Clean Technologies and Environmental Policy (2019) 21:3–22
https://doi.org/10.1007/s10098-018-1624-1

ORIGINAL PAPER

Research on green supply chain: a bibliometric analysis

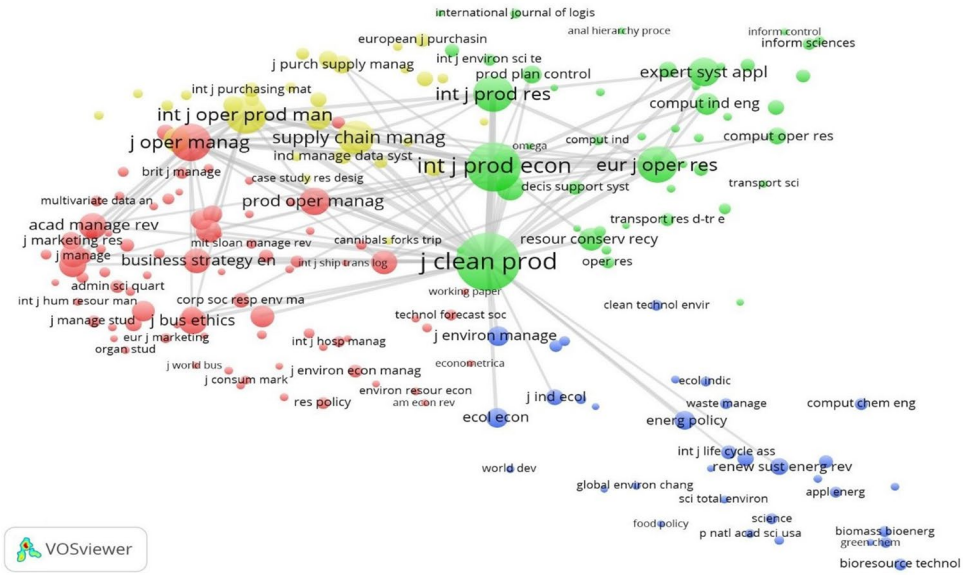
Keivan Amirbagheri[1] · **Ana Núñez-Carballosa**[1] · **Laura Guitart-Tarrés**[1] · **José M. Merigó**[2,3]

Received: 18 July 2018 / Accepted: 3 October 2018 / Published online: 15 October 2018

Abstract

Recently, the emergent concept of green supply chain has received increasing attention. Although popular among scholars, many literature reviews have only examined GSC from a general point of view or focused on a specific issue related to GSC. This study presents a comprehensive analysis of the influence and productivity of research on GSC from 1995 to 2017 by reporting trends among authors, countries and institutions based on a bibliometric approach. To this end, the study analyzes around 1900 papers on GSC. This study uses the Web of Science Core Collection database to analyze the bibliometric data and the visualization of similarities viewer method to graphically map those data. The graphical analysis uses bibliographic coupling, co-citation, co-authorship and co-occurrence of keywords.

Graphical abstract



Keywords Green supply chain · Bibliometric approach · Web of Science · VOS viewer

Introduction

Over the last decades, enterprises have begun to apply environmental management programs and green supply chain practices, to help them compete in the markets. At the same time, the number of studies on green supply chain (GSC) has significantly increased during this period.

✉ Keivan Amirbagheri
kamirbam7@alumnes.ub.edu

Extended author information available on the last page of the article

Numerous studies have reviewed the literature on GSC in the period surveyed in this study. Each of these works has analyzed the GSC literature from a different point of view. For example, Srivastava (2007) adopts an integrated and fresh approach to consider the field of green supply chain management (GSCM) because of the necessity to present a comprehensive references of GSCM to help academicians, researchers and practitioners. Carter and Rogers (2008) provide a large-scale literature review and use conceptual theory to introduce the concept of sustainability to the field of supply chain management. They demonstrate the relationships among environmental, social and economic performance within the context of a supply chain management. Seuring and Müller (2008) offer a conceptual framework to summarize the research in the field of sustainable supply chain. Their paper also offers a literature review on sustainable supply chain management. Hassini et al. (2012) review the literature related to sustainable supply chain (SSC) and provide a framework for SSC and performance management, whereas Ahi and Searcy (2013) identify and analyze the published definitions of GSCM and sustainable supply chain management (SSCM). Tiwari et al. (2018) analyze big data analytics in supply chain management. On the other hand, Govindan et al. (2015) focus on green supplier selection, whereas Miemczyk et al. (2012) investigate the sustainability of a purchasing and supply chain. Fahimnia et al. (2015) present a comprehensive evolution of the field, focusing on forward green supply chain practices by implementing a bibliometric methodology. Although the abovementioned literature review as well as other works provides valuable information on the state of the literature on GSC, there is still much need for a comprehensive bibliometric approach to analyze this literature. Based on this reality, after 2012 that is the last year of the work by Fahimnia et al. (2015), the GSC area experiences a huge increasing trend so our study tries to cover this growth and report it. Besides, we believe that Web of Science (WoS) as a comprehensive database could prepare more complete results that can help us to obtain a more thorough analysis of this area. Also, in our work the items not only from one aspect (no. of papers) but also based on many measurements such as total publications, total citation and *h-index* try to explore the trends and the different items.

The aim of the work is to provide a bibliometric overview of GSC by using a modern bibliometric approach that uses several bibliometric indicators and the VOS viewer software during a 22-year period from 1995 to 2017 by reporting trends among authors, countries and institutions. To present the results graphically, this paper uses VOS viewer software (Van Eck and Waltman 2010). To develop the mapping analysis (Merigó et al.2018), this study uses bibliographic coupling (Kessler 1963), co-citation (Small 1973), co-authorship and co-occurrence of keywords (Merigó et al. 2016).

This paper first briefly discusses concepts and bibliometric studies related to green supply chain and reviews the existing literature. The next section describes the bibliometric methods used throughout the paper. "Results" section presents the bibliometric results of the WoS Core Collection, and "Graphical analysis of GSC with VOS viewer" section develops a graphical analysis of the bibliographic materials. The closing section describes the paper's findings and states its conclusions.

Background

Green supply chain

An important environmental concept that has gained attention among companies and scholars over recent decades is GSCM. At the same time, a diverse set of definitions has been suggested for GSCM. This concept, as Srivastava (2007) notes, can be defined in several ways such as green purchasing, integrated green supply chains flowing from supplier to manufacturer to customer or reverse logistics. As mentioned above, Ahi and Searcy (2013) propose a thorough framework of 22 definitions of GSCM and 12 definitions of SSCM. Tseng et al. (2016) present empirical evidence of firms' GSC capabilities while Tsireme et al. (2012) explore the reasons that affect the decisions of managers of firms to adopt management practices in GSCM. The main objective of GSCM is to reduce, as much as possible, harmful environmental influences such as air and water pollution and to improve the ability to manage waste of resources such as energy, materials and products (Rao and Holt 2005; Eltayeb et al. 2011).

Many studies are conducted to achieve these objectives. For instance, Sarkis (2012) provides a framework to understand and appreciate the relationships among various research streams and topics in the field. Kainuma and Tawara (2006) extend the scope of supply chains to include reuse and recycling of products and services throughout their life cycle and apply that extended notion in a setting to confirm its efficiency. Based on their technique, Kainuma and Tawara (2006) were able to measure environmental and managerial performance. In another study, Kumar et al. (2012) explore a simple model that companies may use to understand and improve supply chain sustainability practices. Besides, de Oliviera et al. (2018) present the GSCM practices from a comprehensive point of view and to analyze the subject's behavior through a bibliometric analysis from 2006 to 2016.

Antecedents

There are numerous definitions for the term bibliometrics in the literature. One of the very first definitions of this term

provided by Pritchard (1969) is "the application of mathematics and statistical methods to books and other media communications." A more comprehensive definition suggested by White and Mccain (1989) is that "bibliometrics is the quantitative study of the literature as they are reflected in bibliographies." According to yet another definition proposed by Broadus (1987), bibliometrics is "the quantitative study of physical published units, or of bibliographic units, or of surrogates of either" (Hood and Wilson 2001). The power of bibliometrics to classify the various aspects of a publication and its reported results in an organized form made bibliometrics a popular method. Additionally, this methodology not only is possible to apply in all of the fields of science but also can be used to review the performance of different journals (Laengle et al. 2018; Martínez-López et al. 2018). By using a very powerful and multifunctional software, it is easy to analyze the results obtained through bibliometrics (Merigó et al. 2015). The traces of a bibliometric analysis can be detected in papers in operational research/management science (OR/MS), production and operational management (POM), supply chain management (SCM), green supply chain (GSC) and some other environmental science disciplines.

In recent decades, the use of OR/MS within the scientific community has increased substantially (Merigó and Yang 2017). They present a bibliometric overview of research published in OR/MS to identify some of the most relevant studies in this field and some of the newest trends according to the information found in the Web of Science database. Chang and Hsieh (2008) evaluate the distribution of papers published by Asian authors in OR/MS journals from 1968 to 2006 based on a bibliometric analysis, whereas White et al. (2011) attempt to present an overall assessment of OR in developing countries. In another work, Mingers and Xu (2010) concentrate on citation counts of papers published in six well-known MS journals.

"The origin of operations management is closely linked with the birth of the company itself, as there has always been a need to produce goods and services to be managed" (Alfalla-Luque and Medina-López 2009). Several bibliometric studies have also been done in the field of POM. Pilkington and Liston-Heyes (1999) use a co-citations analysis to investigate the intellectual foundations of the POM literature and consider whether they are distinct from those commonly associated with rival fields. Hsieh and Chang (2009), based on papers published in 20 core POM journals, explore the global POM research. Moreover, most of the academic areas of management have performed studies based on bibliometric parameters. These areas range from accounting and business to technologies used in business and industry.

Supply chain management is a strategy for integrating the activities of a supply chain (Oliver and Webber 1982) on a day-by-day basis, which has gained popularity among academics, and its nature has been investigated in numerous studies (Shiau et al. 2015). For example, Wong et al. (2012) develop a systematic review of the cross-disciplinary literature on SCM. At the same time, numerous studies analyze supply chain management through a bibliometric perspective. Charvet et al. (2008) use a bibliometric approach to study the intellectual structure of supply chain management. In another work, Alfalla-Luque and Medina-López (2009) examine SCM and its influence on the needs of companies by analyzing the bibliometric studies of the main journals in the discipline. Also, Chen et al. (2017) conduct a systematic literature review and a quantitative bibliometric analysis to review the literature to find out about the items that are studied by the authors and the existing gaps in the body of knowledge.

