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Bibliometric Analysis On Green Supply Chain Management: Year 2000-2014.

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ABSTRACT

Background: Bibliometric is a mathematical and statistical method to study and identify patterns in the usage of materials and services within a library or to analyze the historical development of a specific body of literature, especially its authorship, journal, and citations. A quantitative survey of the literature pertaining to the study of Green Supply Chain Management from Web of Science, covering the period of 2000-2014, based on the scope of 530 literatures of GSCM. The study was pursued and applied bibliometric methods. **Objective:** The aim of the paper is to give a comprehensive information about the features and development of the green supply chain management field base literature. **Results:** It was found that the research related to green supply chain is growing tremendously over the time. **Conclusion:** On different levels of citation aggregations, and frequency distributions indicated a fragmented base literature

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INTRODUCTION

"GSCM is defined as integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing the final product to the consumers, and end life". (Srivastava, 2007) There is a very close relationship between impact of economic system and environment (Schaltegger and Synnsetvedt, 2002), therefore issue related to a supply chain management as a foundation to business sustainability is in ultimate provision (Harland, 1996). Supply chain management (SCM) has become an important competitive approach for organizations in this environment (Zhu, Q., et al 2006). Many researches have conducted related to supply chain management especially in environmental issues for example carbon footprint issues, waste management and logistics (Rasi, RZ. et al., 2014; Zhu, Q., et al., 2006)

In this paper, we have conducted bibliometric techniques on journals articles on 2000-2014 related to green supply chain management. There has been an increasing interest in the use of bibliometric indicators for assessing or monitoring scientific or technological activities. It gives quantitative information on authorship, journals, citations and even forecasting the potential of a particular field.

It utilizes quantitative analysis and statistics to

describe patterns of publications within a given field or body of literature. The term statistical bibliography referred as the application of quantitative techniques to libraries and was first employed by E.W. Hulme in 1923. The term "Bibliometrics" was first introduced by Pritchard in 1969, Objectives of this paper are

1) To figure out the growth of green supply chain literature in 6 areas namely operation management, management, engineering manufacturing, engineering industrial, business and computer science interdisciplinary applications within the period of 2000-2014.

2) To explore the authorship pattern and journals in the area of green supply chain management within the period of 2000-2014.

3) To analysis the citation from author, articles and journals in green supply chain management within the period of 2000-2014.

Methodology:

The data for this study was downloaded from Web of Science (WOS). WOS is produced by Thomson Reuters Corporation. WOS is one of the major bibliography database where it collects an international abstracting and indexing service. It starts indexing in 1970 and the databases are updated weekly. The databases are maintained by the Institute for Scientific Information®, ISI®, Philadelphia,

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Pennsylvania, USA, holding all the copyrights. In January, 2015 we used keyword search “green supply chain management ” to retrieve all the published articles and limited to

- Operation research management
- Management
- Environmental science
- Engineering manufacturing
- Engineering industrial
- Business
- Engineering environmental
- Computer Science Interdisciplinary Applications

Applications

Previously Bibliometric analysis on green supply chain management has been made by Jason J. Jung in 2011 with regard to productivity and sustainability in both researchers and journals, impacts of the journals and citation of journals, authors and articles.

Data Analysis:

The retrieved data contains mostly journal articles. In total 530 articles and the range period within year 2000-2014 and these records are further analyzed using Microsoft Excel for getting further bibliometrics indicators. 530 records matched with keyword “Green supply chain management” of 23,449,468 in the data limited that has been selected.

Periodic Growth of Literature:

The result shows that there is a literature growth in the field of green supply chain management as shown in Table 1. The volume of literature starts increasing from the year 2009 where there were 18 papers produced compare to only one in year 2000. The trend continues on a steadily up to 2012 when the number reached 103 but the number drops to 91 in year 2013. However, a year later there was a phenomenal jump in the publication output where the number reached to 137.

