Mapping the Knowledge Base of Sustainable Supply Chain Management: A Bibliometric Literature Review

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Abstract: Supply chain management (SCM) concerns itself with the integration of a firm’s internal management processes with the external environment. This could explain why sustainability has been embraced by scholars who study SCM. This bibliometric review was undertaken with the explicit goals of updating and extending prior reviews of research on sustainable SCM (S-SCM). The goals of this research were to document the scope and development of S-SCM research; identify influential journals, authors, and documents; analyze the intellectual structure of this field of sustainability inquiry, and highlight emerging topics on the frontier of S-SCM inquiry. By using bibliometric tools, a relatively large and rapidly growing corpus of peer-reviewed research documents concerned with S-SCM were found. Citation analyses of journals, authors, and documents yielded a surprisingly high level of scholarly content for a literature body of such recent vintage. The author co-citation analysis revealed three coherent but closely connected groups of thought that comprise the intellectual structure of this knowledge base. Finally, the analysis identified a constellation of topics concerned with the integration of internal processes (e.g., decision-making, manufacturing, sensitivity analysis, risk assessment, life-cycle assessment) and the organizational environment (e.g., climate change, gas emissions, carbon emissions, greenhouse gases, energy utilization, climate change). The results of this research concluded that SCM practitioners and scholars may have embraced sustainability more than any other field of management.

Keywords: sustainable supply chain management; supply chain development; science mapping; bibliometric review; systematic review of research

1. Introduction

Over the last six decades, management scholars have investigated various supply chain management (SCM) models [1–6]. Precursors of SCM can be traced back to the 1950s, when scholars inquired into methods by which manufacturers could reduce costs associated with sourcing materials and production [6]. Operational SCM is commonly explained and evaluated in terms of its effects on internal organizational procedures, including methods by which to minimize production costs and ensure speedy delivery and those that foster flexibility and superior service [1,2,4,5,7–10]. Over the course of the ensuing decades, SCM has evolved into one of the most commonly studied domains of management practice [5].

A key development in the evolution of SCM has been a focus on “sustainability” in business and society [1,9,11,12]. This focus has prompted management practitioners and scholars to inquire into how SCM could contribute to waste reduction, more efficient resource use, energy conservation, and fewer detrimental environmental effects [5,9,11–15]. This has led to the emergence of a growing...
subfield of SCM known as sustainable supply chain management (S-SCM) [2,5,7,11,14–22]. Indeed, the field has grown so rapidly since the turn of the 21st century that several scholars have conducted bibliometric reviews of prior research [1–4]. Based on their contributions, this research continued to examine S-SCM research which was published between 1995 and the end of July 2019 and kept updating prior reviews as well as in order to fill in gaps in our understanding of the evolution of this field of sustainability management. Four research questions (RQs) are addressed in this research and listed as follows.

RQ1: What have been the volume, publication growth, and global distribution of the S-SCM literature?
RQ2: What journals, documents, and authors have had the greatest impact on the S-SCM literature?
RQ3: What is the intellectual structure of the S-SCM knowledge base during its growth since the 1990s?
RQ4: What topics have emerged in the S-SCM literature?

The science mapping [23–26] was applied to analyze 2358 S-SCM papers, as sourced from the Scopus database. Additionally, quantitative data analyses were employed to describe and synthesize trends within the S-SCM literature in this research.

2. Conceptual Background

The Council of Supply Chain Management Professionals (CSCMP) has defined SCM as encompassing “the planning and management of all activities in sourcing and procurement, conversion and all logistics management activities” [6]. Some researchers supplement this definition by referencing information systems or flows used to monitor and manage all the activities that link suppliers, industries, and users [27–30].

Within an increasingly globalized economy, logistics and SCM have become increasingly complex [1,2,5,31–36]; it therefore stands to reason that, in recent years, S-SCM has attracted the interest of many scholars and practitioners alike [37–40]. Several bibliometric reviews of the S-SCM literature have been conducted (Table 1) with the goal of gaining perspective on the development of this topic [1,2,4]. Before describing the current review, it is important to establish the nature of these prior efforts and identify the value that this review adds to the literature.