Some of the bibliometric studies focus on specific issues of GSC such as performance measurement (Beske-Janssen et al. 2015), corporate social responsibility for supply chain management (Feng et al. 2017) or green innovation (Albort-Morant et al. 2017). For example, Fahimnia et al. (2015) present a comprehensive evolution of the field, focusing on forward green supply chain practices by implementing a bibliometric methodology; their findings provide a robust road map for further investigations in this field. Beske-Janssen et al. (2015) systematically review the academic literature on sustainability performance measurement for SSCM published in the last 20 years. In the other study, Thomé et al. (2016) offer a novel combination of systematic literature review and bibliometric analysis of sustainable new product development.

There are some bibliometric works that have done to study some environmental issues. As an example, Hu et al. (2010) did a bibliometric analysis to identify the global research related to lead in drinking water field from 1991 to 2007 or in another similar work, Fu et al. (2013) analyzed the same topic but during 1992 and 2011. Zhao et al. (2018) conduct a large-scale bibliometric analysis on the trends of the emerging contaminants: nano-adsorbents, nano-photocatalysts and related research topics from the literature during 1998–2017. In another study, Wang et al. (2014) carried out a bibliometric analysis to provide insights into research activities and tendencies of the global risk of engineering nanomaterials (ENMs) from 1999 to 2012. From the other point of view, Andrade et al. (2017) organized a bibliometric analysis to investigate and analyze the scientific production related to indoor air quality of environments used for physical exercise and sports practice. Ioana-Toroimac (2018) through a review of previous publications builds maps of scientific knowledge on the hydromorphology integration in the water framework directive. In a more general and comprehensive perspective, Khan and Ho (2012) identify the top-cited articles published in environmental science journals listed in Journal Citation Reports (JCR). Finally, Dragos and Dragos (2013), with a

help of bibliometric approach, analyze the factors affecting scientific productivity in environmental sciences and ecology.

Bibliometric methods

This study uses certain bibliometric indicators to organize the data in a more reader-friendly form. By implementing these indicators, the paper aims to show different results relating to the same variable (Cancino et al. 2017). Among other things, the study uses the total number of papers and citations to measure productivity and influence (Blanco-Mesa et al. 2017), cites per paper and *h*-index (Alonso et al. 2009; Hirsch 2005). In addition, the study uses citation thresholds and some other indicators such as institutions ranking, country ranking and publications per person (Laengle et al. 2017; Valenzuela et al. 2017).

The study provides the bibliometric data from WoS Core Collection database. The search process occurred in September 2017 by using the keyword "green and supply chain." Search results are for articles published by the end of 2017. The initial search identified 2440 papers which were later reduced to 1892 after removing any document not classified as article, review, letter or note. So, the final number of papers of the analysis is 1892. The documents have 58,785 citations in total resulting in 31.07 citations per paper. The *h*-index is 111, implying that out of the 1892 papers, 111 have 111 citations or more.

As a complementary analysis, this study also presents a graphical image of the bibliographic material using the VOS viewer software (Van Eck and Waltman 2010). This software collects data and generates maps based on bibliographic coupling, co-authorship, citation, co-citation and co-occurrence of keywords (Merigó et al. 2016; Wang et al. 2018). Bibliographic coupling (Kessler 1963) occurs when two papers cite the same third paper. Co-citation (Small 1973) measures the most cited paper; it occurs when two papers are cited by a third paper. Co-authorship measures the degree of co-authorship of the most productive authors. Citation analysis focuses on the degree of citations between two variables. The co-occurrence of keywords shows the most common keywords used by different papers, as well as which keywords usually appear below the abstract. Network connection visualizes the keywords that appear more frequently in the same papers (Cancino et al. 2017).

Results

Publication and citation structure of GSC

The very first paper on GSC was published in 1995. Since then, the number of papers published on GSC has grown. To better understand this trend, Table 1 reports the number of papers published on GSC and their total citations. Additionally, by defining some thresholds, Table 1 identifies the range of highly cited papers relative to those with one or five citations.

During the first 7 years of the period studied in this paper, the number of papers published on GSC had not exceeded one. After this period, there had been a slight growth in the number of papers published on GSC. Until 2012, the number of published papers had increased significantly relative to previous years. From 2012 to 2017, journals had published increasingly more papers; the highest number of published papers is in 2017 with 469 papers. It should be noted that 6.82% of the papers have received more than one hundred citations that is 129 out of 1892 papers. In addition, 15.54% of the papers have received more than 50 citations and 68.08% and 90.17% of the papers have received more than five and one citations, respectively.

The next step is to analyze the most cited published papers in various journals. Table 2 reports the results based on a list of the 50 most cited papers of all time. The most cited paper in the GSC area was published in 2008 by Stefan Seuring and Martin Mueller; this paper has received 1400 citations. Among the ten most cited papers, Joseph Sarkis and Qinghua Zhu are leading in the list with three and two papers, respectively.

Another interesting item involving several factors is the most cited papers by other papers published in the GSC field. To derive this output, this study applies the VOS viewer (Van Eck and Waltman 2010) which enabled us to generate the results for co-citation of papers. Table 3 shows the 30 most cited papers from the highest to the lowest. The first three papers on this list receive the highest number of citations among the papers listed in Table 2.

In addition, another interesting item is the journals that are citing GSC. Table 4 presents the 30 journals that publish the largest numbers of papers citing GSC. To gain a deeper insight into these results, we have divided them into four periods. The first period stretches from 1995 to 2002 and the last from 2013 to 2017. Journal of Cleaner Production is the leading journal on this list. In the last two periods (from 2008 to 2017), there has been a sharp increase in the number of published papers citing GSC. Interestingly, the third-ranked journal on this list, Sustainability, has published 30 papers during the last 5 years.

A valuable point of view is obtained by data on authors, universities and countries of papers citing GSC. This analysis provided us with essential information about the GSC literature. Table 5 shows the top 30. After Clark University, the next two universities are Asians universities: the Hong Kong Polytechnic University and Dalian University of Technology. The presence of a remarkable number of Asian universities among the top universities shows the high interest in GSC in this region. Besides, the presence of many Asian countries

Table 1 Annual citation structure of GSC

Years	TP	TC	≥100	≥50	≥20	≥10	≥5	≥1
1995	1	21	0	0	1	1	1	1
1996	1	300	1	1	1	1	1	1
1997	2	80	0	1	2	2	2	2
1998	1	244	1	1	1	1	1	1
1999	0	0	0	0	0	0	0	0
2000	3	235	1	1	2	2	2	3
2001	1	69	0	1	1	1	1	1
2002	6	620	2	2	4	5	6	6
2003	4	809	2	2	4	4	4	4
2004	11	1360	3	6	8	10	11	11
2005	10	2362	5	8	10	10	10	10
2006	9	1604	7	9	9	9	9	9
2007	20	3870	12	16	17	20	20	20
2008	35	5559	16	22	29	32	33	34
2009	30	2572	8	18	24	28	29	29
2010	69	3631	13	25	40	56	60	67
2011	81	5884	19	43	55	65	72	78
2012	150	7203	18	51	103	120	137	148
2013	141	5830	13	36	88	113	126	137
2014	206	5811	6	30	101	148	180	199
2015	283	5235	2	19	99	170	214	267
2016	359	3288	0	1	50	120	218	328
2017	469	2198	0	1	17	70	151	350
Total	1892	58,785	129	294	666	988	1288	1706
%	100		6.82	15.54	35.20	52.22	68.08	90.17

TP and Tc = Total papers and citations; ≥100, ≥50, ≥20, ≥10, ≥5, ≥1. Number of papers with equal or more 100, 50,20, 10, 5 and 1 citations

in the analysis of countries also indicates the importance of this research area in Asia. Note that in this table and the other ones, we considered China and Taiwan as one country and also as separated countries.

Leading institutions and countries of GSC

Table 6 reports valuable information about the active institutions in the field of GSC. This table was organized based on the largest number of papers published in the journal. In addition, this comprehensive source shows some valuable information such as cites per paper, *h-index* and number of papers in each journal among the top 50 most cited articles.

The Hong Kong Polytechnic University is the most productive and influential institute on this list. Because the ranking is based on the level of productivity, some universities, such as the Dalian University of Technology, have a higher level of influence and a lower level of productivity than other institutions. Thus, although the Dalian University of Technology is ranked third, it has more citations relative to the University of Southern Denmark.

With the help of Table 7, it is possible to consider a more detailed view of the institutions during the period surveyed in this paper. According to the information shown in these tables, although a Danish university is the leader of the last period of this study, the presence of Asian universities and especially the Chinese one is an important fact. The vital message folded in these data is the presence of Asian universities among the top universities; for example, the Islamic Azad University is the fourth one or University of Tehran is the seventh university of the list in the last period of the study.

Table 8 which reports results on countries provides a general understanding of these results and some important general criteria and represents the same results through 5-year intervals. The USA in both the general and the 5-year-interval formats occupies the first position if we do not consider China and Taiwan as the same country. However, the table shows a rapid ascent of Asian countries to the top of the list. Moreover, additional changes in the ranking of countries seem to be inevitable.