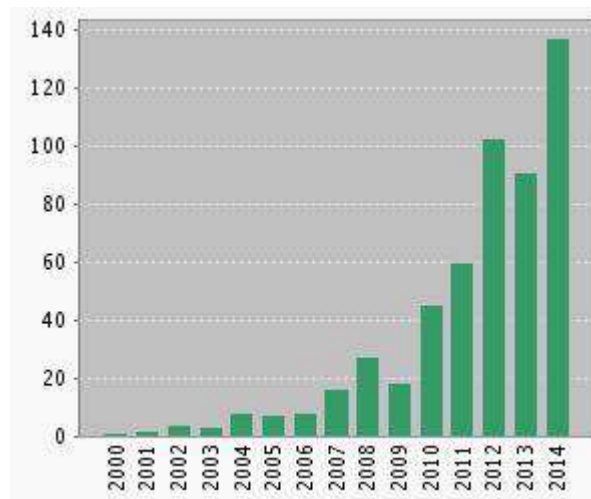


Fig. 1: Number Of Papers Over Years

Table 1: Number Of Papers Over Years

Publication Years	Records	% of 530
2014	137	25.8
2012	103	19.4
2013	91	17.2
2011	60	11.3
2010	45	8.5
2008	27	5.1
2009	18	3.4
2007	16	3.0
2006	8	1.5
2004	8	1.5
2005	7	1.3
2002	4	0.8
2003	3	0.6
2001	2	0.4

Author Analysis:

We found there was 1441 authors published 530 papers in this area.

1) Author Productivity:

Author productivity identifies a number of papers published by author. Table 2 shows the productivity of authors and it clearly shows Sarkis, J

is the highest contributor to this area. He published in total of 35 papers followed by Zhu, Qh (24), Lai KH(21) and so forth

Table 2: Productivity Author

Authors	Records	% Of 530
Sarkis J	35	6.6
Zhu QH	24	4.5
Lai KH	21	4.0
Govindan K	16	3.0
Klassen RD	12	2.3
Vachon S	11	2.1
Jabbour Cjc	10	1.9
Geng Y	10	1.9
Sheu JB	9	1.7
SEURING S	9	1.7

2) Collaborative Authorship:

Table 3 provides the data on collaborative authorship in Green Supply Chain Management.

Table 3: Collaborative Authorship

Year	1 author	2 Authors	3 Authors	4 Authors	5 Authors	Number of Publication
2000	0	0	1	0	0	1
2001	1	0	1	0	0	2
2002	2	1	1	0	0	4
2003	2	1	0	0	0	3
2004	0	4	3	1	0	8
2005	1	3	3	0	0	7
2006	0	7	1	0	0	8
2007	4	5	7	0	0	16
2008	7	9	6	4	1	27
2009	4	11	0	3	0	18
2010	7	17	13	6	2	45
2011	10	25	18	5	2	60
2012	8	35	43	14	3	103
2013	9	21	28	22	11	91
2014	9	33	51	36	8	137
Total	64	172	176	91	27	530
	12.08%	32.45%	33.21%	17.17%	5.09%	

Table 3 shows the collaborative authorship of the articles published during the period of study. The largest number of articles had been published by three authors 176 papers (33.21%). This is followed by two authors 91 (17.17%). There were small percentage of articles published by one and five and more authors with 64(12.08%) and 27(5.09%) of the total articles. The data clearly reflects that the large number of articles by many author. This means that there are well established research groups in the area and the subject is quite new and emerging one. From the number in the table we are able to figure out the degree of collaboration. The degree of collaboration is to find out collaboration dominance upon individual contribution. To determine degree of collaboration in quantitative terms, the formula given by K. Subramanyam (1983) was used.

The formula is:

$$C = \frac{NM}{(NM+NS)}$$

Where

C= Degree of Collaboration

NM= Number of multi authored papers

NS= Number of single authored papers

In the present study the value of

$$NM = 466$$

$$NS = 64$$

$$C = 0.88$$

As a result the degree of collaboration is 0.88 which clearly indicates its dominance upon individual contribution.

3) Sustainability Authorship:

Table 4: Sustainability Authorship

Name of Author	Period	Number of years
Sarkis, J	2003-2014	11
Klassen, RD	2003-2014	11
Vachon, S	2003-2013	10
Geng, Y	2005-2014	9
Sheu, JB	2005-2014	9
Zhu, QH	2006-2014	8
Lai, KH	2007-2014	7
Seuring, S	2008-2014	6
Govindan, K	2011-2014	3

Table 4 shows the sustainability of the authorship in the area of green supply chain management. The most productive author in the area is Sarkis, J. Besides as the most productive author, Sarkis J also is the most sustainable author too. Klassen, RD is also a sustainable author but less papers produced compared to Sarkis, J. In 11 year both Sarkis, J and Klassen, RD are involved in this area and Sarkis, J. produces 39 papers and Klassen, RD produces 11 papers. Govindan, K is a new

entrant in this area but he manages to produce a lot of papers too.

