

USING R-PROGRAMMING FOR ANALYSIS OF E-WASTE MANAGEMENT PUBLICATION IN INDIA

Manju P. U.*, S. Raja.**

Abstract *The present study discusses the use of R programming software for the bibliometric analysis of E-waste management publications in India. The period of the study is 1992 to 2018 January. By the help of this software the Author, Organization, document & Country-wise distribution of literature Citation Pattern and Author collaboration on E-waste management in India are analyzed. R- programming software is used to create graphs and maps for the schematic representation of the data.*

Keywords: *E-Waste Management, Scientometrics, R-Programming, Author Productivity*

INTRODUCTION

Now our world is facing E-waste is a biggest problem. It creates health as well as environmental issues. Discarding this waste is a very big problem. The common people who are the user of these products are ignorant of how to destroy the same. This ignorance leads the people to choose some unofficial ways of destroying this. This ever increasing waste is very complex in nature and is also a rich source of metals such as gold, silver and copper which can be recovered and brought back into the production cycle. This paper discusses the research output in India in the field of E-waste management.

REVIEW OF LITERATURE

Depending on the analysis of the objectives several approaches of the reviews are found. Dr. B. M Gupta (2013), Saini, Pawan Kumar. (2014). Giacomo et.al (2017), Dhanya P (2017) done scientometric Analysis on various fields of study. In their study they have analyzed the author productivity, co-authorship Pattern, word frequency distribution, type of the documents, organization wise publication. Most of the studies are combination of all these topics. Common objective of all these studies are the identification and quantification of research topics using bibliometric and scientometric techniques. Gouri (2017) in their paper discussed the application of Bradford's law of scattering to the literature of microbiology in India.

OBJECTIVES

Objectives of the study are

- Find out the growth of literature in the field of E-waste management in India during the period of 1992 to 2017.
- Find out the Author, Organization, document & Country-wise distribution of literature on E-waste management in India.
- Citation Pattern and Author collaboration on E-waste management in India.
- Application of Bradford, Lotkas and other scientometric laws to analyze the data.

SCOPE AND LIMITATIONS OF THE STUDY

The scope of the present study is limited to the journals available in Web of Science database. The keyword used for the study is E-waste management in India. Publications from 1992 to 2017 are included in the study. R-programming is the software used for the analysis of the data.

METHODOLOGY

This paper discusses India's scientific output in the area of E-waste management. The data is collected from Web of

* Research Scholar, Alagappa University, Tamil Nadu, India. Email: manjukaliany@gmail.com

** Assistant Librarian, Alagappa University, Tamil Nadu, India. Email: lisraja1979@gmail.com

Science database. Period of study is 1992 to 2017. Year wise, Document-wise, Journal-wise, author-wise and country wise publication data is collected. Retrieved Bibliographic and citation data is analyzed using various bibliometric techniques and R programming tool is used to sort the data. Vos viewer software also used in this study.

RESULTS AND DISCUSSION

Main Information About Data

This table contains the summary of main information included in this study. The collected data contains 187 articles, collected from Journals; books etc. period of study is 1992 to 2017. During this period 532 authors are contributed to this area of study, and 187 articles are published. Among these 13 articles are single authored and 519 articles are multi authored. Average citations per article is 12.81, co-authors per article is 3.38. Collaboration Index is 3.11.

Table 1: Main Information about Data

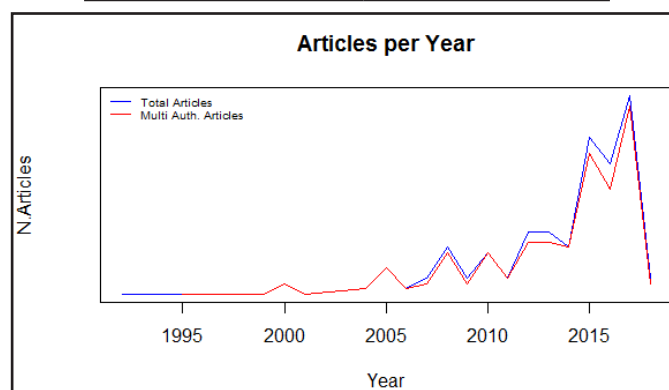
Article	187
Sources (Journals, Books, etc.)	122
Keywords Plus (ID)	817
Author's Keywords (DE)	751
Period	1992 – 2018
Average citations per article	12.81
Authors	532
Author Appearances	632
Authors of single authored articles	13
Authors of multi authored articles	519
Articles per Author	0.352
Authors per Article	2.84
Co-Authors per Articles	3.38
Collaboration Index	3.11

Year Wise Distribution

This table describes the year wise distribution of the articles. The study shows importance of this study increasing and recent days more publications are coming. 1992 the publication was 1 article, and till 1999 one publication per year was the output but after that publications gradually increased and in the year 2017 has more publications with 39 articles. And in this year first two months had 4 publications. Annual percentage of growth rate is 6.504109.