Table 2 Fifty most cited documents in GSC

R	Journal	TC	Title	Author/s	Years	C/Y
1	JCP	1400	From a literature review to a conceptual framework for sustainable supply chain management	Seuring, S; Mueller, M	2008	140
2	IJMR	1079	Green supply chain management: a state-of-the-art literature review	Srivastava, SK	2007	98.09
3	IJPDL	825	A framework of sustainable supply chain management: moving toward new theory	Carter, CR.; Rogers, DS	2008	82.50
4	JOM	783	Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises	Zhu, QH; Sarkis, J	2004	55.93
5	IJOPM	670	Do green supply chains lead to competitiveness and economic performance?	Rao, P; Holt, D	2005	51.54
6	POM	569	Sustainable operations management	Kleindorf, PR; Singhal, K; Van Wassenhove, LN	2005	43.77
7	JOM	558	Sustainable supply chains: An introduction	Linton, JD.; Klassen, RD; Jayaraman, V	2007	50.73
8	JCP	529	A strategic decision framework for green supply chain management	Sarkis, J	2003	35.27
9	IJPE	504	An organizational theoretic review of green supply chain management literature	Sarkis, J; Zhu, QH; Lai, KH	2011	72
10	IJPE	491	Environmental management and manufacturing performance: the role of collaboration in the supply chain	Vachon, S; Klassen, RD	2008	49.10
11	IJOPM	471	Extending green practices across the supply chain: the impact of upstream and downstream integration	Vachon, S; Klassen, RD	2006	39.25
12	JSCM	423	Building a more complete theory of sustainable supply chain management using case studies of ten examples	Pagell, M; Wu, Z	2009	47
13	IJOPM	409	Green supply chain management in China: pressures, practices and performance	Zhu, QH; Sarkis, J; Geng, Y	2005	31.46
14	IJPE	375	Confirmation of a measurement model for green supply chain management practices implementation	Zhu, QH; Sarkis, J; Lai, KH	2008	37.50
15	IJPDL	360	Sustainable supply chain management: evolution and future directions	Carter, CR.; Easton, PL	2011	51.43
16	JCP	354	Green supply chain management: pressures, practices and performance within the Chinese automobile industry	Zhu, QH; Sarkis, J; Lai, KH	2007	32.18
17	JCP	300	An inter-sectoral comparison of green supply chain management in China: drivers and practices	Zhu, QH; Sarkis, J	2006	25.00
18	CMR	300	Lean and green: the move to environmentally conscious manufacturing	Florida, R	1996	13.64
19	IJPR	292	The moderating effects of institutional pressures on emergent green supply chain practices and performance	Zhu, QH; Sarkis, J	2007	26.55
20	DSS	288	A review of modeling approaches for sustainable supply chain management	Seuring, S	2013	57.60
21	IJOPM	285	Greening the supply chain: a new initiative in South East Asia	Rao, P	2002	17.81
22	EJOR	284	Quantitative models for sustainable supply chain management: developments and directions	Brandenburg, M; Govindan, K; Sarkis, J; Seuring, S	2014	71
23	IJPE	266	A literature review and a case study of sustainable supply chains with a focus on metrics	Hassini, Elkafi; S, Chirag; SC	2012	44.33
24	ESA	262	A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers	Buyukozkan, G; Cifci, G	2012	43.67
25	IJPE	260	Impact of lean manufacturing and environmental management on business performance: an empirical study of manufacturing firms	Yang, MG; Hong, P; Modi, SB	2011	37.14
26	JCP	257	Mapping the green product development field: engineering, policy and business perspectives	Baumann, H; Boons, F; Bragd, A	2002	16.06

Table 2 (continued)

R	Journal	TC	Title	Author/s	Years	C/Y
27	RCR	255	An analysis of the drivers affecting the implementation of green supply chain management	Diabat, A; Govindan, K	2011	36.43
28	ESA	253	A green supplier selection model for high-tech industry	Lee, AHI; Kang, HY; Hsu, CF; et al.	2009	28.11
29	MQ	248	Information systems innovation for environmental sustainability	Melville, NP	2010	31
30	EJOR	246	Operations research for green logistics – an overview of aspects, issues, contributions and challenges	Dekker, R; Bloemhof, J; Mallidis, I	2012	41
31	EJOR	244	Evaluating environmentally conscious business practices	Sarkis, J	1998	12.20
32	JCP	224	A comparative literature analysis of definitions for green and sustainable supply chain management	Ahi, P; Searcy, C	2013	44.80
33	TRE	224	An integrated logistics operational model for green supply chain management	Sheu, JB; Chou, YH; Hu, CC	2005	17.23
34	OIJMS	223	Network design for reverse logistics	Srivastava, SK	2008	22.30
35	POM	220	Collaboration and evaluation in the supply chain: the impact on plant-level environmental investment	Klassen, RD; Vachon, S	2003	14.67
36	DSS	216	A multi-objective optimization for green supply chain network design	Wang, F; Lai, X; Shi, N	2011	30.86
37	TRE	215	Green supply chain management implications for closing the loop	Zhu, QH; Sarkis, J; Lai, KH	2008	21.50
38	IJPE	212	Modeling carbon footprints across the supply chain	Sundarakani, B; de Souza, R; Goh, M; Wagner, SM; Manikandan, S	2010	26.50
39	SCMIJ	212	Corporate social responsibility in global supply chains	Andersen, M; Skjoett-Larsen, T	2009	23.56
40	TRE	209	Environmental purchasing and firm performance: an empirical investigation	Carter, CR; Kale, R; Grimm, CM	2000	11.61
41	JOM	203	Balancing priorities: decision making in sustainable supply chain management	Wu, Z; Pagell, M	2011	29
42	SCMIJ	201	Use the supply relationship to develop lean and green suppliers	Simpson, DE; Power, DF	2005	15.46
43	JCP	200	Integration of artificial neural network and MADA methods for green supplier selection	Kuo, RJ; Wang, YC; Tien, FC	2010	25.00
44	ESA	199	Supplier selection using fuzzy AHP and fuzzy multi-objective linear programming for developing low-carbon supply chain	Shaw, K; Shankar, R; Yadav, SS; Thakur, LS	2012	33.17
45	SCMIJ	199	Green supply chain management practices: impact on performance	Green, KW Jr.; Zelbst, PJ; Meacham, J; et al.	2012	33.17
46	SCMIJ	198	Drivers for the participation of small- and medium-sized suppliers in green supply chain initiatives	Lee, SY	2008	19.80
47	OIJMS	193	Firm-level correlates of emergent green supply chain management practices in the Chinese context	Zhu, QH; Sarkis, J; Cordeiro, JJ; Lai, KH	2008	19.30
48	SCMIJ	191	Making connections: a review of supply chain management sustainability literature	Ashby, A; Leat, M; Hudson-Smith, M	2012	31.83
49	JSCM	190	Corporate social responsibility reports: A thematic analysis related to supply chain management	Tate, WL; Ellram, LM; Kirchoff, JF	2010	23.75
50	POM	188	Drivers and Enablers That Foster Environmental Management Capabilities in Small- and Medium-Sized Suppliers in Supply Chains	Lee, SY; Klassen, RD	2008	18.80

Abbreviations available in Table 1 except for: *R* rank; *C/Y* citations per year; *JCP* Journal of Cleaner Production; *IJMR* International Journal of Management Reviews; *JOM* Journal of Operations Management; *IJPLDL* International Journal of Physical Distribution and Logistics Management; *IJOPM* International Journal of Operations and Production Management; *IJPE* International Journal of Production Economics; *JSCM* Journal of Supply Chain Management; *IJPR* International Journal of Production Research; *EJOR* European Journal of Operational Research; *MQ* MIS Quarterly; *TRE* Transportation Research Part E Logistics and Transportation Review; *ESA* Expert Systems with Applications; *POM* Production and Operations Management; *RCR* Resource Conversation and Recycling; *OIJMS* Omega International Journal of Management Science; *DSS* Decision Support Systems; *SCMIJ* Supply Chain Management: an International Journal; *M&SOM* Manufacturing & Service Operations Management; *JSCM* Journal of Supply Chain Management; *JEM* Journal of Environmental Management

Table 3 Most cited documents in GSC publications

R	Cited reference	Citations	TLS
1	Srivastava SK, 2007, Int J Manag Rev, v9, p53	388	381
2	Zhu QH, 2004, J Oper Manag, v22, p265	374	374
3	Seuring S, 2008, J Clean Prod, v16, p1699	348	346
4	Rao P, 2005, Int J Oper Prod Man, v25, p898	323	323
5	Vachon S, 2006, Int J Oper Prod man, v26, p795	242	241
6	Sarkis J, 2011, Int J Prod Econ, v130, p1	223	223
7	Sarkis J, 2003, J Clean Prod, v11, p397	220	219
8	Carter CR, 2008, Int J Phys Distr Log, v38	214	213
9	Vachon S, 2008, Int J Prod Econ, v111, p299	204	203
10	Zhu QH, 2005, Int J Oper Prod Man, v25, p449	203	203
11	Porter ME, 1995, Harvard Bus Rev, v73, p120	202	201
12	Hart Sl, 1995, Acad Manage Rev, v20, p986	200	200
13	Zhu QH, 2008, Int J Prod Econ, v111, p261	191	191
14	Bowen FE, 2001, Prod Oper Manag, v10, p174	187	187
15	Hervani AA, 2005, Benchmarking, v12, p330	170	170
16	LInton JD, 2007, J Oper Manag, v25, p1075	170	169
17	Kleindorfer PR, 2005, Prod Oper Manag, v14, p482	165	163
18	Zhu QH, 2006, J Clean Prod, v14, p472	158	158
19	Zhu QH, 2007, J Clean Prod, v15, p1041	156	156
20	Rao P, 2002, Int J Oper Prod Man, v22	154	154
21	Walker H, 2008, Journal Purchas Supply Manag, v14, p69	150	150
22	Min H, 2001, Int J Oper Prod Man, v21, p1222	139	138
23	Zhu QH, 2007, Int J Prod Res, v45, p4333	138	137
24	Klassen RD, 1996, Manage Sci, v42, p1199	125	125
25	Russo MV, 1997, Acad Manage J, v40, p534	123	123
26	Handfield R, 2002, Eur J Oper Res, v141, p70	121	120
27	Geffen CA, 2000, Int J Oper Prod Man, v20	120	120
28	King AA, 2001, Prod Oper Manag, v10, p244	120	120
29	Fornell C, 1981, J Marketing Res, v18, p39	117	116
30	ArmStrong JS, 1977, J Marketing Res, v14, p396	111	111

TLS Total link strength

Graphical analysis of GSC with VOS viewer

The previous part focused on general results concerning leading authors, institutions and countries in the field of GSC. It is also useful, however, to examine such outputs as co-citation and co-occurrence of keywords. To this end, this study uses VOS viewer software (Van Eck and Waltman 2010).

To show co-citation, that is, two journals cited by a third journal, Fig. 1 reports the results of journals with a threshold of 100 citations and of papers with the 100 most representative co-citation connections. As it can be seen, different clusters of journals are separated by distinct colors. The Journal of Cleaner Production is in the center of this figure being a leading journal with the highest number of citations received in this field. Besides, another interesting item is the form of the dispersion of the journals. Normally, the clusters are formed based on the common subjects in the same area and cite the journals that are in their area although there are some exceptions also.

To gain a deeper insight into the results presented in Fig. 1, Table 9 shows the 50 most cited journals. This report is divided into two classifications: global and periodic. The periodic analysis allowed us to study the effects and evolution of each of these journals.

