Deciding Pertinent Citations in Published Empirical Articles

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Abstract

This article is an attempt to precede with the validation that pertinence of citations in scientific articles is a core problem in citation analytics.

In this study, an empirical investigation of pertinence of citations made in Indian Journal of Chemistry A is presented. In this particular study, citations made in the introduction sections in issues published from 1999 to 2007 were analyzed. An empirical scientific article was randomly selected every issue published, and the pertinence of selected article was determined.

The result showed that less than 20% of the citations were pertinent to the study. Overall, over 80% of citations made in the introduction sections may not be applicable in the computation of effective impact of publications.

***Keywords**: Content analysis; Content pertinence; Performance evaluation; Impact factor; Citation analysis*

Introduction

Objective evaluation of research performance has gained widespread importance as necessary tools that allows one to gain insight into institutional productivity, and benchmark their activities against peers worldwide (Thomson Reuters, 2016). While various methodologies have been used to evaluate research performance, however, the prominent methodologies are bibliometric assessments which involve some citation analytics (Adedayo, 2015a). Although the use and acceptation of citation analytics in research benchmarking is widespread (Hubbard and McVeigh, 2011; Garfield, 1972; Thomson Reuters, 2014), however, many critiques of citation analytics have been published (Thomson Reuters, 2014; Saha et al., 2003; Adler et al., 2008; Adedayo, 2015b, Adedayo, 2016a; 2016b; DoRA, 2013; RCUK, 2013).

Also, many of its limitations have been identified and it's usage with caution has been advised (Saha et al., 2003; DoRA, 2013; RCUK, 2013). Adedayo (2014a; 2014b; 2015c) discussed important issues that identified means through which citation analytics can be adulterated. Recently, Lariviere et al., (2016) with their straightforward protocol, revealed the full extent of the skew of distributions and variation in citations received by published papers that is characteristic of all scientific journals. Their study found out that about 75% of articles in journals have citations less than the average indicated by Journal Impact Factor (JIF) of the journal where they were published. The simple implication of this result is that, if reward system or credit distribution is based on JIF, then about 75% of rewards and recognition would be attributed to undeserving persons. Obviously, there is the need to refine the JIF methodologies. To refine the methodologies of citation analytics, various approaches proposed include careful cull and curate of appropriate citations to count in evaluation computations. Also, many published studies have advocated discouraging honourific reward attribution (Persson and Glanzel, 2014; Adedayo, 2015b; 2015c). Cawkell, (1977) and Adedayo, (2015c) have proposed that the citation analytics would work better, only

if every citing author meticulously cited only the earlier works pertinent to theme of the new manuscript. Therefore, pertinence of the cited reference to the new study being reported becomes crucial as an important consideration during performance evaluation.

In this particular paper, an empirical study to investigate pertinence of citations made in the introduction sections of articles published in Indian Journal of Chemistry A is presented. The idea presented in the report is very fresh, and original! It forms one of the first attempts to use empirical methods to determine pertinence of citations in scientific publications. Herein, the rationale for the study is identified.

Methodology

Citation pattern in articles published in Indian Journal of Chemistry A, was studied. Citation pattern in issues published in the journal from 1999 to 2007 was studied. An article is randomly selected from each issue published by the journal, and a systematic cull of citation in the articles was made (Adedayo, 2015a; Adedayo, 2015b; Adedayo, 2016a; 2016b). Citations in the articles were classified as citations with Real and Imaginary Pertinence (Adedayo, 2015a; Adedayo, 2016a; 2016b). Citations made in Introduction sections were considered as Citations with Imaginary Pertinence while those made in the Methodology/Results/Discussion of Result/Conclusions are considered to have Real Pertinence.

The total number of authors cited in the Introduction sections were counted and recorded as N_c. Also, a counting of common citations made both in the Imaginary and the Real sections was made, and recorded as n_c. Pertinence (p) of the Imaginary section (Introduction section) of each article was determined by finding the ratio $n_c : N_c$ expressed as a percentage i.e.

$$p = 100\left(\frac{n_c}{N_c}\right) \quad (1)$$

The average Pertinence for each journal and the entire publishers were determined.