Journal Analysis:

Journal Of Cleaner Production is the core journal in green supply chain management, which covers mostly (14%) of the total literature coverage.

1) Productivity journals:

Table 5: Productivity Journals

Source Titles	records	% of 530
Journal Of Cleaner Production	81	15.3
International Journal Of Production Economics	58	10.9
International Journal Of Production Research	32	6
Supply Chain Management An International Journal	30	5.7
Transportation Research Part E Logistics And Transportation Review	25	4.7
Business Strategy And The Environment	20	3.8
International Journal Of Physical Distribution Logistics Management	18	3.4
International Journal Of Operations Production Management	18	3.3
Resources Conservation And Recycling	16	3
Industrial Marketing Management	13	2.4

Table 5 shows that Journal Of Cleaner Production is the most productive journal in the area of green supply chain management in the period of

14 years. Followed by International Journal Of Production Economics (64).

2) Sustainability Journal:

Table 6: Sustainability Journals

Journal	Period	Year
Transportation Research Part E-Logistics And Transportation Review	2000-2014	14
Journal Of Cleaner Production	2002-2014	12
International Journal Of Operations & Production Management	2002-2014	12
International Journal Of Production Economics	2004-2014	10
Supply Chain Management-An International Journal	2004-2014	10
International Journal Of Production Research	2006-2014	8
International Journal Of Physical Distribution & Logistics Management	2008-2014	6
Business Strategy And The Environment	2009-2014	5
Industrial Marketing Management	2010-2014	4
Resources Conservation And Recycling	2011-2014	3

Table 6 above shows that between Year 2000-2014, Transportation Research Part E-Logistics And Transportation Review is the most sustainable journal. It has been involved in the area of green supply chain for 14 years. It followed with Journal Of Cleaner Production and International Journal Of Operations & Production Management (12 years), International Journal Of Production Economics and

Supply Chain Management-An International Journal for 10 years.

Area:

Table 7 shows the area of research in green supply chain management. The engineering covers the most area of research in green supply chain management that is more than 50% (281 records),

follows by business economics (240 records), Operations Research Management Science (181 records). Toxicology and Public Environmental

Occupational Health give the lowest number which each of them recorded 3 times in this area (0.6%). The area of research are as in table 7 as follows:

Table 7: Research Area in Green Supply Chain Management

Research Areas	Records	% of 530
Engineering	281	53.0
Business Economics	240	45.3
Operations Research Management Science	181	34.2
Environmental Sciences Ecology	159	30.0
Computer Science	39	7.4
Transportation	28	5.3
Social Sciences Other Topics	11	2.1
Automation Control Systems	7	1.3
Toxicology	3	0.6
Public Environmental Occupational Health	3	0.6

Countries:

Table 8 shows the USA is the highest contributor in Green Supply Chain Management (149

papers). China contributed 81 papers and followed by England 76 papers. Germany and Denmark also contributed 23 papers in this area.

Table 8: Countries

Countries/Territories	Records	% of 530
USA	149.0	28.1
PEOPLES R CHINA	81.0	15.3
ENGLAND	76.0	14.3
TAIWAN	71.0	13.4
CANADA	36.0	6.8
SPAIN	29.0	5.5
ITALY	26.0	4.9
INDIA	24.0	4.5
GERMANY	23.0	4.3
DENMARK	23.0	4.3

Citation Analysis:

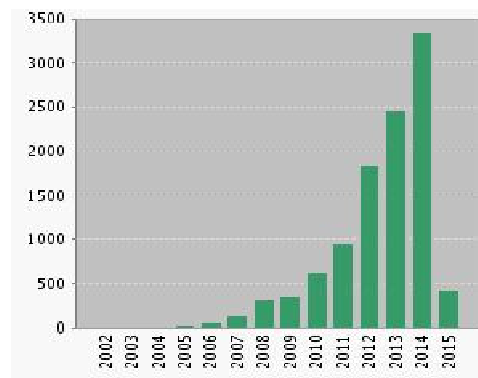


Fig. 2: Citation Analysis Over The Years

The references provided by the authors at the end of their articles are the basis of citation analysis. Citation traces a connection between two documents, one which cites and the other which is cited. Citation analysis is one of the popular methods applied to derive the following benefits. The above figure 2 showed that in 2014 is the highest number of citation, followed by year 2013 where the number of

citation almost 2500. There are about 3817 citations from 2000-2015. Average cited per item is the sum of the Times Cited count divided by the number of results found. The average is 19.88. Table 9 below shows the highest citation in the area of Green supply chain management.