Another noticeable item is the bibliographic coupling of institutions. Figure 2 presents a visual report of data involving at least 100 papers and 300 bibliographic coupling connections. In addition, this figure shows how each of the leading institutions is connected to the other institutions. To interpret this figure and justify the obtained result, two items are important: 1. the proximity of the universities either in the same country or in the same continent and 2. the nationality of the authors. As it can be seen, normally the collaboration occurs

Table 4 Citing article of GSC: journals

R	Journal	95–02	03–07	08–12	13–17	TP
1	J. of Cleaner Production	2	8	24	243	277
2	Int J. of Production Economics	–	3	38	91	132
3	Sustainability	–	–	–	74	74
4	Int J. of Production Research	–	6	20	46	72
5	Supply Chain Management an Int J.	–	2	15	29	46
6	Business Strategy and the environment	–	–	14	23	37
7	Transportation Research Part E Logistics and Transportation Review	1	1	10	23	35
8	Production Planning Control	–	–	6	25	31
9	Resources conservation and Recycling	–	–	10	21	31
10	Int J. of Physical Distribution Logistics Management	–	–	12	18	30
11	Computers & Industrial Engineering	–	–	3	26	29
12	Int J. of Operations Production Management	1	5	4	18	28
13	European J. of Operational Research	1	1	2	21	25
14	Industrial Management & Data Systems	1	–	4	15	20
15	Industrial Marketing Management	–	–	8	12	20
16	Expert Systems with Applications	–	–	9	9	18
17	Benchmarking an Int J.	–	–	–	17	17
18	Int J. of Logistics Management	–	–	4	12	16
19	J. of Purchasing and Supply Management	–	–	6	9	15
20	Int J. of Advanced Manufacturing Technology	–	–	2	11	13
21	OMEGA Int J. of Management Science	–	–	3	10	13
22	J. of Environmental Management	–	2	4	6	12
23	Renewable Sustainable Energy Reviews	–	–	–	12	12
24	Int J. of Logistics Research and Applications	–	–	4	7	11
25	J. of Supply Chain Management	–	–	3	8	11
26	Transportation Research Part D Transport and Environment	–	–	1	10	11
27	Int J. of Environmental Science and Technology	–	1	4	5	10
28	J. of Manufacturing Technology Management	–	–	–	10	10
29	Mathematical Problems in Engineering	–	–	–	10	10
30	Annals of Operations Research	–	–	–	9	9

Abbreviations available in Tables 1 and 2 except: 95–96, 97–01, 02–06, 07–11, 12–16—number of papers published in GSC in the 5-year period considered

between the universities that are in the same area or even those that have the same language. In addition, in many cases the authors of the universities do not have the same nationality as the university, and in some cases, it is observed that one author collaborates with a university from his nationality.

Figure 3 reports the type and level of co-authorship between authors who have published at least 80 papers. The lines between authors' labels show the co-authorship relationship. The more the lines there are, the higher the level of co-authorship. As it can be seen, among the clusters of this figure, there are three main clusters that their cores are the Sarkis, Govindan and Zhu that have the highest level of the co-authorship, respectively.

Figure 4 presents bibliographic coupling of countries that publish in GSC with a threshold of 50 papers. The size of the labels reflects the country's number of publications. The USA is the most productive country, and China and the UK (England, Scotland, Wales and North Ireland) are the second and third most productive countries. Also, the links among the countries demonstrate the level of collaboration that based on what said before about the institutions, usually this collaboration happens among the countries with geographical proximity or language proximity.

The last item in this analysis is the most common keywords used by authors publishing in the field of GSC. To obtain the pertinent results, a co-occurrence of author keywords should be developed. Figure 5 presents a visual report of keywords that appear 100 times or more, as well as the 300 most frequent co-occurrences. The most common keywords are sustainability, green supply chain management and supply chain management. Table 10 reports the results of Fig. 5. This table shows the 40 most common keywords in

Table 5 Citing articles of GSC: authors, universities and countries

R	Author	TP	Institution	TP	Country	TP
1	Sarkis J	3512	Clarck U.	3049	Peoples R China + Taiwan	3135
2	Zhu QH	2335	Hong Kong Polytechnic U.	2528	Peoples R China	2371
3	Seuring S	1862	Dalian U. Technology	2478	USA	2128
4	Lai KH	1706	U. Kassel	1879	UK	1186
5	Govindan K	1468	Western U. Western Ontario	1791	Taiwan	764
6	Klassen RD	1421	U. Southern Denmark	1514	Germany	695
7	Vachon S	1306	U. Montreal	895	India	684
8	Carter CR	1183	Worchester Polytechnic U.	803	Spain	659
9	Geng Y	848	Khalifa U. Science Technology	736	Italy	653
10	Pagell M	738	Erasmus U. Rotterdam	730	Australia	566
11	Diabat A	736	U. East Anglia	685	Canada	557
12	Wu ZH	667	National Cheng Kung U.	608	Malaysia	482
13	Kannan D	637	Aalborg U.	603	France	472
14	Searcy C	536	National Central U.	595	Iran	470
15	Lee SY	523	Chinese Academy of Sciences	569	The Netherlands	457
16	Gunasekaran A	511	U. Tennessee Knoxville	531	Brazil	428
17	Chan HK	509	U. Estadual Paulista	525	Turkey	364
18	Jabbour CJC	508	National Taipei U. Technology	522	Denmark	329
19	Tseng ML	480	Wageningen U. Research	515	Sweden	323
20	Buyukozkan G	468	U. Nova de Lisboa	499	South Korea	292
21	Sheu JB	424	National Taiwan U.	499	Finland	195
22	Tate WL	418	National Taiwan U. Science and Technology	486	Japan	183
23	Hsu CW	407	U. Teknologi Malaysia	482	Portugal	169
24	Jabbour ABLD	347	Cardiff U.	475	Belgium	160
25	Cruz-Machado V	345	Esade Business School	458	Greece	158
26	Azevedo SG	340	Lunghwa U. Sci Technology	442	Switzerland	156
27	Kuo TC	332	U. Bath	438	Norway	150
28	Bai CG	319	Chung Yuan Christian U.	429	Singapore	149
29	Koh SCL	313	National Tsing Hua U.	400	Poland	132
30	Carvalho H	312	U. Nottingham	386	New Zealand	114

Abbreviations are available in Tables 1 and 2

the field of GSC both globally and periodically. This figure and this table disclose one interesting result that during the years of this study, the interest to various keywords changes. In the other words, some keywords do not exist during the very first years of the analysis but in the next years gain importance and vice versa. In addition, the relationship among the keywords somehow shows the approach of the publications in this area.

Conclusions

This study presents a bibliometric overview of publications on GSC from 1995 until 2017. The study uses the WoS Core Collection database to analyze publications in the above-mentioned period. The results show a significant growth of publications on GSC during the years surveyed in this paper.

The work reports the leading institutions and countries of journals that have published papers on GSC. Although the USA is the most productive country, some Asian countries, especially China, are quickly improving their rankings. The most productive and influential institution is the Hong Kong Polytechnic University. To justify the rapid growth of countries' number of publications in GSC, there are many effective reasons such as economic, environmental and social (Lee et al. 2013). The companies found out that the key to improve the performance in various aspects is applying GSC practices, and from the other point of view, global and governmental obligations are the other items that can influence this item. During the years of the study, the developing countries including many Asian countries try to have a share in the studies around GSC from one side, and from the other side, their efforts are dedicated to improving the

Table 6 Most productive and influential institutions in GSC

R	Institution	Country	TP	TC	H	C/P	≥50	≥25	≥5	ARWU	QS	Top 50
1	Hong Kong Polytechnic U.	Peoples R China	60	4086	29	68.10	21	32	55	201–300	111	7
2	U. Southern Denmark	Denmark	53	2517	28	47.49	15	30	46	301–400	390	2
3	Dalian U. Technology	Peoples R China	37	5026	26	135.84	21	26	36	301–400	481–490	10
4	Clarck U.	USA	37	6172	31	166.81	29	34	37	601–700	471–480	12
5	Worcester Polytechnic Institute	USA	29	1029	16	35.48	4	10	22	701–800	601–650	1
6	U. Estadual Paulista	Brazil	26	678	13	26.08	3	8	21	–	–	–
7	Islamic Azad U.	Iran	23	321	10	13.96	1	3	18	–	–	–
8	U. Teknologi Malaysia	Malaysia	20	515	10	25.75	4	7	13	701–800	288	–
9	Wageningen U. Research	The Netherlands	20	547	10	27.35	2	5	14	–	119	1
10	National Kaohsiung U. Science Technology	Peoples R China	20	240	7	12.00	2	3	9	301–400	85	–
11	U. Tehran	Iran	19	413	10	21.74	3	7	12	301–400	551–600	–
12	Aalborg U.	Denmark	19	796	10	41.89	6	7	13	201–300	374	–
13	U. Nova de Lisboa	Portugal	18	638	12	35.44	4	9	15	501–600	366	–
14	U. Sheffield	UK	18	413	11	22.94	3	6	15	101–150	84	–
15	U. East Anglia	UK	18	767	13	42.61	4	10	16	301–400	252	–
16	U. Kassel	Germany	17	2463	11	144.88	7	10	12	–	–	3
17	Cranfield U.	UK	17	263	9	15.47	–	5	13	–	–	–
18	Lunghwa U. Science and Technology	People R China	16	529	11	33.06	3	6	15	–	–	–
19	Chinese Academy of Sciences	Peoples R China	16	697	11	43.56	7	9	12	–	–	–
20	National Taiwan U.	People R China	16	540	8	33.75	4	4	10	–	–	1
21	Dongebi U. Finance Economics	Peoples R China	16	298	8	18.63	2	5	11	–	–	–
22	Indian Institute of Technology Kharagpur	India	15	244	8	16.27	2	4	9	–	185	1
23	Khalifa U. Science Technology	United Arab Emirates	15	1014	14	67.60	6	12	15	–	401–410	1
24	U. Nottingham	UK	15	421	11	28.07	2	7	11	101–150	75	–
25	Western U. Western Ontario	Canada	15	2724	14	181.60	11	13	14	–	198	7
26	National Tsing Hua U.	Peoples R China	15	428	9	28.53	2	4	11	48	151	–
27	U. Padua	Italy	14	288	9	20.57	1	6	11	151–200	–	–
28	U. Montreal	Canada	14	1062	9	75.86	5	6	11	151–200	126	2
29	Esade Business School	Spain	14	530	9	37.86	3	8	12	–	–	–
30	U. Bath	UK	14	519	13	37.07	3	10	14	501–600	159	–
31	Polytechnic U. Milan	Italy	14	306	8	21.86	2	5	11	201–300	183	–
32	CNRS	France	13	158	7	12.15	1	4	11	–	–	–
33	U. Tennessee Knoxville	USA	13	580	10	44.62	2	5	12	201–300	461–470	2
34	Chung Yuan Christian U.	Peoples R China	13	477	8	36.69	4	5	11	201–300	–	–
35	U. Electronic Science Technology of China	Peoples R China	12	129	8	10.75	–	1	8	201–300	–	–
36	U. Sao Paulo	Brazil	12	307	8	25.58	2	4	9	151–200	120	–