Results and discussion

Tables 1 to 9 present the results for the study. Table 1 provides information on pertinence of Introduction section in articles published in Indian Journal of Chemistry A, Volume 38A. From the Table, the highest pertinence observed is 50%, which is for the article published in March, 1999 in volume 38A, number 11, pages 244-.248. The lowest pertinences were 0%. Articles: Volume 38 A, Number 5, pages 453-457; Volume 38 A, Number 8, pages 792-796; Volume 38 A, Number 10, pages 973-976, all had 0% pertinences. The average pertinence for articles published in the journal for the year 1999 is 15%.

Table 1. Representative citation distribution in articles published in the journal issue in 1999

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 38 A(01)	January, 1999	17-25	25	7	28
2.	Vol. 38 A (02)	February, 1999	130-135	4	1	25
3.	Vol. 38 A (03)	March, 1999	244-.248	6	3	50
4.	Vol. 38 A (04)	April, 1999	303-306	20	1	5

5.	Vol. 38 A (05)	May, 1999	453-457	9	0	0
6.	Vol. 38 A (06)	June, 1999	529-532	9	1	11
7.	Vol. 38 A (07)	July, 1999	639-645	11	2	18
8.	Vol. 38 A (08)	August, 1999	792-796	5	0	0
9.	Vol. 38 A (09)	September, 1999	884-887	24	2	8
10.	Vol. 38 A (10)	October, 1999	973-976	1	0	0
11.	Vol. 38 A (11)	November, 1999	1129-1138	19	6	32
12.	Vol. 38 A (12)	December, 1999	1244-1248	14	0	0
	Average for the year					15

Table 2 provides information on pertinence for Volume 39A. From the Table, the highest pertinence observed is 100%, which is for the article published in November, 2000 in volume 39 A, number 11, pages 1174-1176. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2000 is 21%.

Table 2. Representative citation distribution in articles published in the journal issue in 2000

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 39 A(01)	January, 2000	68-74	25	3	12
2.	Vol. 39 A (02)	February, 2000	32-39	22	10	45
3.	Vol. 39 A (03)	March, 2000	92-99	16	1	6
4.	Vol. 39 A (04)	April, 2000	375-377	10	3	30
5.	Vol. 39 A (05)	May, 2000	501-506	15	0	0
6.	Vol. 39 A (06)	June, 2000	603-610	35	0	0
7.	Vol. 39 A (07)	July, 2000	690-696	13	3	23
8.	Vol. 39 A (08)	August, 2000	851-855	6	0	0
9.	Vol. 39 A (09)	September, 2000	974-979	10	0	0
10.	Vol. 39 A (10)	October, 2000	1005-1010	20	1	5
11.	Vol. 39 A (11)	November, 2000	1174-1176	3	3	100
12.	Vol. 39 A (12)	December, 2000	1286-1294	16	4	25
	Average for the year					**21**

Table 3 provides information on pertinence for Volume 40A. From the Table, the highest pertinence observed is 83%, which is for the article published in August, 2001 in volume 40 A, number 08, pages 896-900. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2001 is 34%.

Table 3. Representative citation distribution in articles published in the journal issue in 2001

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 40 A (01)	January, 2001	1-3	7	1	14
2.	Vol. 40 A (02)	February, 2001	222-224	7	0	0
3.	Vol. 40 A (03)	March, 2001	236-240	6	1	17
4.	Vol. 40 A (04)	April, 2001	361-367	22	7	32
5.	Vol. 40 A (05)	May, 2001	437-441	6	1	17
6.	Vol. 40 A (06)	June, 2001	588-593	11	1	9
7.	Vol. 40 A (07)	July, 2001	738-741	5	2	40
8.	Vol. 40 A (08)	August, 2001	896-900	6	5	83
9.	Vol. 40 A (09)	September, 2001	973-975	9	6	67
10.	Vol. 40 A (10)	October, 2001	1082-1085	5	4	80
11.	Vol. 40 A (11)	November, 2001	1176-1181	24	0	0
12.	Vol. 40 A (12)	December, 2001	1282-1287	9	3	33
	Average for the year					34

Table 4 shows information on pertinence for Volume 41A. From the Table, the highest pertinence observed is 100%, which is for the article published in November, 2002 in volume 41 A, number 11, pages 2251-2255. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2002 is 27%.