Highest Citation:

Table 9: Citation Articles

Authors	Title	Journal Name	Year
Verrier B. <i>et al</i>	Combining organizational performance with sustainable development issues: the Lean and Green project benchmarking repository	JOURNAL OF CLEANER PRODUCTION	2014
Johansson, G & Sundin, Erik	Lean and green product development: two sides of the same coin?	JOURNAL OF CLEANER PRODUCTION	2014
Appolloni A., <i>et al</i>	Green Procurement in the private sector: a state of the art review between 1996 and 2013	JOURNAL OF CLEANER PRODUCTION	2014
Jose Martinez-Jurado, Pedro; Moyano-Fuentes, Jose	Lean Management, Supply Chain Management and Sustainability: A Literature Review	JOURNAL OF CLEANER PRODUCTION	2014
Galeazzo A. <i>et al</i>	Lean and green in action: interdependencies and performance of pollution prevention projects	JOURNAL OF CLEANER PRODUCTION	2014
Govindan K. <i>et al</i>	Impact of supply chain management practices on sustainability	JOURNAL OF CLEANER PRODUCTION	2014
Chiarini, Andrea	Sustainable manufacturing-greening processes using specific Lean Production tools: an empirical observation from European motorcycle component manufacturers	JOURNAL OF CLEANER PRODUCTION	2014
Rizzi F. <i>et al</i>	Environmental value chain in green SME networks: the threat of the Abilene paradox	JOURNAL OF CLEANER PRODUCTION	2014
Jimenez-Parra B. <i>et al.</i>	Key drivers in the behavior of potential consumers of remanufactured products: a study on laptops in Spain	JOURNAL OF CLEANER PRODUCTION	2014
Mohanty, R. P.; Prakash, Anand	Green supply chain management practices in India: an empirical study	PRODUCTION PLANNING & CONTROL	2014

Articles Without Self-Cited:

The sum of times cited without self-citations shows that item found in the result set minus any

citation from articles in the set. The total articles without self-cited is 6668. The following tables shows the top 10 authors without self-cited.

Table 10: The Top 10 Authors Without Self-Cited

Authors	Title	Journal Name	Year
Melo, M. T. <i>et al</i>	Facility location and supply chain management - A review	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH	2009
Grollman P. <i>et al</i>	Aristolochic acid and the etiology of endemic (Balkan) nephropathy	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	2007
Ilgın, Mehmet <i>ali</i> ; Gupta, Surendra M.	Environmentally conscious manufacturing and product recovery (ECMPRO): A review of the state of the art	JOURNAL OF ENVIRONMENTAL MANAGEMENT	2010
Chertow, Marian R.	Uncovering industrial symbiosis	JOURNAL OF INDUSTRIAL ECOLOGY	2007
Lenzen M. <i>et al</i>	Shared producer and consumer responsibility - Theory and practice	ECOLOGICAL ECONOMICS	2007
Maloni, Michael J.; Brown, Michael E.	Corporate social responsibility in the supply chain: An application in the food industry	JOURNAL OF BUSINESS ETHICS	2006
Boiral, Olivier	Corporate greening through ISO 14001: A rational myth?	ORGANIZATION SCIENCE	2007
Matos, Stelvia; Hall, Jeremy	Integrating sustainable development in the supply chain: The case of life cycle assessment in oil and gas and agricultural biotechnology	JOURNAL OF OPERATIONS MANAGEMENT	2007
Sarkis J. <i>et al</i>	Stakeholder pressure and the adoption of environmental practices: The mediating effect of training	JOURNAL OF OPERATIONS MANAGEMENT	2010
Kouvelis P. <i>et al</i>	Supply chain management research and Production and Operations Management: Review, trends, and opportunities	PRODUCTION AND OPERATIONS MANAGEMENT	2006

Conclusion:

This study shows the publishing pattern that totally depends on the literature trends, authorship and journal pattern and the quality of research. From the period between 2000-2014, year 2014 shows the maximum number of contributions to the area of Green supply chain management. This study also reveals that the research in this area is growing and the number collaboration also motivating.

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