Table 6 (continued)

R	Institution	Country	TP	TC	H	C/P	≥50	≥25	≥5	ARWU	QS	Top 50
37	National Central U.	Peoples R China	12	754	9	62.83	1	2	9	–	411–420	–
38	Lund U.	Sweden	12	109	6	9.08	–	2	8	101–150	73	–
39	Cardiff U.	UK	12	521	9	43.42	4	6	9	99	140	–
40	U. Leeds	UK	12	257	9	21.42	1	4	11	101–150	93	–
41	U. Beira Interior	Portugal	12	400	8	33.33	1	6	9	–	–	–
42	Erasmus U. Rotterdam	The Netherlands	12	769	9	64.08	4	7	9	101–150	183	1
43	U. Malaya	Malaysia	11	124	6	11.27	–	1	7	401–500	133	–
44	Tianjin U.	Peoples R China	11	121	5	11	–	2	6	301–400	481–490	–
45	National Taipei U. Technology	People R China	11	674	8	61.27	4	5	9	–	551–600	2
46	U. Sydney	Australia	11	263	8	23.91	2	4	9	83	46	–
47	U. Sains Malaysia	Malaysia	11	236	6	21.45	1	4	6	–	330	–
48	Ryerson U.	Canada	11	452	7	41.09	4	7	11	–	701	2
49	National Taiwan U. Science and Technology	People R China	11	532	8	48.36	3	5	11		243	1
50	U. Massachusetts Dartmouth	USA	11	363	10	33	2	7	11	–	–	–

Abbreviations are available in Tables 1 and 2 except: H—h-index; C/P—cites per year; ≥25—number of documents with equal or more than 25 citations; ARWU and QS—ranking in the general ARWU and QS U. rankings; top 50—paper among the fifty most cited publishes in GSC

situation of some less-studied industries in terms of green supply chain issue.

By using the VOS viewer software, the study considers co-citations, bibliographic coupling, co-authorship and the co-occurrence of keywords. The graphic results confirm the table's outputs. The most important benefit of using a graphical representation is the ability to show the various connections among variables.

Note that this work provides a general overview of the publication and citation structure of GSC by using a wide range of indicators including the total number of papers and citations, *h*-index, cites per paper and several citation thresholds. Based on this methodology, we comprehensively reviewed published articles to uncover prominent works. The study includes all published papers from different countries by all authors working in the field, so the results are as accurate and complete as possible. In addition, by analyzing approximately 1900 papers, this study has reviewed more papers relative to previous works.

The paper is very useful for policy-makers to understand the current trends in the field. Additionally, it is also very useful for PhD students and newcomers to get a quick overview of the current trends of the journal. Moreover, readers of the journal can complete their knowledge by reading these results. Usually, experts know well the field but it is very common that due to specialization, they do not know the whole field of the journal, and therefore, by reading this paper, they can complement and/or improve their knowledge very well.

This work aims to present the data from different perspectives, so each reader can understand the data according to his or her interests and priorities. Nevertheless, many limitations exist due to the wide range of issues surveyed in this work, such as the use of Web of Science and the future evolution of the reported results over time. However, the expectations of the authors about the trend of the publications in this area following the trends during the past years are incremental. Additionally, it is important to say that after studying the trends, it seems that Asian countries and specially China will experience a better ranking in the future in terms of the publications in this area.

Table 7 Most productive institutions in GSC throughout time

R	1995–2007			2008–2012			2013–2017		
	Institution	TP	TC	Institution	TP	TC	Institution	TP	TC
1	Clark U.	9	3133	Hong Kong Polytechnic U.	26	2840	U. Southern Denmark	51	2237
2	Dalian U. Technology	7	2454	Clarck U.	20	2598	Hong Kong Polytechnic U.	32	722
3	Western U. Western Ontario	6	1686	Dalian U. Technology	15	2108	Worcester Polytechnic Institute	29	1029
4	Clarckson U.	3	850	Chung Yuan Christian U.	9	327	Islamic Azad U.	23	321
5	Aristotle U. Thessaloniki	2	245	National Chiao Tung U.	8	538	U. Estadual Paulista	23	545
6	Asian Inst Management	2	955	National Tsing Hua U.	8	388	Aalborg U.	19	796
7	Erasmus U. Rotterdam	2	287	National Kaoshiung U. Science Technology	7	161	U. Tehran	18	336
8	U. Montreal	2	271	Erasmus U. Rotterdam	6	432	U. Teknologi Malaysia	17	255
9	Hong Kong Polytechnic U.	2	524	Galatasaray U.	6	556	Dongbei U. Finance and Economics	16	298
10	Kansas State U.	2	44	National Cheng Kung U.	6	409	Dalian U. Technology	15	464
11	Michigan State U.	2	142	National Taipei U Technology	6	460	Lunghwa U. Science and Technology	15	519
12	Norwegian U. Science and Technology	2	82	Wageningen U. Research	6	344	U. Sheffield	15	261
13	U. California Los Angles	2	208	Western U. Western Ontario	6	894	Indian Institute of Technology Kharagpur	14	187
14	U. Melbourne	2	355	Esade Business School	5	349	U. Nottingham	14	392
15	York U. Canada	2	46	U. Montreal	5	658	Wageningen U. Research	14	203
16	Austral U.	1	3	Monash U.	5	227	Chinese Academy of Science	13	611
17	California State U. Northridge	1	23	National Taiwan U.	5	199	Cranfield U.	13	178
18	Carnegie Mellon U.	1	300	Oregon State U.	5	756	Khalifa U. Science Technology	13	684
19	Chalmers U. Technology	1	257	U. Nova de Lisboa	5	368	National Kaoshiung U. Science Technology	13	79
20	Chung Hua U.	1	19	U. East Anglia	5	498	U. Nova de Lisboa	13	270

Table 8 Temporal evolution of the publications classified by countries

Total						1995–2002		2003–2007		2008–2012		2013–2017	
R	Country	TP	TC	H	C/P	TP	TC	TP	TC	TP	TC	TP	TC
1	China (Peoples R China + Taiwan)	467	14,732	60	31.55	–	–	11	3020	100	6289	356	5423
2	USA	381	20,445	73	53.66	7	854	24	5739	99	8882	251	4970
3	Peoples R China	323	10,003	46	30.97	–	–	7	2454	45	3578	271	3971
4	UK	257	6665	46	25.93	3	112	6	456	53	2889	195	3208
5	Taiwan	161	5454	40	33.88	–	–	4	566	58	3102	99	1786
6	India	141	4525	32	32.09	–	–	1	1079	10	737	130	2709
7	Italy	100	1897	27	18.97	–	–	1	76	12	525	87	1296
8	Germany	94	4134	29	43.98	–	–	2	162	17	2151	75	1821
9	Canada	92	6005	35	65.27	1	21	10	2110	21	2378	60	1496
10	Denmark	88	3415	31	38.81	–	–	–	–	6	527	82	2888
11	Iran	80	1614	21	20.18	–	–	–	–	3	124	77	1490
12	Spain	78	2050	25	26.28	–	–	2	157	22	1105	54	788
13	Brazil	75	1172	19	15.63	–	–	–	–	6	236	69	936
14	France	75	2063	23	27.51	–	–	1	569	7	481	64	978
15	Australia	72	2323	23	32.26	1	24	2	355	18	1194	51	750
16	The Netherlands	69	1851	23	26.83	2	287	4	110	14	716	49	738
17	Malaysia	66	1170	19	17.73	–	–	–	–	7	491	59	679
18	South Korea	45	1068	16	23.73	–	–	1	64	10	701	34	303

Table 8 continued

Total						1995–2002		2003–2007		2008–2012		2013–2017	
R	Country	TP	TC	H	C/P	TP	TC	TP	TC	TP	TC	TP	TC
19	Turkey	42	1282	18	30.52	–	–	–	–	14	930	28	352
20	Sweden	38	886	15	23.32	1	257	1	11	10	364	26	254
21	United Arab Emirates	35	2023	17	57.80	–	–	1	670	4	550	30	803
22	Portugal	28	729	14	26.04	–	–	–	–	5	368	23	361
23	Japan	26	479	9	18.42	–	–	2	173	4	156	20	150
24	Singapore	21	676	12	32.19	–	–	1	6	6	419	14	251
25	South Africa	21	205	6	9.762	–	–	1	50	2	91	18	64
26	Belgium	20	331	10	16.55	–	–	1	71	1	66	18	194
27	Finland	20	306	10	15.30	–	–	–	–	2	91	18	215
28	Greece	20	997	12	49.85	–	–	2	245	7	558	11	194
29	Ireland	20	627	13	31.35	–	–	–	–	4	156	16	462
30	Switzerland	18	587	11	32.61	–	–	–	–	4	324	14	263
31	Poland	17	240	8	14.12	–	–	1	50	2	66	14	124
32	Austria	16	160	8	10	–	–	–	–	–	–	16	160
33	New Zealand	16	246	7	15.38	–	–	–	–	5	183	11	63
34	Thailand	15	121	5	8.067	–	–	–	–	2	22	13	99
35	Lithuania	14	215	8	15.36	–	–	–	–	1	6	13	209
36	Norway	12	368	8	30.67	–	–	3	150	2	79	7	139
37	Indonesia	11	150	7	13.64	–	–	–	–	1	21	10	129
38	Philippines	9	1314	8	146	1	285	1	670	–	–	7	359
39	Chile	8	149	5	18.63	–	–	1	90	–	–	7	59
40	Colombia	8	107	6	13.38	–	–	–	–	–	–	8	107
41	Mexico	8	42	4	5.25	–	–	–	–	–	–	8	42