The aforementioned research spans the period that extends as far back as 1992 [2] and leads up to 2016 [4]. Within these reviews, the number of documents (as per Scopus and Web of Science) and the size of the document review datasets ranged from 180 [2] to 884 [3]. The objectives and foci of this research include the identification of key topics, research methods, the citation impact of certain authors and journals, examinations of definitions of related constructs (e.g., green supply chain, sustainable supply chain), and analyses of key dimensions of this literature (Table 1).

Bibliometric analysis is a popular and effective method applied to recognize research trends and popular issues based on historic publications, and it has been used in many disciplines of science and engineering [41]. This analysis method mainly focuses on the frequency of keywords, number of publication outputs from countries, research institutes, journals, and subject categories; however, this method cannot completely specify the development trends within a research field [42]. In recent years, many methods and tools have been used in bibliometric analysis, such as social network analysis tools and impact factors [43,44].

As indicated in our RQs and discussed in subsequent sections, the current review updates these prior efforts in several respects. Firstly, the current review covers a longer period (i.e., up to and including 2019). Secondly, we analyze a much larger set of S-SCM documents (n = 2358). Thirdly, we employ bibliometric software (i.e., VOSviewer) which has multiple data synthesis capabilities that go beyond those of MS Excel. Finally, the foci of this review overlap but also extend those of prior bibliometric reviews of the S-SCM literature.
Table 1. Analysis of past bibliometric reviews of research on sustainable supply chain management.

| Author | Seuring and Muller (2008) [1] | Ahi and Searcy (2013) [2] | Fahimnia, Sarkis, and Davarzani [3] | Ansari and Kant (2017) [4] |
|--------|-------------------------------|--------------------------|-----------------------------------|---------------------------|
| Title  | From a literature review to a conceptual framework for sustainable supply chain management | A comparative literature analysis of definitions for green and sustainable supply chain management | Green supply chain management: A review and bibliometric analysis | A state-of-the-art literature review reflecting 15 years of focus on sustainable supply chain management |
| n      | 191                           | 180                      | 884                               | 286                       |
| Source | Mixed sources                | Scopus                   | Scopus                            | Scopus                    |
| Objectives | Analyze and identify methods, approaches, dimensions | Identify and analyze definitions of green SCM and sustainable SCM | Analyze and identify dimensions of green SCM | Data analysis techniques, type of industry, and geography |
| Timeframe | 1994–2007                    | 1992–2012               | 1992–2013                         | 2002–2016                 |
| Focus | Sustainable supply chain management | Green SCM Sustainable supply chain management | Green SCM Sustainable supply chain management | Sustainable supply chain management |
| Search Keywords | Sustainability; supply chain management | Green supply chain management; sustainable supply chain management | Green supply chain management; Environmental sustainability | Sustainable supply chain |
| Software | Excel                        | Excel                    | BibExcel; PageRank; Gephi         | Excel                     |
| Analytical Foci | Journals, methods, dimensions of sustainability | Definitions, journals, sustainability characteristics | Journals, analysis techniques | Journals, research methods, analysis techniques |
3. Method and Materials

Bibliometric reviews of research have capitalized on advances in text mining and “big data” approaches to information management [23,24,26]. This has led to the emergence of a new branch of research review that seeks to describe the status and evolution of the knowledge base in different research domains [45–47]. Science mapping methods that draw on bibliometric analysis guide the current review.

3.1. Search Criteria and Identification of Sources

To source documents for this review, we drew on the Scopus database, which offers the most extensive array of relevant peer-reviewed journals and other documents covering the management domains; additionally, it can export bibliographic data on selected documents [24,48,49]. Additionally, this research focuses on peer-reviewed journal articles, given their more consistent and rigorous review process relative to books, chapters, and conference papers. The timeframe for the document search was open-ended with respect to the start date and continued up until the end of July 2020. The first relevant article identified in the search was published in 1995 [50].

The authors followed the protocols of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [51] in establishing the search procedures (Figure 1). The keywords used in the first search were TITLE-ABS-KEY (“sustainable development and supply chain”) OR TITLE-ABS-KEY (“sustainability in supply chain”). A supplementary search was conducted using the search terms TITLE-ABS-KEY (“sustainable supply chain”) AND TITLE-ABS-KEY (“sustainable supply chain management”). These search results uncovered 9643 journal articles.

Subsequently, the authors applied a combination of Scopus filters and screening of article abstracts to identify relevant documents. The most frequent cause of rejection of articles was a primary focus on supply chain management, in which sustainability was mentioned as a secondary consideration. As indicated in Figure 1, after excluding these documents, there were 2358 eligible articles remaining in the review database.