Table 2: Annual Scientific Productions

Year	Articles
1992	1
1993	1
1995	1
1996	1
1998	1
1999	1
2000	3
2001	1
2004	2
2005	6
2006	2
2007	4
2008	10
2009	4
2010	9
2011	4
2012	13
2013	13
2014	10
2015	31
2016	26
2017	39
2018	4



Author Productivity

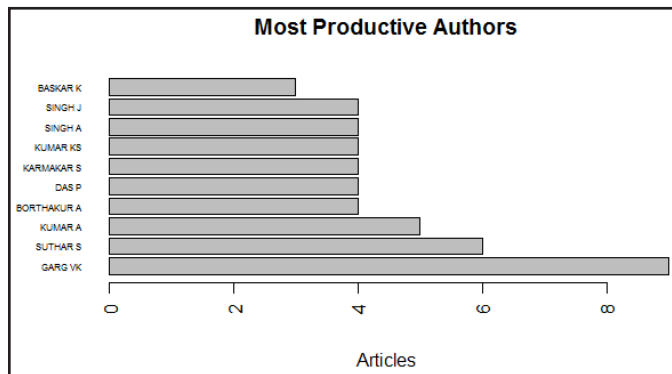
Among the first 10 authors Garg V K is the most productive author with 9 articles, Suthar S has 6 articles, Kumara A has 5 articles the serial number 4 to 9 authors has 4 articles each. Bhasker comes at the 10th position with 3 articles. Most productive author during the period of study is Garg VK. The below graph also shows the schematic representation

of author productivity. Article fractionalized report shows Garg VK comes at the first position with 3.67 fractionalized ratio, and Borthakura comes at the second position with

fractionalized ratio of 3.00 followed by Suthar S and Pant D with fractionalized ratio of 2.67 and 2.25 respectively.

Table 3: Most Productive Authors

S.No	Authors	Articles	Authors	Articles Fractionalized
1	GARG VK	9	GARG VK	3.67
2	SUTHAR S	6	BORTHAKUR A	3.00
3	KUMAR A	5	SUTHAR S	2.67
4	BORTHAKUR A	4	PANT D	2.25
5	DAS P	4	KUMAR A	1.99
6	KARMAKAR S	4	KUMAR KS	1.83
7	KUMAR KS	4	BASKAR K	1.33
8	SINGH A	4	DWIVEDY M	1.33
9	SINGH J	4	KAUSHAL RK	1.33
10	BASKAR K	3	KAUSHIK P	1.33



Country Wise Distribution

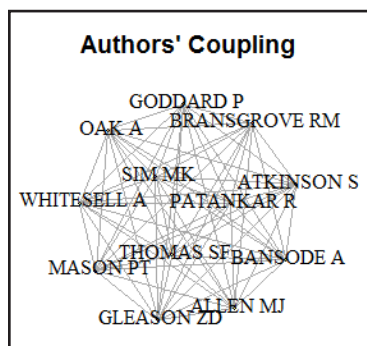
This table discusses the country wise distribution of publications. India is the most productive country among the first 10 productive countries. India has 163 articles and least productive countries are Mauritius, Malaysia, France and Italy, with one publication each. India has the production frequency of 1630.87 followed by Australia-50.026, Korea – 40.021, USA – 30.0160 and England, Germany, France, Italy, Malaysia, Mauritius respectively. Among these France Italy, Malaysia and Mauritius has frequency of 10.00535 each.

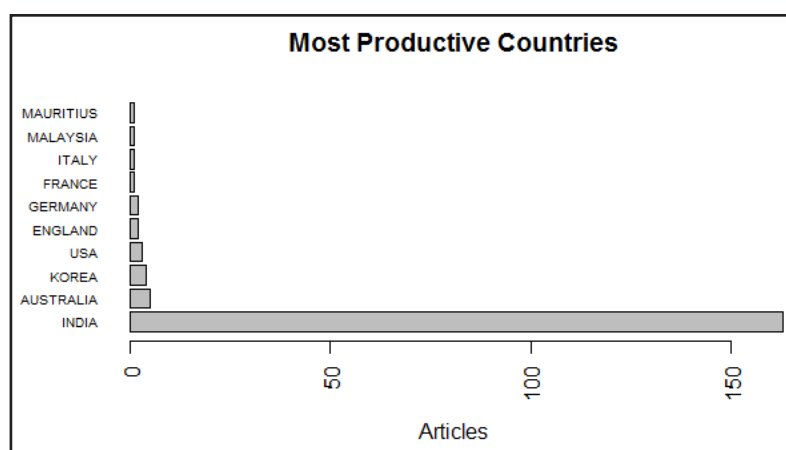
Table 4: Most Productive Countries

S.No	Country	Articles	Freq
1	INDIA	163	163 0.87166
2	AUSTRALIA	5	5 0.02674
3	KOREA	4	4 0.02139
4	USA	3	3 0.01604
5	ENGLAND	2	2 0.01070
6	GERMANY	2	2 0.01070
7	FRANCE	1	1 0.00535
8	ITALY	1	1 0.00535
9	MALAYSIA	1	1 0.00535
10	MAURTIUS	1	1 0.00535