Abbreviations available in previous tables

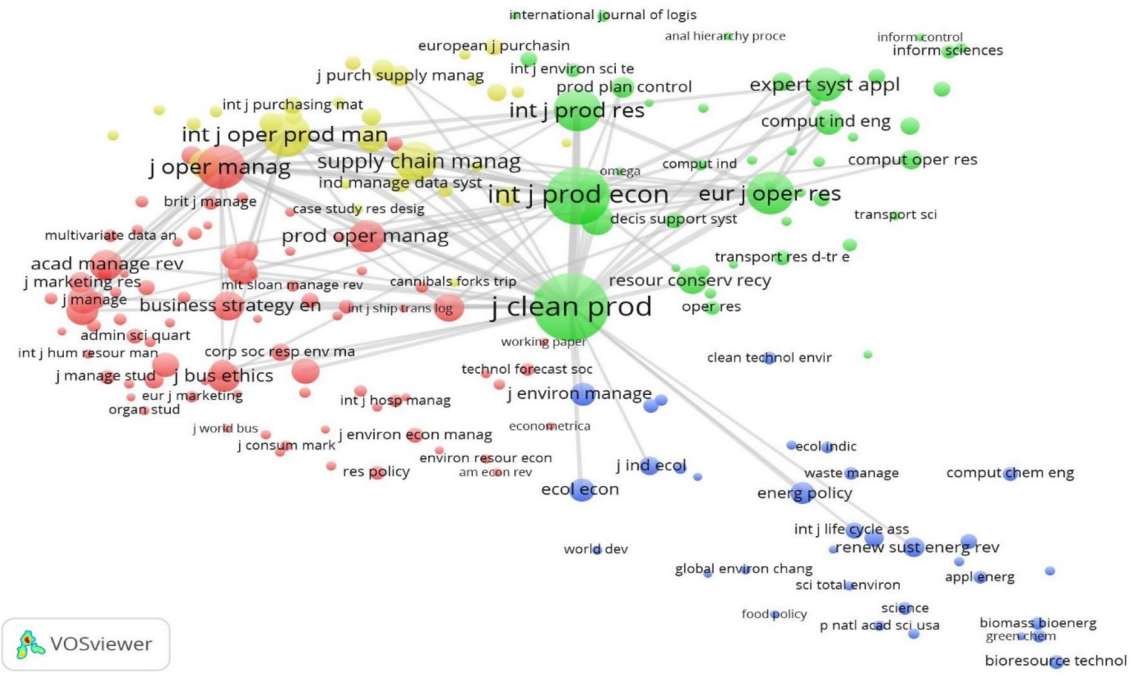


Fig. 1 Co-citation of journals cited in GSC

Table 9 Most cited journals in GSC

R	Journal	Global		1995–2007		2008–2012		2013–2017	
		Cit	CLS	Cit	CLS	Cit	CLS	Cit	CLS
1	J Clean Prod	7404	6060.33	50	44.06	792	696.01	6562	5317.81
2	Int J Prod Econ	5101	4511.32	25	22.93	590	526.98	4486	3959.63
3	Int J Oper Prod Man	2851	2641.03	81	75.12	629	581.71	2141	1983.8
4	J Oper Manag	2757	2552.53	75	69.24	619	568.44	2063	1913.74
5	Eur J Oper Res	2670	2394.66	66	57	335	301.26	2269	2037.31
6	Int J Prod Res	2635	2403.18	23	21.97	359	336.87	2253	2044.1
7	Supply Chain Manag	2116	1996.12	22	21.39	206	196.3	871	828.76
8	Expert Syst Appl	1476	1317.44	–	–	113	95.67	1363	1223.85
9	Prod Oper Manag	1463	1369.9	97	77.53	384	361.39	982	931.82
10	J Bus Ethics	1223	1136.93	–	–	179	168.03	1043	967.3
11	Transport Res E-log	1177	1125.83	14	13.88	185	178.48	978	933.78
12	Acad Manage Rev	1152	1105.6	35	33.96	329	313.39	788	757.99
13	Business Strategy En	1108	1040.57	60	43.28	316	294.9	732	702.35
14	Acad Manage J	1107	1051.94	54	50.24	299	282.03	754	719.32
15	J Supply Chain Manag	1083	1031.46	6	5.96	206	196.3	871	828.76
16	Strategic Manage J	1035	983.18	35	32.89	277	262.4	723	687.45
17	Manage Sci	1023	954.94	42	38.33	255	235.65	726	680.16
18	Int J Phys Distr Log	931	890.93	–	–	85	82.65	846	807.96
19	Harvard Bus Rev	913	885.71	60	56.94	250	239.18	603	589.54
20	Resour Conserv Recy	909	871.03	10	9.46	85	80.03	814	781.61
21	Omega-Int J Manage S	876	850.49	12	11.8	171	164.43	693	674.15
22	Bus Strateg Environ	804	765.62	–	–	93	88.43	709	674.67
23	Comput Ind Eng	786	750.35	16	15.34	113	103.57	657	631.08
24	J Marketing	707	655.42	16	15.81	174	161.47	517	477.55
25	Ecol Econ	682	646.76	4	3.93	89	82.95	589	558.03
26	Ind Market Manag	677	641.46	7	6.96	127	117.46	543	516.54
27	J Environ Manage	649	635.32	4	4	102	98.3	543	531.54
28	Energ Policy	588	527.73	–	–	62	53.2	525	472.59
29	Calif Manage Rev	544	533.64	49	46.71	170	166.41	325	320.9
30	J Bus Res	521	506.42	6	5.87	93	90.55	422	409.9
31	J Purch Supply Manag	516	500.87	–	–	19	18.86	497	481.91
32	J Business Logistics	509	496.06	23	20.54	142	137.48	344	338.18
33	J Marketing Res	503	491.52	10	9.8	119	116.09	374	365.5
34	Prod Plan Control	500	476.89	–	–	32	31.17	468	445.75
35	Int J Manag Rev	467	465.93	–	–	82	81.97	385	383.96
36	Comput Oper Res	462	439.81	–	–	55	53.75	404	383.41
37	Renew Sust Energ Rev	443	378.91	–	–	19	18.47	424	359.07
38	Int J Adv Manuf Tech	426	410.52	–	–	20	19.95	406	390.72
39	Decision Sci	420	413.54	30	29.22	99	98.05	291	286.31
40	Ind Manage Data Syst	418	409.69	–	–	59	57.31	358	351.32
41	J Ind Ecol	385	365.24	24	23.48	95	92.93	266	250.67
42	Benchmarking	378	370.67	–	–	56	55.7	322	314.95
43	Environ Sci Technol	378	326.63	8	7.6	56	47.78	314	270.46
44	J Manage	376	370.89	–	–	67	66.08	307	302.74
45	Greener Management I	370	357.53	36	34.12	171	162.55	163	161.19
46	Int J Logist Manag	362	353.64	7	7	63	60.88	292	285.81
47	J Acad Market Sci	355	340.24	–	–	60	57.76	293	280.34
48	Corp Soc Resp Env Ma	351	344.26	–	–	38	37.76	313	306.42
49	Appl Math Model	332	321.15	–	–	16	15.84	316	305.43

Table 9 (continued)

R	Journal	Global		1995–2007		2008–2012		2013–2017	
		Cit	CLS	Cit	CLS	Cit	CLS	Cit	CLS
50	Int J Purchasing Mat	330	323.13	36	33.99	113	109.96	181	179.21