3.2. Data Extraction and Analysis

Metadata related to the S-SCM-related journal articles were exported from Scopus. These included a variety of publication data, including citations. Bibliometric analyses were run through the use of a variety of software packages, including Scopus analyses, MS Excel, and VOSviewer [23]. Analyses aimed at answering RQ1—which concerns trends in the S-SCM literature—and these too were conducted with Scopus tools and MS Excel.

We undertook citation and co-citation analyses in VOSviewer to assess the scholarly impact of journals, authors, and documents within the S-SCM literature. In the current review, “Scopus citation” metrics refer to citations of journals, authors, or documents located in the review dataset by other documents indexed in Scopus. “Co-citation” refers to the frequency with which two authors
(or documents or journals) appear together in the reference lists of articles in our S-SCM review dataset [23,24]. Author co-citation analysis (ACA) has also been used as a means of uncovering the “intellectual structure” or dominant theoretical strands that comprise a body of knowledge; this constitutes the focus of RQ3 [25,26].

RQ4 concerns the topics that have been studied in the S-SCM literature, and these too were analyzed with VOSviewer. In this case, keyword co-occurrence analysis was used to identify frequently co-occurring keywords. This analysis initially allowed us to identify the most frequently occurring keywords. The temporal analysis of keywords was used to identify topics concentrated in the most recent years of the review [24].

4. Results

4.1. Descriptive Analysis of the S-SCM Literature

In the Scopus database, 2358 journal articles indexed for “sustainable supply chain management” were found in this research. This sample constitutes a larger dataset than had been identified in previous reviews of this knowledge base (Table 2). Explanations for this large discrepancy emerged in subsequent analyses.

| Rank | Country     | Documents | Citations | Total Link Strength |
|------|-------------|-----------|-----------|--------------------|
| 1    | United States | 396       | 13,496    | 6763               |
| 2    | United Kingdom | 396       | 8161      | 6248               |
| 3    | Germany      | 184       | 6789      | 3676               |
| 4    | Canada       | 101       | 5400      | 3092               |
| 5    | China        | 346       | 5246      | 4518               |
| 6    | Italy        | 178       | 2676      | 1723               |
| 7    | Netherlands  | 104       | 2625      | 992                |
| 8    | Denmark      | 76        | 2624      | 2061               |
| 9    | India        | 196       | 2442      | 4237               |
| 10   | France       | 125       | 2112      | 1995               |
| 11   | Australia    | 107       | 1977      | 1566               |
| 12   | Spain        | 86        | 1815      | 1344               |
| 13   | Hong Kong    | 52        | 1671      | 688                |
| 14   | Iran         | 97        | 1365      | 1398               |
| 15   | Taiwan       | 61        | 1268      | 948                |
| 16   | Malaysia     | 80        | 1218      | 1112               |
| 17   | Sweden       | 88        | 1172      | 596                |
| 18   | Brazil       | 88        | 931       | 1148               |
| 19   | Greece       | 27        | 888       | 297                |
| 20   | Switzerland  | 38        | 785       | 618                |

Next, we analyzed the growth trend in S-SCM publications from several perspectives (Figures 2 and 3). Firstly, the long-tailed distribution in Figure 2 supports the conclusion that, after a 15-year period of slow growth in the 1990s and 2000s, this body of literature experienced an explosion of activity; indeed, 93% of the collected literature was published after 2010 and 65% of it between 2016 and 2018. This reflects a remarkable increase in interest in S-SCM topics and explains, to some extent, the difference in size between our dataset and those featured in prior bibliometric reviews of the S-SCM literature [1,24].

Disaggregation of the growth trajectory by geographical location of the first author of these publications revealed unexpected trends. Specifically, scholars located in Europe and Asia accounted for the largest proportion of journal publications in this field, followed by scholars in North America.
To gain further insights into the sources of S-SCM scholarship, we identified the countries from which the most relevant scholarship has been published (Table 2).

Table 2 shows that the United States and United Kingdom are the leading producers of S-SCM knowledge. This is no surprise, given the predominance of their scholars in the broader management literature. These two countries also account for the largest number of citations.