Authors Coupling

The below picture shows the authors coupling, ie how the authors are linked to other authors through their publicaion citations. Authors Goddard P, Oak A, SiM MK and others showed in the picture shows the author wise coupling and how the authors are linked each other.





CITATION ANALYSIS

Total citations per country are shown in the table 5. India has more citations with highest average articles citation. India's total citation is 1972 and an average article citation is 12.10. Lowest citation is of Netherlands with 9 article and 9 average article citations. Australia has the 23.40 average article citations with 117 numbers of total citations. Switzerland and France has 89 and 80 number of citations respectively. USA got least average article citations with the value 4.

Table 5: Total Citations Per Country

S.No	Country	Total Citations	Average Article Citations
1	INDIA	1972	12.10
2	AUSTRALIA	117	23.40
3	SWITZERLAND	89	89.00
4	FRANCE	80	80.00
5	GERMANY	35	17.50
6	ENGLAND	25	12.50
7	SOUTH AFRICA	17	17.00
8	ITALY	14	14.00
9	USA	12	4.00
10	NETHERLANDS	9	9.00

SOURCE WISE DISTRIBUTION

Table 6 shows the sources wise distribution. The journal namely waste management has 8 articles in its credit and had come the top most position. 3 Journals has 6 articles each

in their credit. 2 journals Applied radiation and isotopes and Environmental Science and Pollution Research have 3 articles and had come at the last position.

Table 6: Most Relevant Sources

S.No	Sources	Articles
1	Waste management	8
2	Bioresource technology	6
3	Resources conservation and recycling	6
4	Waste management & research	6
5	Ecological engineering	5
6	Journal of cleaner production	5
7	Journal of environmental management	4
8	Science of the total environment	4
9	Applied radiation and isotopes	3
10	Environmental science and pollution research	3

SEARCH TERM

Most frequent search term or keyword used is E-waste it could retrieve 23 articles and when the term management also added to the first key term using Boolean operator plus the retrieved volume of data increased. The keyword recycling and waste management could retrieve 12 numbers of articles when the word growth is added to the word recycling the retrieved volume increased to 14. When the term Electronic waste added to the search term waste management retrieved volume of data decreased to 10 articles. The below map shows the clustering of key words.

Table 7: Most Relevant Keywords

S.No	Author Keywords (DE)	Articles	Keywords-Plus (ID)	Articles
1	E-WASTE	23	MANAGEMENT	36
2	RECYCLING	12	GROWTH	14
3	WASTE MANAGEMENT	12	ELECTRONIC WASTE	10
4	VERMICOMPOSTING	11	MANURE	9
5	EISENIA FETIDA	7	RECOVERY	9
6	INDIA	6	INDIA	8
7	MANAGEMENT	6	MODEL	8
8	HEAVY METALS	5	WASTE-WATER	8
9	MUNCIPAL SOLID WASTE	5	CHINA	7
10	VERMICOMPOST	5	COW DUNG	7