R Rank; *Cit* total citations in CIE; *CLS* co-citation links

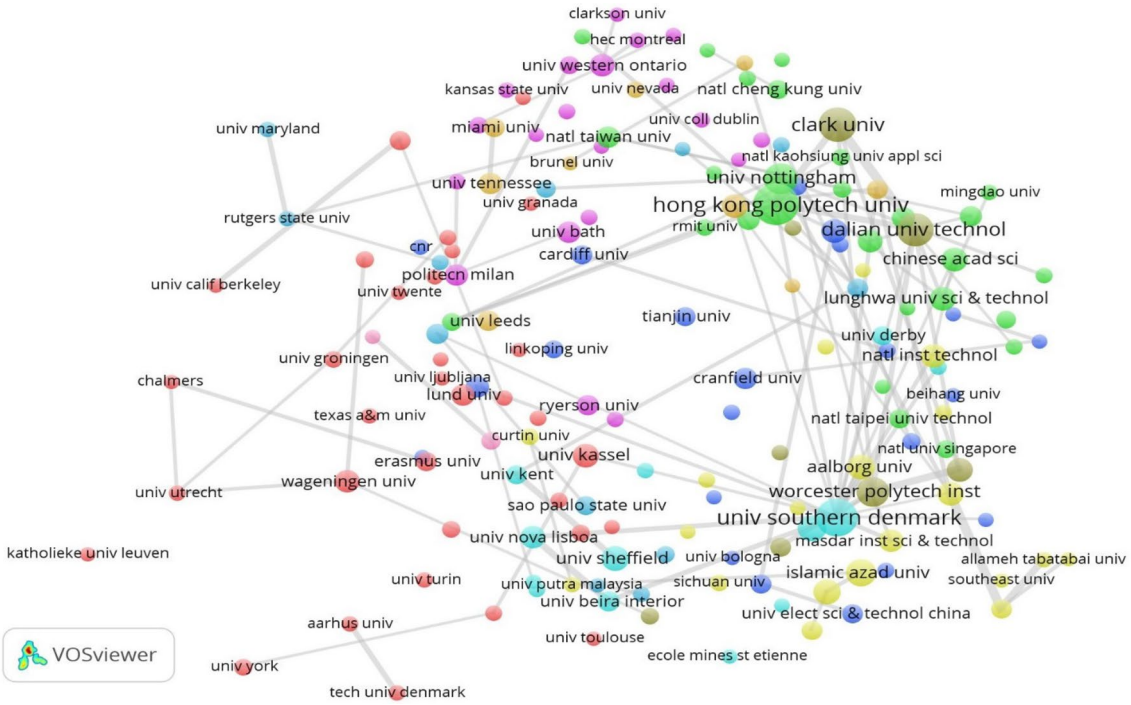


Fig. 2 Bibliographic coupling of institutions that publish in GSC

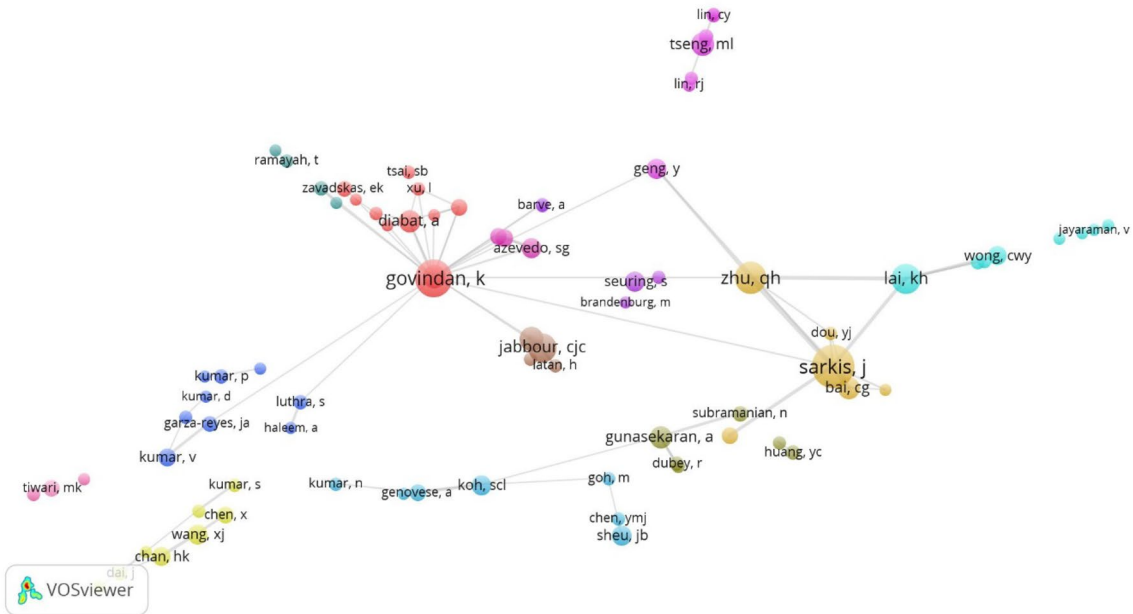


Fig. 3 Co-authorship of authors in GSC

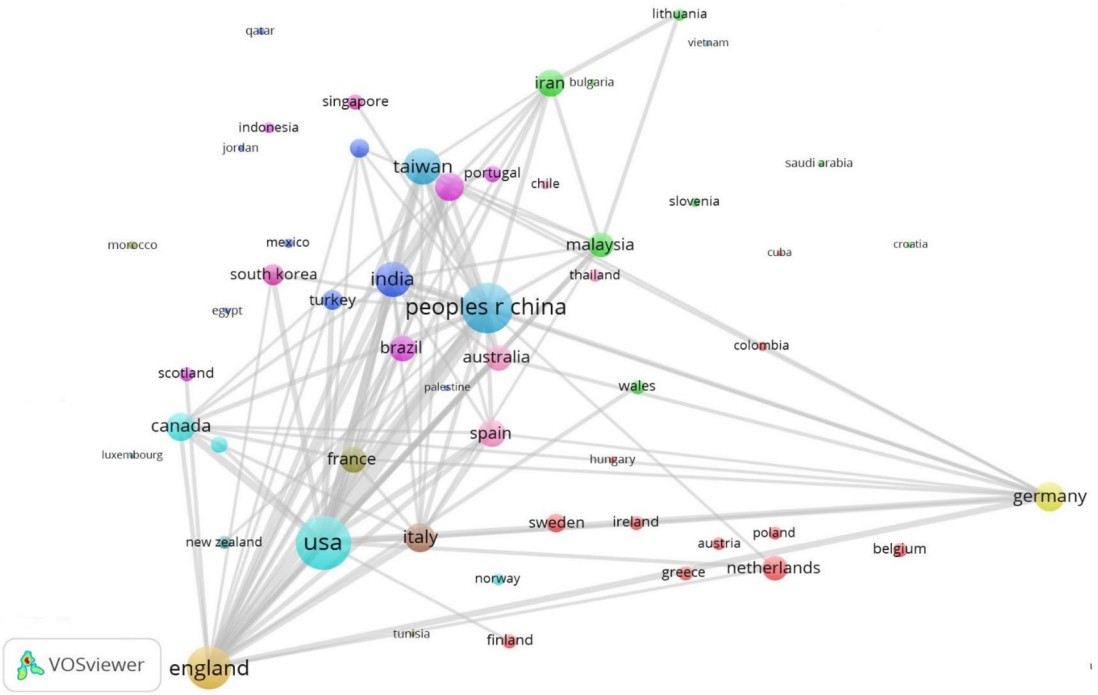


Fig. 4 Bibliographic coupling of countries that publish in GSC

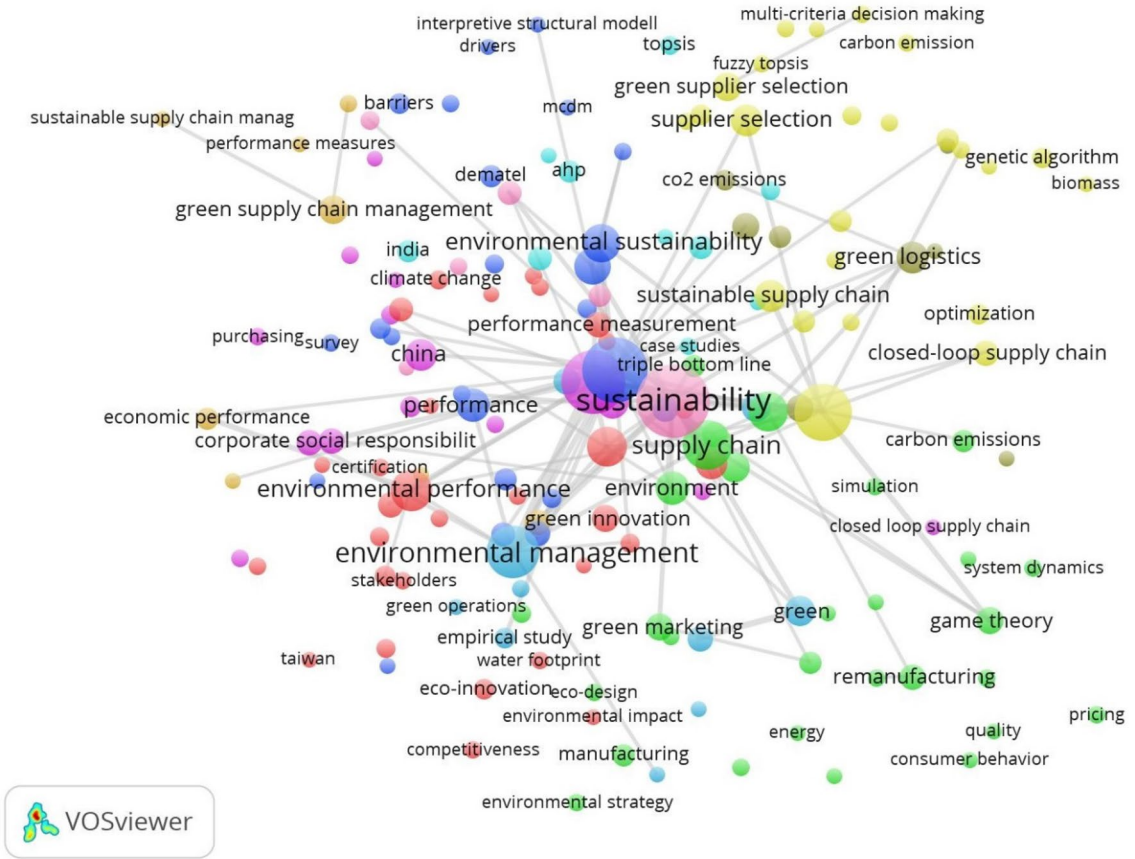


Fig. 5 Co-occurrence of author keywords of documents published in GSC

Table 10 Most common author keyword occurrences in GSC

R	Journal	Global		1995–2007		2008–2012		2013–2017	
		Oc	Co	Oc	Co	Oc	Co	Oc	Co
1	Sustainability	229	208	4	4	41	40	184	164
2	Green supply chain management	176	150	5	5	36	27	135	118
3	Supply chain management	165	146	15	15	52	46	98	85
4	Green supply chain	128	88	3	3	30	18	95	67
5	Environmental management	106	94	12	12	43	36	51	46
6	Supply chain	96	83	8	8	16	13	72	62
7	Environmental performance	62	55	3	3	14	12	45	40
8	Reverse logistics	56	51	3	3	16	14	37	34
9	Sustainable development	56	47	1	1	18	14	37	32
10	Environmental sustainability	52	43	1	1	5	3	46	39
11	Sustainable supply chain management	48	42	–	–	5	5	43	37
12	Environment	40	37	1	1	12	11	27	25
13	Performance	40	37	1	1	3	3	36	33
14	Life cycle assessment	37	29	2	2	9	7	26	20
15	Literature review	37	35	–	–	3	3	34	32
16	Supplier selection	37	30	–	–	8	7	29	23
17	Sustainable supply chain	37	36	–	–	3	2	34	34
18	China	35	26	2	2	11	7	22	17
19	Green logistic	34	29	0	0	11	8	23	21
20	Green	30	28	1	1	3	3	26	24
21	Green supply chains	30	25	–	–	3	2	27	23
22	Green supplier selection	29	20	–	–	2	–	27	20
23	Green supply chain management (gscm)	28	25	–	–	4	4	24	21
24	Case study	27	23	1	1	2	1	24	21
25	Logistics	26	24	1	1	5	5	20	18
26	Automotive industry	25	24	1	1	5	5	19	18
27	Green innovation	25	22	–	–	2	1	23	21
28	Carbon footprint	24	21	–	–	10	8	14	13
29	Game theory	24	22	–	–	3	3	21	19
30	Green marketing	24	20	3	3	7	7	14	10
31	Corporate social responsibility	23	22	–	–	8	8	15	14
32	Green manufacturing	23	22	1	1	3	2	19	19
33	Institutional theory	23	23	1	1	7	8	15	14
34	Sustainable operations	23	18	1	1	3	1	19	16
35	Performance measurement	22	21	–	–	4	4	18	17
36	Remanufacturing	22	19	–	–	6	4	16	15
37	Closed-loop supply chain	21	17	–	–	11	8	10	9
38	Firm performance	21	15	1	1	3	2	17	12
39	Innovation	21	19	1	1	3	2	17	16
40	Lean	21	21	–	–	1	1	20	20