Table 2 does, however, hold two surprises. Firstly, we did not expect to find China and India positioned solidly among the top 10 producers of S-SCM publications. This finding runs counter to the broader publication trends in the management field, which is dominated by North American and European scholarship [1–4]. Secondly, although the data are consistent with the trends that Figure 2 reports, we were surprised by the dominance of European countries—six of which (i.e., Germany, Italy, Netherlands, France, Sweden, and Spain) are found within the top 10.

Given the urgency of addressing sustainability issues in developing economies, we undertook an additional analysis of the growth trajectory, with the goal of identifying the proportion of S-SCM publications that had been authored outside of developed economies (Figure 3). Consistent with
the data in Table 1, we found that, although this literature is led by scholars in developed countries, there is a rapidly growing corpus of research that examines S-SCM from the perspectives of authors in developing economies. Nonetheless, emerging economies (represented by countries transitioning to a free market-oriented economy) were at the lowest level and are the slowest-growing contributors to the S-SCM literature.

4.2. Analysis of Journals, Authors, and Documents

Our next set of analyses sought to go beyond a description of broad publication trends to gain insights into the influential sources and documents that comprise the S-SCM literature. Thus, to address RQ2, we empirically analyzed influential journals, authors, and documents in terms of both frequency and citation impact and ranked them accordingly. As noted, we assessed citation impact by employing both citation and co-citation analysis.

4.2.1. Analysis of Influential Journals

The status of journals that publish S-SCM scholarship was analyzed by using a combination of frequency and citation analyses (Table 3). For both criteria, the Journal of Cleaner Production is the clear center of knowledge production in this field, with 660 published articles that accrued 15,563 citations; this was followed by the International Journal of Production Economics (164 documents and 8028 citations). Table 3 shows that these journals have contributed significantly to progress in the field of S-SCM.

Table 3. Top 20 Scopus-indexed journals on sustainable supply chain management.

| Rank | Journal (Scopus Domain) | Documents | SCOPUS Citations | Scopus Quartile | CPD ² |
|------|-------------------------|-----------|-----------------|----------------|-------|
| 1    | Journal of Cleaner Production (Bus and Env) | 660       | 15,563          | Q1             | 23.58 |
| 2    | International Jnl of Production Economics (Bus and Econ) | 164       | 8028            | Q1             | 48.95 |
| 3    | Supply Chain Management (Bus and Env) | 77        | 4747            | Q1             | 61.65 |
| 4    | International Jnl of Production Research (Bus and Man) | 119       | 2952            | Q1             | 24.81 |
| 5    | Intl Jnl of Operations & Prod Man (Bus and Man) | 36        | 2489            | Q1             | 69.14 |
| 6    | Journal of Supply Chain Management (Bus and Man) | 21        | 2242            | Q1             | 106.76|
| 7    | European Jnl of Operations Research (Bus and Dec Sci) | 41        | 2207            | Q1             | 53.83 |
| 8    | Resources, Conservation and Recycling (Bus and Env) | 96        | 1678            | Q1             | 17.48 |
| 9    | Business Strategy and the Environment (Bus and Env) | 65        | 1517            | Q1             | 23.34 |
| 10   | Sustainability (Switzerland) (Env) | 337       | 1289            | Q2             | 3.82  |
| 11   | Journal of Purchasing & Supply Man (Bus and Man) | 15        | 917             | Q1             | 61.13 |
| 12   | Production Planning and Control (Bus and Dec Sci) | 47        | 823             | Q1             | 17.51 |
| 13   | Supply Chain Management (Bus and Man) | 7         | 623             | Q3             | 89.00 |
| 14   | Sustainable Development (Env and Society) | 30        | 438             | Q1             | 14.60 |
| 15   | Intl Jnl of Productivity & Performance Man (Bus and Man) | 13        | 250             | Q1             | 19.23 |
| 16   | European Management Journal (Bus and Man) | 5         | 244             | Q1             | 48.80 |
| 17   | Business Process Management Journal (Bus and Man) | 7         | 238             | Q1             | 34.00 |
| 18   | Intl Jnl of Logistics Systems & Management (Bus and Man) | 28        | 234             | Q2             | 8.36  |
| 19   | Intl Jnl of Logistics Management (Bus and Man) | 20        | 207             | Q1             | 10.35 |
| 20   | Intl Jnl of Logistics Res & Applications (Bus and Man) | 20        | 200             | Q1             | 10.00 |

1 Domains: Bus = Business; Man = Management; Env = Environment; Dec Sci = Decision Science. ² CPD = citations per document.