In Table 5, we see the information about pertinence for Volume 42 A. From the Table, the highest pertinence observed is 50%, which is for the article published in November, 2003 in volume 42 A, number 11, pages 2677-2679. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2003 is 8%.

For Table 6, we see have pertinence for Volume 43 A. From the Table, the highest pertinence observed is 86%, which is for the article published in January, 2004 in volume 43 A, number 01, pages 28-34. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2004 is 16%.

Table 4. Representative citation distribution in articles published in the journal issue in 2002

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 41 A (01)	January, 2002	54-64	-	-	- (NERA)
2.	Vol. 41 A (02)	February, 2002	304-307	13	1	8
3.	Vol. 41 A (03)	March, 2002	500-505	11	2	18
4.	Vol. 41 A (04)	April, 2002	771-773	6	3	50
5.	Vol. 41 A (05)	May, 2002	955-959	11	3	27

6.	Vol. 41 A (06)	June, 2002	1199-1201	8	0	0
7.	Vol. 41 A (07)	July, 2002	1438-1440	7	0	0
8.	Vol. 41 A (08)	August, 2002	1554-1561	27	9	33
9.	Vol. 41 A (09)	September, 2002	1795-1803	20	4	20
10.	Vol. 41 A (10)	October, 2002	2008-2016	13	5	38
11.	Vol. 41 A (11)	November, 2002	2251-2255	8	8	100
12.	Vol. 41 A (12)	December, 2002	2551-2554	10	0	0
	Average for the year					27

Table 5. Representative citation distribution in articles published in the journal issue in 2003

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 42 A (01)	January, 2003	79-83	0	0	0
2.	Vol. 42 A (02)	February, 2003	250-254	23	1	4
3.	Vol. 42 A (03)	March, 2003	564-567	23	0	0
4.	Vol. 42 A (04)	April, 2003	719-726	12	0	0
5.	Vol. 42 A (05)	May, 2003	1086-1088	8	0	0
6.	Vol. 42 A (06)	June, 2003	1426-1435	23	8	35
7.	Vol. 42 A (07)	July, 2003	1557-1563	32	2	6
8.	Vol. 42 A (08)	August, 2003	1865-1867	1	0	0
9.	Vol. 42 A (09)	September, 2003	2205-2209	5	0	0
10.	Vol. 42 A (10)	October, 2003	2531-2535	3	0	0
11.	Vol. 42 A (11)	November, 2003	2677-2679	2	1	50
12.	Vol. 42 A (12)	December, 2003	2954-2958	8	0	0
	Average for the year					8

Table 6. Representative citation distribution in articles published in the journal issue in 2004

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 43 A (01)	January, 2004	28-34	8	7	86
2.	Vol. 43 A (02)	February, 2004	333-336	5	0	0
3.	Vol. 43 A (03)	March, 2004	473-480	9	2	22
4.	Vol. 43 A (04)	April, 2004	752-755	9	1	11
5.	Vol. 43 A (05)	May, 2004	1066-1075	33	4	12

6.	Vol. 43 A (06)	June, 2004	1224-1227	6	1	17
7.	Vol. 43 A (07)	July, 2004	1403-1408	18	1	6
8.	Vol. 43 A (08)	August, 2004	1692-1695	3	0	0
9.	Vol. 43 A (09)	September, 2004	1901-1905	6	1	17
10.	Vol. 43 A (10)	October, 2004	2087-2090	7	1	14
11.	Vol. 43 A (11)	November, 2004	2343-2346	17	1	6
12.	Vol. 43 A (12)	December, 2004	2568-2572	7	0	0
	Average for the year					16

In Table 7, the information about pertinence for Volume 44 A is presented. From the Table, the highest pertinence observed is 30%, which is for the article published in May, 2005 in volume 44 A, number 05, pages 1016-1018. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2005 is 11%.

