146	28
2	Kim H	36 (0.4)	2	9	107	21
3	Lee S	36 (0.4)	2	9	129	41
4	Shen XM	35 (0.4)	3	14	460	80
5	Wang J	33 (0.4)	4	7	203	36
6	Chen HH	31 (0.4)	5	11	214	45
7	Kim J	31 (0.4)	5	8	93	15
8	Park JH	31 (0.4)	5	6	87	28
9	Xiao Y	29 (0.4)	6	11	299	41
10	Fang YG	27 (0.3)	7	20	629	61

Table 4 depicts the ranking of authors. There are a total of 25,249 authors who contributed 8051 numbers of articles in the subject of network security during 2002 to 2011. It is found that the author Kim S (41 articles) is the leading author contributing highest articles followed by Kim H & Lee S with each 36 articles securing second position and Shen XM with 35 articles securing the third position. Wang J contributed 33 articles and ranked third with fourth rank. Chen HH has 31 articles each securing fifth rank.
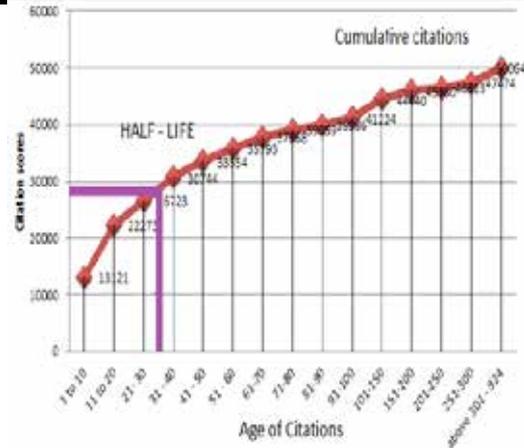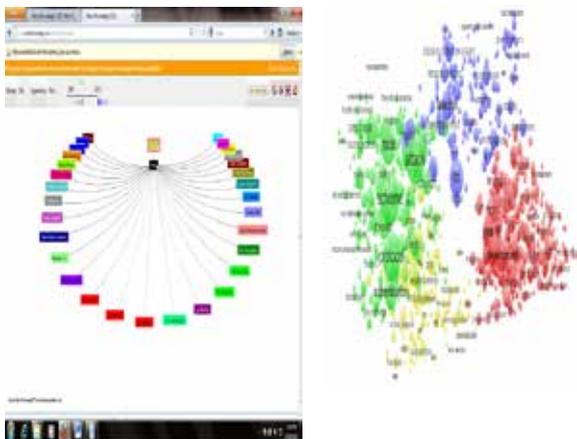

Fig. 3 & 4: Example of citation maps; Fig. 5: Age of citations and citation scores with half-life citations

Table 5: Chronological Distribution of Citations of network security output

Age of citations (A)	No of citations (B)	A X B	Age of citations (A)	No of citations (B)	A X B
0	2998	0	71 - 80	16	1191
1	1374	1374	81 - 90	11	927
2	740	1480	91 - 100	13	1238
3	515	1545	101 - 110	10	1051
4	439	1756	111 - 120	6	685
5	222	1110	121 - 130	4	496
6	85	510	131 - 140	4	550
7	214	1498	141 -150	3	434
8	176	1408	151 -160	2	309
9	150	1350	161 -170	4	670
10	109	1090	171 - 180	1	174
11 -20	614	9152	181 - 190	-	-
21 - 30	176	4450	191 - 200	2	387
31 - 40	116	4021	201 - 210	1	205
41 - 50	63	2810	211 - 220	2	428
51 - 60	41	2239	271 - 280	1	275
61 - 70	33	2135	281 - 290	2	586
			Above 300 to 924	4	2572

2998 articles does not have any citations values, 1374 articles having only one citations score, 740 articles has each 2 citations followed by 515 articles has each 3 citations, 439 articles has each four citations and 222 articles has each five citations values respectively. It is also found that the age of citation score is above 200 to 924 are has mostly individual article. The analysis of the age of citations helps to determine the useful life of information resources used in any field of knowledge. It is also used by academic librarians to maintain or discard monographs or serials in the library which would be no longer needed by researchers (Sharma, 2009). It is found that authors' citation of documents ranged from very recent year of publication to as old as documents of 200 years old, and the half-life of the cited documents is about 10 years. Figure 3 reveals that the age of citation and half-life (between the age of 30 to 40 citation and 25032 citation scores) citation.

LOTKA'S LAW OF AUTHOR PRODUCTIVITY
Lotka's law is one of the three major laws of bibliometrics that mainly explain the literature distribution of various authors' productivity in a given field (Lotka, 1926). Therefore, Lotka summarizes the logarithmic relation between researchers and publication quantities.

Table 6: Showing Lotka's law of author productivity (n – value)

No. of contribution X	Number of contributors	Y	$\sum X = \log x$	$\sum Y = \log y$	$\sum X*Y$	$\sum X*X$
1	12582	12582	0	9.440	0	0
2	2020	4040	0.693	8.303	5.753	0.48
3	682	2046	1.098	7.623	8.370	1.21
4	377	1508	1.386	7.318	10.142	1.92
5	187	935	1.609	6.840	11.005	2.59
6	121	726	1.791	6.587	11.797	3.21
7	66	462	1.945	6.135	11.932	3.78
8	52	416	2.079	6.030	12.536	4.32
9	40	360	2.197	5.886	12.931	4.83
10	22	220	2.302	5.393	12.414	5.30
11 to 41	121	1970	64.243	90.059	271.49	199.52
Total		25249	79.343	159.614	368.379	227.16

Pao (1989) proposed the way to calculate n-value and c- value of Lotka's law as

$$n = \frac{N\Sigma XY - \Sigma X \Sigma Y}{N\Sigma X^2 - (\Sigma X)^2} \qquad K\text{-}S = \frac{1.63}{\sqrt{N}}$$

X is log(x) and Y is log(y) where y are the authors who have x number of contribution. n = 0.0440. K-S statistics method can be used to verify if Lotka's law could hold for the sample area publications. K-S = 0.010 for N = 25249. Single contributions of authors' are 1046 (4.14 %). It means value of single authored contributed 4.14 percent. Thus the present analysis clearly invalidates the Lotka's findings.

FINDINGS AND CONCLUSION

The average citation per article is 6.21; It is found that the articles from journal citations are predominant. It is found that the most productive author is Kim.S. Three authored papers are found to be the highest. It is found the collaborative authorship productivities highest. The degree of collaboration is found to be 0.958; and the half-life period of document citations value is between the ages of citation is 30 to 40 and 25032 citation scores for 10 years.

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