From the list of journals in Table 3, one can see that the topic of S-SCM was represented from a variety of perspectives, including SCM, business strategy, production, operation management, environmental management, logistics, and supply chains; in this sense, we can clearly see the interdisciplinary nature of SCM. On account of their combination of publication volume and citation impact, other journals are making notable contributions to the literature as well; these include Supply Chain Management, International Journal of Production Research, Resources, Conservation and Recycling, and Business Strategy and the Environment. Sustainability also deserves mention, as it held second place in terms of frequency of publication, despite having a relatively low rate of citations per document.
Another notable finding in Table 3 was that including the breadth of journal coverage, high citation impact, and journal quality. These journals published over 95% of the documents in our review dataset; this reflects a high concentration of publications from a rather narrow set of sources. Nonetheless, the journals listed in Table 3 cut across various subject areas, including business, the environment, and decision science. What is especially noteworthy is that such a high proportion of this Scopus-indexed literature is concentrated in first and second-quartile journals. This speaks well of the quality of this literature. Given that most of this literature has been published in the most recent decade, it is similarly noteworthy that it has accrued so many citations. It should be clarified that the citations associated with these journals are exclusively citations gained from the documents in the review dataset.

4.2.2. Analysis of Influential Authors

Our next set of analyses sought to identify the scholars who have made signal contributions to the launch and development of this knowledge base. Author citation analysis has been used in science mapping for highlighting thought leaders within a field of inquiry and revealing the conceptual pillars of that field [24,26]. These analyses—including those of frequency, citation, and co-citation—were designed to extend the findings of Fahimnia et al. [3].

Table 4 presents the most productive and influential authors conducting research on S-SCM. The most productive scholars in this field have been Sarkis, Govindan, Seuring, Gunasekaran, Tseng, Mangla, Zhu, Luthra, Zhang (Y.), and Dubey, each of whom has 10 or more publications. This list aligns with the broader distribution of S-SCM scholarship, wherein the most productive scholars come from Europe, North America, and Asia.

Table 4. Top 20 most highly cited authors on sustainable supply chain management by Scopus citations, 1995–2020.

| Rank | Author     | Nation | Topical Focus           | Documents | Scopus Citations | Citations per Document |
|------|------------|--------|-------------------------|-----------|------------------|------------------------|
| 1    | Sarkis J.  | USA    | Sustainable supply chain| 49        | 4085             | 83.4                   |
| 2    | Seuring S. | DEU    | Sustainable supply chain| 32        | 4070             | 127.2                  |
| 3    | Müller M.  | DEU    | Sustainable supply chain| 5         | 2223             | 444.6                  |
| 4    | Govindan K.| DNK    | Supply chain performance| 34        | 1957             | 57.6                   |
| 5    | Zhu Q.     | CHN    | Supply chain performance| 14        | 1762             | 125.9                  |
| 6    | Pagell M.  | CAN    | Sustainable supply chain| 8         | 1129             | 141.1                  |
| 7    | Gunasekaran A.| USA    | Green supply chain      | 27        | 1085             | 40.2                   |
| 8    | Vachon S.  | CAN    | Sustainable supply chain| 5         | 992              | 198.4                  |
| 9    | Wu Z.      | USA    | Sustainable supply chain| 7         | 933              | 133.3                  |
| 10   | Searcy C.  | CAN    | Sustainable supply chain| 6         | 915              | 152.5                  |
| 11   | Walker H.  | GBR    | Green supply chain      | 6         | 800              | 133.3                  |
| 12   | Bai C.     | CHN    | Sustainable supply chain| 11        | 665              | 60.5                   |
| 13   | Zailani S. | MYS    | Green supply chain      | 5         | 533              | 106.6                  |
| 14   | Diabat A.  | ARE    | Sustainable supply chain| 8         | 510              | 63.8                   |
| 15   | Huisingsh D.| USA    | Sustainable supply chain| 8         | 448              | 56.0                   |
| 16   | Tseng M.-L.| TWN    | Green supply chain      | 24        | 438              | 18.3                   |
| 17   | Mangla S.K.| IND    | Green supply chain      | 24        | 437              | 18.2                   |
| 18   | Luthra S.  | IND    | Supply chain performance| 18        | 434              | 24.1                   |
| 19   | Papadopoulos T.| GBR    | Green supply chain      | 11        | 430              | 39.1                   |
| 20   | Fahimnia B.| AUS    | Supply chain performance| 7         | 423              | 60.4                   |

Note: Minimum of 4 authored documents on S-SCM. \(^1\) CPD = citations per document.