Table 7. Representative citation distribution in articles published in the journal issue in 2005

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 44 A (01)	January, 2005	80-84	8	1	13
2.	Vol. 44 A (02)	February, 2005	261-264	27	1	4
3.	Vol. 44 A (03)	March, 2005	521-525	23	1	4
4.	Vol. 44 A (04)	April, 2005	687-692	15	1	7
5.	Vol. 44 A (05)	May, 2005	1016-1018	10	3	30
6.	Vol. 44 A (06)	June, 2005	1151-1158	15	0	0
7.	Vol. 44 A (07)	July, 2005	1378-1382	13	1	8
8.	Vol. 44 A (08)	August, 2005	1594-1596	5	0	0
9.	Vol. 44 A (09)	September, 2005	1756-1765	18	3	17
10.	Vol. 44 A (10)	October, 2005	2010-2014	12	3	25
11.	Vol. 44 A (11)	November, 2005	2240-2246	12	3	25
12.	Vol. 44 A (12)	December, 2005	2445-2449	21	0	0
	Average for the year					11

In Table 8, the information about pertinence for Volume 45 A is presented. From the Table, the highest pertinence observed is 29%, which is for the article published in November, 2006 in volume 45 A, number 11, pages 2418-2420. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2006 is 5%.

Table 8. Representative citation distribution in articles published in the journal issue in 2006

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 45 A (01)	January, 2006	45-50	10	0	0
2.	Vol. 45 A (02)	February, 2006	409-411	6	0	0
3.	Vol. 45 A (03)	March, 2006	581-586	18	0	0
4.	Vol. 45 A (04)	April, 2006	858-863	13	2	15
5.	Vol. 45 A (05)	May, 2006	1139-1143	14	1	7
6.	Vol. 45 A (06)	June, 2006	1400-1404	7	0	0
7.	Vol. 45 A (07)	July, 2006	1631-1637	16	0	0
8.	Vol. 45 A (08)	August, 2006	1813-1819	10	1	10
9.	Vol. 45 A (09)	September, 2006	2045-2047	8	0	0
10.	Vol. 45 A (10)	October, 2006	2406-2411	15	0	0
11.	Vol. 45 A (11)	November, 2006	2418-2420	7	2	29
12.	Vol. 45 A (12)	December, 2006	2628-2631	13	0	0
	Average for the year					5

Table 9. Representative citation distribution in articles published in the journal issue in 2007

S/N	Journal Issue	Publication Date	Article Pages	N_c	n_c	Pertinence (%)
1.	Vol. 46 A (01)	January, 2007	54-59	8	0	0
2.	Vol. 46 A (02)	February, 2007	276-279	22	1	5
3.	Vol. 46 A (03)	March, 2007	416-421	3	3	100
4.	Vol. 46 A (04)	April, 2007	589-594	5	0	0
5.	Vol. 46 A (05)	May, 2007	742-747	10	0	0
6.	Vol. 46 A (06)	June, 2007	933-936	9	7	75
7.	Vol. 46 A (07)	July, 2007	1069-1074	5	0	0
8.	Vol. 46 A (08)	August, 2007	1283-1288	11	0	0
9.	Vol. 46 A (09)	September, 2007	1414-1418	18	4	22
10.	Vol. 46 A (10)	October, 2007	1594-1604	10	2	20
11.	Vol. 46 A (11)	November, 2007	1796-1800	6	3	50
12.	Vol. 46 A (12)	December, 2007	1938-1946	5	0	0
	Average for the year					23

In Table 9, the information about pertinence for Volume 46 A is presented. From the Table, the highest pertinence observed is 100%, which is for the article published in March, 2007 in volume 46 A, number 03, pages 416-421. The lowest pertinences were 0%. The average pertinence for articles published in the journal for the year 2006 is 23%.