R Rank; *Oc* author keyword occurrences; *Co* author keyword co-occurrences links

References

Ahi P, Searcy C (2013) A comparative literature analysis of definitions for green and sustainable supply chain management. J Clean Prod 52:329–341

Albort-Morant G, Henseler J, Leal-Millán A, Cepeda-Carrión G (2017) Mapping the field: a bibliometric analysis of green innovation. Sustainability 9:1011

Alfalla-Luque R, Medina-Lopez C (2009) Supply chain management: unheard of in the 1970s, core to today's company. Bus Hist 51:202–221

Alonso S, Cabrerizo FJ, Herrera-Viedma E, Herrera F (2009) h-Index: a review focused in its variants, computation and standardization for different scientific fields. J Informetr 3:273–289

Andrade A, Dominski FH, Coimbra DR (2017) Scientific production on indoor air quality of environments used for physical exercise and sports practice: bibliometric analysis. J Environ Manage 196:188–200

Beske-Janssen P, Johnson MP, Schaltegger S (2015) 20 years of performance measurement in sustainable supply chain management–what has been achieved? Supply Chain Manag 20:664–680

Blanco-Mesa F, Merigó JM, Gil-Lafuente AM (2017) Fuzzy decision making: A bibliometric-based review. J Intell Fuzzy Syst 32:2033–2050

Broadus R (1987) Toward a definition of "bibliometrics". Scientometrics 12:373–379

Cancino C, Merigó JM, Coronado F, Dessouky Y, Dessouky M (2017) Forty years of computers and industrial engineering: a bibliometric analysis. Comput Ind Eng 113:614–629

Carter CR, Rogers DS (2008) A framework of sustainable supply chain management: moving toward new theory. Int J Phys Distr Log 38:60–387

Chang PL, Hsieh PN (2008) Bibliometric overview of operations research/management science research in Asia. Asia Pac J Oper Res 25:217–241

Charvet FF, Cooper MC, Gardner JT (2008) The intellectual structure of the supply chain management: a bibliometric approach. J Bus Logist 29:47–53

Chen L, Zhao X, Tang O, Price L, Zhang S, Zhu W (2017) Supply chain collaboration for sustainability: a literature review and future research agenda. Int J Prod Econ 193:73–87

de Oliveira UR, Espindola LS, da Silva IR, da Silva IN, Rocha HM (2018) A systematic literature review on green supply chain management: research implications and future perspectives. J Clean Prod 187:537–561

Dragos CM, Dragos SL (2013) Bibliometric approach of factors affecting scientific productivity in environmental sciences and ecology. Sci Total Environ 449:184–188

Eltayeb TK, Zailani S, Ramayah T (2011) Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: investigating the outcomes. Resour Conserv Recycl 55:495–506

Fahimnia B, Sarkis J, Davarzani H (2015) Green supply chain management: a review and bibliometric analysis. Int J Prod Econ 162:101–114

Feng Y, Zhu Q, Lai KH (2017) Corporate social responsibility for supply chain management: a literature review and bibliometric analysis. J Clean Prod 158:296–307

Fu HZ, Wang MH, Ho YS (2013) Mapping of drinking water research: a bibliometric analysis of research output during 1992–2011. Sci Total Environ 443:757–765

Govindan K, Rajendran S, Sarkis J, Murugesan P (2015) Multi criteria decision making approaches for green supplier evaluation and selection: a literature review. J Clean Prod 98:66–83

Hassini E, Surti C, Searcy C (2012) A literature review and a case study of sustainable supply chains with a focus on metrics. Int J Prod Econ 140:69–82

Hirsch JE (2005) An index to quantify an individual's scientific research output. Proc Natl Acad Sci USA 102:16569–16572

Hood W, Wilson C (2001) The literature of bibliometrics, scientometrics, and informetrics. Scientometrics 52:291–314

Hsieh PN, Chang PL (2009) An assessment of world-wide research productivity in production and operations management. Int J Prod Econ 120:540–551

Hu J, Ma Y, Zhang L, Gan F, Ho YS (2010) A historical review and bibliometric analysis of research on lead in drinking water field from 1991 to 2007. Sci Total Environ 408:1738–1744

Ioana-Toroimac G (2018) Outcomes of the hydromorphology integration in the water framework directive: a review based on science mapping. J Environ Manage 206:1135–1144

Kainuma Y, Tawara N (2006) A multiple attribute utility theory approach to lean and green supply chain management. Int J Prod Econ 101:99–108

Kessler MM (1963) Bibliographic coupling between scientific papers. J Assoc Inf Sci Technol 14:10–25

Khan MA, Ho YS (2012) Top-cited articles in environmental sciences: merits and demerits of citation analysis. Sci Total Environ 431:122–127

Kumar S, Teichman S, Timpernagel T (2012) A green supply chain is a requirement for profitability. Int J Prod Res 50:1278–1296

Laengle S, Merigó JM, Miranda J, Słowiński R, Bomze I, Borgonovo E, Dyson RG, Oliveira JF, Teunter R (2017) Forty years of the European Journal of Operational Research: a bibliometric overview. Eur J Oper Res 262:803–816

Laengle S, Modak NM, Merigo JM, Zurita G (2018) Twenty-five years of group decision and negotiation: a bibliometric overview. Group Decis Negot 27:505–542

Lee SM, Sung Rha J, Choi D, Noh Y (2013) Pressures affecting green supply chain performance. Manage Decis 51:1753–1768

Martínez-López FJ, Merigó JM, Valenzuela-Fernández L, Nicolás C (2018) Fifty years of the European Journal of Marketing: a bibliometric analysis. Eur J Mark 52:439–468

Merigó JM, Yang JB (2017) A bibliometric analysis of operations research and management science. Omega 73:37–48

Merigó JM, Gil-Lafuente AM, Yager RR (2015) An overview of fuzzy research with bibliometric indicators. Appl Soft Comput 27:420–433

Merigó JM, Cancino CA, Coronado F, Urbano D (2016) Academic research in innovation: a country analysis. Scientometrics 108:559–593

Merigó JM, Pedrycz W, Weber R, de la Sotta C (2018) Fifty years of Information Sciences: A bibliometric overview. Inf Sci 432:245–268

Miemczyk J, Johnsen TE, Macquet M (2012) Sustainable purchasing and supply management: a structured literature review of definitions and measures at the dyad, chain and network levels. Supply Chain Manag 17:478–496

Mingers J, Xu F (2010) The drivers of citations in management science journals. Eur J Oper Res 205:422–430

Oliver RK, Webber MD (1982) Supply-chain management: logistics catches up with strategy. Outlook 5:42–47

Pilkington A, Liston-Heyes C (1999) Is production and operations management a discipline? A citation/co-citation study. Int J Oper Prod Man 19:7–20

Pritchard A (1969) Statistical bibliography or bibliometrics. J Doc 25:348–349

Rao P, Holt D (2005) Do green supply chains lead to competitiveness and economic performance? Int J Oper Prod Man 25:898–916

Sarkis J (2012) A boundaries and flows perspective of green supply chain management. Supply Chain Manag 17:202–216

Seuring S, Müller M (2008) From a literature review to a conceptual framework for sustainable supply chain management. J Clean Prod 16:1699–1710

Shiau WL, Dwivedi YK, Tsai CH (2015) Supply chain management: exploring the intellectual structure. Scientometrics 105:215–230

Small H (1973) Co-citation in the scientific literature: a new measure of the relationship between two documents. J Assoc Inf Sci Technol 24:265–269

Srivastava SK (2007) Green supply-chain management: a state-of-the-art literature review. Int J Manag Rev 9:53–80

Thomé AMT, Scavarda A, Ceryno PS, Remmen A (2016) Sustainable new product development: a longitudinal review. Clean Technol Environ Policy 18:2195–2208

Tiwari S, Wee HM, Daryanto Y (2018) Big data analytics in supply chain management between 2010 and 2016: insights to industries. Comput Ind Eng 115:319–330

Tseng ML, Tan K, Chiu AS (2016) Identifying the competitive determinants of firms' green supply chain capabilities under uncertainty. Clean Technol Environ Policy 18:1247–1262

Tsireme AI, Nikolaou EI, Georgantzis N, Tsagarakis KP (2012) The influence of environmental policy on the decisions of managers to adopt G-SCM practices. Clean Technol Environ Policy 14:953–964

Valenzuela LM, Merigó JM, Johnston WJ, Nicolas C, Jaramillo JF (2017) Thirty years of the Journal of Business & Industrial Marketing: a bibliometric analysis. J Bus Ind Mark 32:1–17

Van Eck NJ, Waltman L (2010) Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics 84:523–538

Wang Q, Yang Z, Yang Y, Long C, Li H (2014) A bibliometric analysis of research on the risk of engineering nanomaterials during 1999–2012. Sci Total Environ 473:483–489

Wang W, Laengle S, Merigó JM, Yu D, Herrera-Viedma E, Cobo MJ, Bouchon-Meunier B (2018) A bibliometric analysis of the first twenty-five years of the International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems. Int J Uncertain Fuzziness Knowl Based Syst 26:169–193

White HD, McCain K (1989) Bibliometrics. Ann Rev Inf Sci Technol 24:119–186

White L, Smith H, Currie C (2011) OR in developing countries: a review. Eur J Oper Res 208:1–11

Wong C, Skipworth H, Godsell J, Achimugu N (2012) Towards a theory of supply chain alignment enablers: a systematic literature review. Supply Chain Manag 17:419–437

Zhao L, Deng J, Sun P, Liu J, Ji Y, Nakada N, Yang Y (2018) Nanomaterials for treating emerging contaminants in water by adsorption and photocatalysis: systematic review and bibliometric analysis. Sci Total Environ 627:1253–1263

Affiliations

Keivan Amirbagheri[1] · Ana Núñez-Carballosa[1] · Laura Guitart-Tarrés[1] · José M. Merigó[2,3]

[1] Department of Economics and Business, Faculty of Economics and Business, University of Barcelona, Av. Diagonal 690, 08034 Barcelona, Spain

[2] Department of Management Control and Information Systems, School of Economics and Business, University of Chile, Av. Diagonal Paraguay 257, 8330015 Santiago, Chile

[3] School of Information, Systems and Modelling, Faculty of Engineering and Information Technology, University of Technology Sydney, 81 Broadway, Ultimo, NSW 2007, Australia