Our analysis complements scholarly productivity (i.e., number of articles) in tandem with the analysis of Scopus citation impact. First, the extremely strong scholarly impact that these Scopus citation statistics suggest was highlighted. These raw Scopus citation and citations per document statistics are very large in comparison to those studying sustainability in other fields of management (e.g., Hallinger and Suriyankietkaew [52]). Second, this level of citation impact is impressive given just how recently the literature has been published, as it typically takes time for citations to accumulate. This high level of citation impact could be attributable to the fact that S-SCM has been embraced...
by some of the leaders in the broader field of SCM. This quality contrasts, for example, with that in leadership studies, where a relatively small number of influential leadership scholars have chosen to focus on sustainability.

The analytical strategy in the next step was to undertake ACA. As mentioned, ACA examines the reference lists of documents in a dataset and in this way is able to capture authors from the broader bodies of management and sustainability literature. Scientometric scholars assert that ACA offers a useful complementary perspective on scholarly impact [24,26]. The results of the ACA are presented in Table 5.

Table 5. High impact scholars in the field of sustainable supply chain management based on author co-citations.

| Rank | Author       | Nation | Topical Focus                  | Co-Citations | Total Link Strength |
|------|--------------|--------|--------------------------------|---------------|---------------------|
| 1    | * Sarkis J.  | USA    | Sustainable supply chain       | 3365          | 323,032             |
| 2    | * Seuring S. | DEU    | Sustainable supply chain       | 1976          | 168,070             |
| 3    | * Govindan K.| DNK    | Supply chain performance       | 1714          | 164,340             |
| 4    | * Zhu Q.     | CHN    | Supply chain performance       | 1573          | 161,894             |
| 5    | Carter C.R.  | USA    | Sustainable supply chain       | 1126          | 108,074             |
| 6    | Klassen R.D. | CAN    | Sustainable supply chain       | 1061          | 108,845             |
| 7    | Gunasekaran A.| USA | Green supply chain             | 1004          | 100,966             |
| 8    | * Vachon S.  | CAN    | Sustainable supply chain       | 759           | 79,540              |
| 9    | * Müller M.  | DEU    | Sustainable supply chain       | 739           | 60,086              |
| 10   | * Pagell M.  | CAN    | Sustainable supply chain       | 676           | 67,952              |
| 11   | Van Wassenhove L.N.| FRA | Sustainable supply chain | 577       | 33,297              |
| 12   | Kannan D.    | DNK    | Sustainable supply chain       | 547           | 55,979              |
| 13   | * Searcy C.  | CAN    | Sustainable supply chain       | 542           | 46,928              |
| 14   | Geng Y.      | CHN    | Green supply chain             | 529           | 49,252              |
| 15   | * Wu Z.      | USA    | Sustainable supply chain       | 472           | 45,591              |
| 16   | Rogers Z.S.  | USA    | Supply chain performance       | 471           | 41,311              |
| 17   | * Walker H.  | GBR    | Green supply chain             | 469           | 45,486              |
| 18   | Diabat A.    | ARE    | Sustainable supply chain       | 459           | 44,380              |
| 19   | Lai K.H.     | HKG    | Supply chain performance       | 452           | 52,605              |
| 20   | Blome C.     | GBR    | Supply chain performance       | 430           | 46,298              |

* Indicates that the scholar was also one of the most highly cited scholars identified in Table 3.

Although the top co-cited scholars reprise some names identified in Table 3 (e.g., Seuring, Müller, Vachon, Klassen, and Zhu), the list also reveals highly co-cited scholars who published either outside of Scopus or in fields associated with (but not centered in) S-SCM (e.g., Butler, Buckley, Scott, and Getz). Scholars who appeared on the lists of highly cited and co-cited authors (e.g., Sarkis, Seuring, Zhu, Govindan, Klassen, and Vachon) have achieved particularly high measures of scholarly impact. When one takes into account productivity, Scopus citation, and co-citation metrics, the thought leaders in this literature appear to be Seuring [1,10,38,53], Sarkis [3,8,9,11,20,21,42,54], Govindan [55,56], Zhu (Q.) [9,11,21,22], Klassen [57–59], Pagell [32,34,60], and Gunasekaran [61].