Figure 1 presents the overview the variation of pertinence within the articles analyzed. From this figure, it can be seen that about 95% of the article have pertinences $\leq$ 50%. Figure 2 gives the information on the frequency distribution of N_c within the articles analyzed. Here, it is shown that the most frequent N_c lies within the range 3-25. Within this range, N_c have at least a frequency of 4. Figure 3 presents the frequency distribution of n_c within the articles analyzed, while Figure 4 shows the frequency distribution of pertinence within the articles analyzed. These figures show the same trend. Frequencies were highest for zero n_c and pertinence. These decreased down the line. From here, it shows that the probability of finding article with higher pertinence decreases as both n_c and pertinence increased.
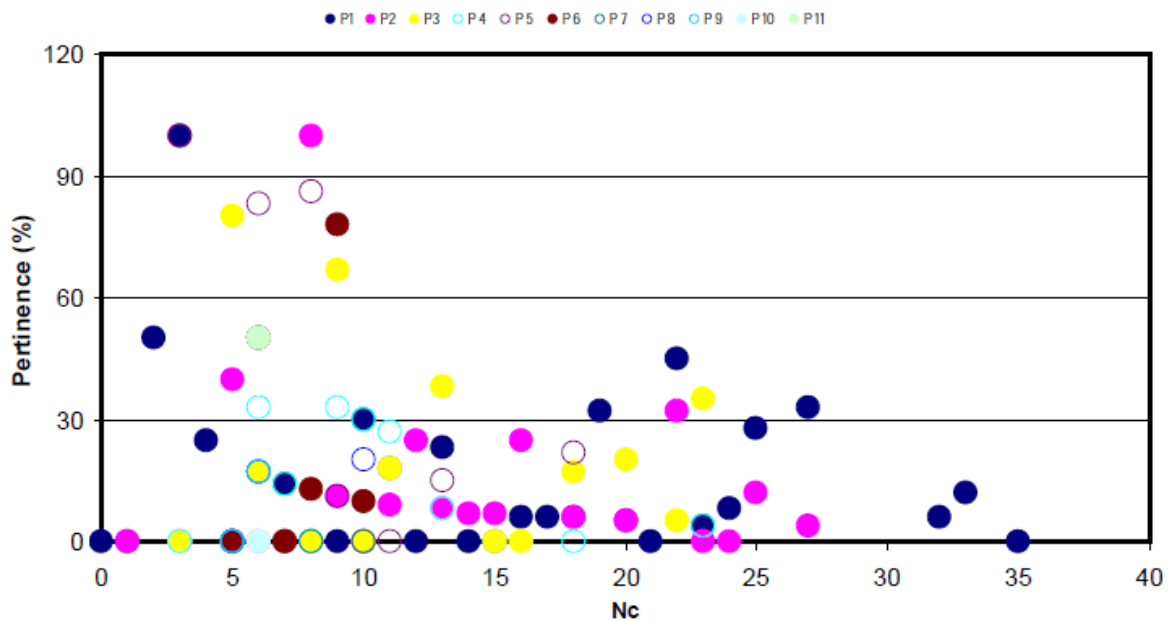
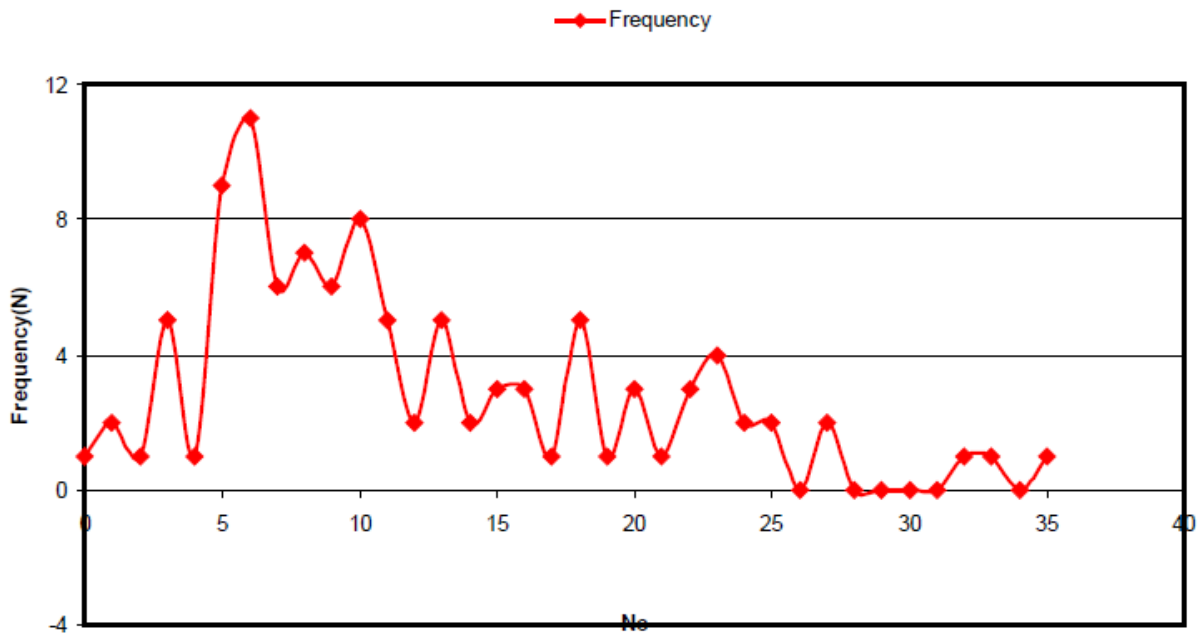**Figure 1.** Overview of the Variation of Pertinence within the Articles Analyzed