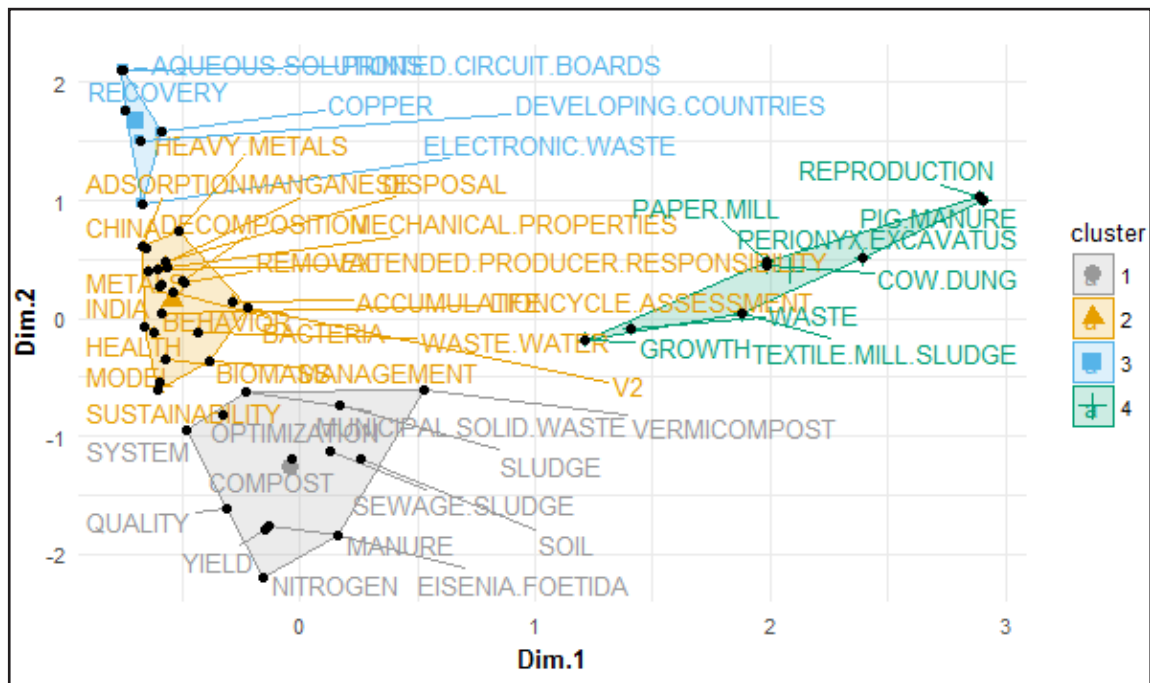


Table 8 shows the author dominance factor Garg V K comes at the top most position Rank by first authored 9 articles. Suthar S has came at the second position of author dominance factor rank, Suthar S has first authored 6 articles , and multi authored 1 article and his article wise rank is 6. Rank by author dominance factor in this table shows Kumara

A, Borthakur A, DAS P, Karmakar S, Kumar K S, Singh J and Dwivedy M comes third to ninth position respectively. And Mr. Kaushal R K comes at the 10th rank of author dominance factor, he has multi authored only one article, first authored 3 articles.

Table 8: Author Dominance Factor

Dominance Factor	Multi Authored	First Authored	Rank by Articles	Rank by DF
SUTHAR S	1.0000000	6	6	2
DWIVEDY M	1.0000000	3	3	9
KAUSHAL RK	1.0000000	3	3	10
KUMAR KS	0.7500000	4	3	7
BORTHAKUR A	0.5000000	4	2	4
KUMAR A	0.4000000	5	2	3
DAS P	0.2500000	4	1	5
KARMAKAR S	0.2500000	4	1	6
SINGH J	0.2500000	4	1	8
GARG VK	0.2222222	9	2	1

AUTHOR H-INDEX

Below Table Discusses the author h-index g-index and m-index . It also discusses the Total Citation, National patent of the author. As per the table Garg VK has highest h-index and g-index his TC is 287 and NP is 9. Garg VK's m-index

is 0.466. Suthar S and Singh J has h- index of 4 and g-index is 6 and 4 each. m-index is .36 and .44. Suthar S's TC is 54 and NP is 6, and Singh J has TC of 80 and NP of 4. Kumar A has least h-index and g-index with the value of 1. Kumar A has TC 2 and NP 5.

Table 9: Author H-Index

S.No.	Author	h_index	g_index	m_index	TC	NP
1	GARG VK	7	9	0.4666667	287	9
2	SUTHAR S	4	6	0.3636364	54	6
3	KUMAR A	1	1	0.1428571	2	5
4	BORTHAKUR A	2	2	0.5000000	7	4
5	DAS P	2	3	0.2857143	12	4
6	KARMAKAR S	2	3	0.2857143	12	4
7	KUMAR KS	2	3	0.5000000	11	4
8	SINGH A	2	4	0.2222222	52	4
9	SINGH J	4	4	0.4444444	80	4
10	BASKAR K	2	3	0.5000000	11	3

CONCLUSION

This article made an attempt to reveal the bibliometric characteristics of the articles published in the area of E-waste management in India and indexed in web of science database during the period of 1992 to 2018 January. A total of 187 articles were contributed in this area of study during the period. India is the major contributed county in this area of study. The journal Waste Management was the most preferred and productive journal among all the journals. Analysis of authorship pattern shows the trend towards the multiple authorship. Garg VK is the most productive author and analysis of author dominance factor shows Mr. arg as the most dominant author in this area of study. The

limitations of present study are that the citations present here is only based on Web of Science database and hence may not be comprehensive, and chances are there to citations may have missed in the WoS database due to the possibilities of simple spelling errors in titles and DOI. However this analysis shows scientific productivity in the area of e- waste management.

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