Additionally, the highly co-cited authors again include scholars not belonging to traditional centers of management knowledge production (e.g., Zhu, Geng, Lai, and Diabat). This result is noteworthy as it indicates that the growing publication corpus from developing economies is making an impact. Finally, the data presented in Table 5 suggest that S-SCM practices have been studied with respect to increasing efficiency in commercial firms [5,6,9–13,15], as well as in environmental management [1–4,8,14].

4.2.3. Analysis of Influential Documents

Our next of set analyses—which focused on identifying influential documents—followed the same analytical strategy used to pinpoint authors. Scopus citation analysis (Table 6) determined which of the documents in our review dataset were considered highly cited. Unsurprisingly, many of the highly cited authors listed earlier in Tables 3 and 4 are also associated with these documents (e.g., Seuring, Müller, Vachon Klassen, Zhu, Sarkis, Geng, Pagell, and Wu). It is interesting to note that
the balance of documents leaned towards empirical studies, followed by reviews of research and conceptual articles. Although these findings are somewhat unusual, they suggest that the field is developing an empirically grounded knowledge base of S-SCM practices.

The authors read these highly cited documents to derive a better sense of their foci and scope. The topics reflect a focus on defining S-SCM [2,6,33], conceptualizing the green supply chain [1,5,9,16,31], elaborating on how the organizational environment shapes a sustainable supply chain [7,12,54,58], documenting and evaluating SCM practices [11,19,35,40], and analyzing issues concerned with performance measurement and analysis [8,11,17,20–22,33,57,62,63].

Table 6. Highly cited S-SCM documents based on Scopus citations, 1995–2019 (n = 2170).

| Rank | Documents | Type | Cited by |
|------|-----------|------|----------|
| 1    | Seuring and Müller. (2008). From a literature review to a conceptual framework for sustainable supply chain management [1] | Rev | 1926     |
| 2    | Vachon and Klassen (2006). Extending green practices across the supply chain: The impact of upstream and downstream integration [53] | Emp | 666      |
| 3    | Zhu et al. (2005). Green supply chain management in China: Pressures, practices and performance [11] | Emp | 598      |
| 4    | Pagell and Wu Z. (2009). Building a more complete theory of sustainable supply chain management [60] | Con | 583      |
| 5    | Walker et al. (2008). Drivers and barriers to environmental supply chain management practices [64] | Emp | 547      |
| 6    | Zhu et al. (2007). Green supply chain management: pressures, practices and performance [62] | Emp | 490      |
| 7    | Zhu and Sarkis (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance [63] | Emp | 428      |
| 8    | Brandenburg et al. (2014). Quantitative models for sustainable supply chain management [65] | Rev | 418      |
| 9    | Chaabane et al. (2012). Design of sustainable supply chains under the emission trading scheme [66] | Emp | 404      |
| 10   | Hassini et al. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics [67] | Rev | 400      |
| 11   | Hutchins and Sutherland (2008). An exploration of measures of social sustainability and their application to supply chain decisions [68] | Emp | 382      |
| 12   | Bai and Sarkis (2010). Integrating sustainability into supplier selection with grey system and rough set methodologies [69] | Con | 376      |
| 13   | Klibi et al. (2010). The design of robust value-creating supply chain networks: A critical review [70] | Rev | 372      |
| 14   | Ageron et al. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management [71] | Rev | 366      |
| 15   | Govindan et al. (2013). A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach [55] | Emp | 332      |
| 16   | Burgess et al. (2006). Supply chain management: A structured literature review and implications for future research [72] | Rev | 329      |
| 17   | Ageron et al. (2012). Sustainable supply management: An empirical study [73] | Emp | 327      |
| 18   | Spekman et al. (1998). An empirical investigation into supply chain management [74] | Emp | 312      |
| 19   | Kuo et al. (2010). Integration of artificial neural network and MADA methods for green supplier selection [75] | Emp | 281      |
| 20   | Ashby et al. (2012). Making connections: A review of supply chain management and sustainability literature [76] | Rev | 274      |