Figure 2. Frequency Distribution of Nc within the Articles Analyzed
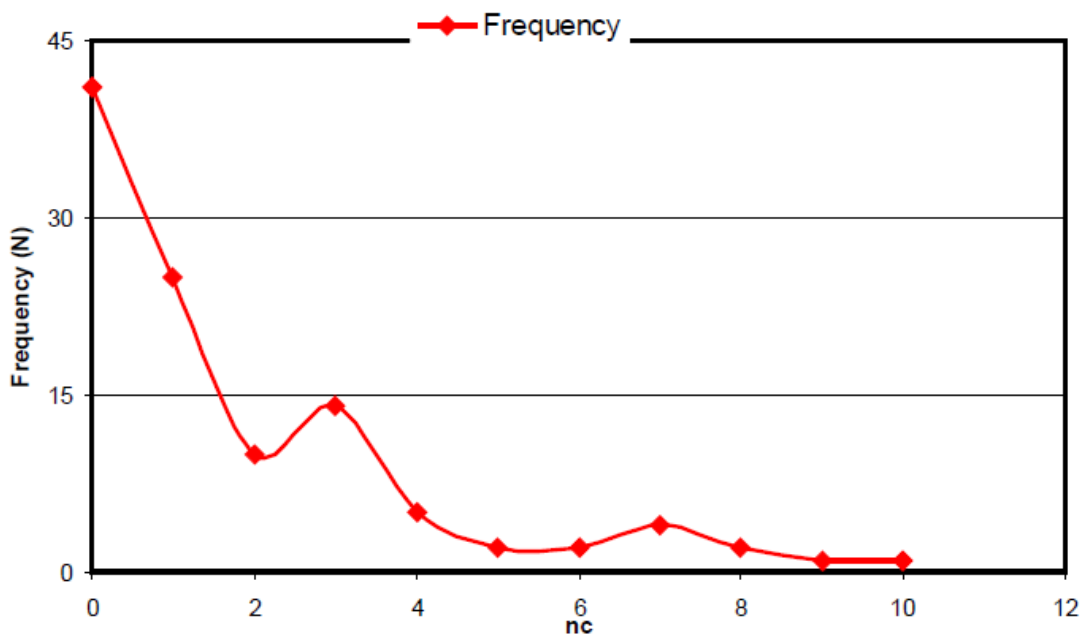

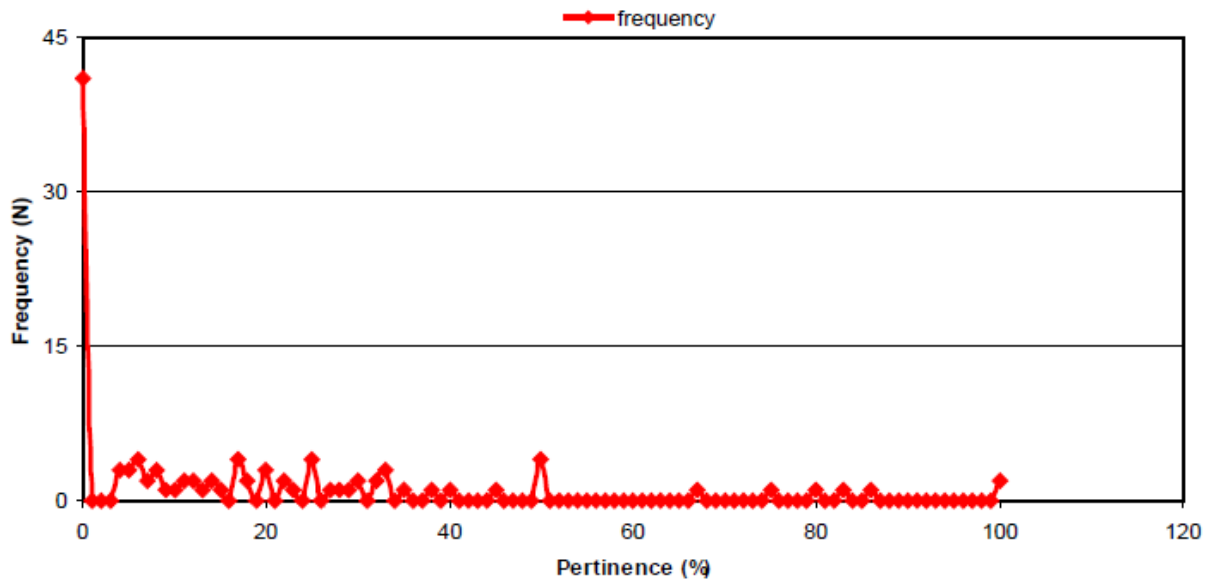**Figure 3.** Frequency Distribution of nc within the Articles Analyzed

Figure 4. Frequency Distribution of Pertinence within the Articles Analyzed

Overall the average pertinence for the study is found by calculating the mean for the average pertinences for all the journals issues analyzed i.e.

$$p_m = \frac{p_{Vol.38.A} + p_{Vol.39.A} + p_{Vol.40.A} + p_{Vol.41.A} + p_{Vol42.A} + p_{Vol.43.A} + p_{Vol.44.A} + p_{Vol.45.A} + p_{Vol.46.A}}{9}$$

Where p_m is the mean of the average pertinences for the entire journal issues analyzed.

$$p_m = \frac{(15+21+34+27+8+16+11+5+23)\%}{9}$$

$p_m = 18\%$

With this, it is clear that, on the average, only 18% of citations in the introduction sections of the articles studied are pertinent to the reported research. This result is supported by the works of Lariviere et al., (2016) and Adedayo, (2015b). In his study, Adedayo, (2015b) extended the work of Saha et al., (2003), drawing similarities between citations and votes. When citations are considered as votes, Adedayo, (2015b) predicted that about 80% of citations made in the introduction sections may not be applicable in the computation of effective impact of publications. The result of the study also agrees with the assertion of Cawkell, (1977), that pertinence of cited literature reference in a scientific article is very important in impact evaluation considerations.

Conclusion

This investigation has shown that significant proportion of citations made in the introduction sections of scientific articles only have imagined pertinence to the study reported. Overall the average pertinence

for the study is less than 20%. Going by this fact, therefore, citations in scientific articles can be validly classified into two i.e. Citations in Imaginary sections and citations in the Real sections. Also, ***pertinence;*** a new parameter useful in the evaluation of scientific publications has been introduced.

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