Table 7 presents the results of our document co-citation analysis (DCA). DCA offers a useful complement to Scopus document citation analysis by determining the underlying literature from which S-SCM scholars have drawn. In this way, this DCA-derived list affirmed the earlier stated
proposition that SCM forms the conceptual core of the S-SCM knowledge base. Indeed, several of these highly co-cited documents focus on broader supply chain concepts, without explicitly focusing on sustainability [72,74]. Simultaneously, however, most of these documents do focus explicitly on S-SCM, thereby reinforcing the picture of S-SCM as comprising a knowledge base that is both rapidly emerging and strongly grounded in (and exerting influence on) the broader SCM literature.

Table 7. Rank order of the twenty most highly co-cited documents on sustainable supply chain management.

| Rank | Documents                                                                 | Type | Cited by |
|------|---------------------------------------------------------------------------|------|----------|
| 1    | Seuring and Müller. (2008). From a literature review to a conceptual framework for sustainable supply chain management [1] | Rev  | 443      |
| 2    | Carter and Rogers. (2008). A framework of sustainable supply chain management: moving toward new theory [5] | Rev  | 221      |
| 3    | Pagell and Wu. (2009). Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars [60] | Con  | 120      |
| 4    | Vachon and Klassen. (2008). Environmental management and manufacturing performance: the role of collaboration in the supply chain [60] | Emp  | 111      |
| 5    | Hassini et al. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics [67] | Rev  | 95       |
| 6    | Zhu and Sarkis. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises [20] | Emp  | 95       |
| 7    | Ahi and Searcy. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management [2] | Rev  | 93       |
| 8    | Seuring. (2013). A review of modelling approaches for sustainable supply chain management [53] | Rev  | 89       |
| 9    | Srivastava. (2007). Green supply-chain management: a state-of-the-art literature review. New | Rev  | 86       |
| 10   | Carter and Easton. (2011). Sustainable supply chain management: evolution and future directions [7] | Rev  | 83       |
| 11   | Rao and Holt. (2005). Do green supply chains lead to competitiveness and economic performance? [77] | Con  | 78       |
| 12   | Brandenburg et al. (2014). Quantitative models for sustainable supply chain management: developments and directions [65] | Rev  | 77       |
| 13   | Bai and Sarkis. (2010). Integrating sustainability into supplier selection with grey system and rough set methodologies [69] | Con  | 74       |
| 14   | Linton et al. (2007). Sustainable supply chains: an introduction [58] | Con  | 73       |
| 15   | Barney. (1991). Firm resources and sustained competitive advantage [78] | Emp  | 70       |
| 16   | Pagell and Shevchenko. (2014). Why research in sustainable supply chain management should have no future [34] | Com  | 67       |
| 17   | Ageron et al. (2012). Sustainable supply management: an empirical study [73] | Emp  | 66       |
| 18   | Govindan et al. (2013). Fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach [55] | Rev  | 62       |
| 19   | Hart. (1995). A natural-resource-based view of the firm [79] | Con  | 60       |
| 20   | Gold et al. (2010). Sustainable supply chain management and inter-organizational resources: a literature review [80] | Rev  | 58       |

If we step back and examine the joint ACA and DCA results, we can identify the key documents that have defined this field and shaped its discourse. These include:

- “From a literature review to a conceptual framework for sustainable supply chain management”, authored by Seuring and Müller [1];
- “Building a more complete theory of sustainable supply chain management”, authored by Pagell and Wu [60];
The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so. The lines linking author nodes represent the co-citations of those scholars by other scholars. Finally, the proximity of the nodes, on the other hand, indicates the degree of intellectual affinity: authors located close to one another are frequently co-cited, while those who are at a distance are less so.
The first group of thought, denoted by the red cluster of authors, concerns S-SCM. Authors affiliated with this school have theorized and developed S-SCM models [1,5,7,18,41,60]. Scholars working within this school have sought to solidify the connections between sustainability and SCM [57,59] and project future sustainable supply chain trends [7,33,34]. As seen in the ACA map and the data in Table 4, the leading authors in this group of thought include Sarkis and Zhu [9,11,20–22], Seuring [1,10,38,53], Klassen [57–59], Carter [5,7,33], Vachon [57,59], and Pagell [32,34,60].

The next group of thought, in blue, consists of authors concerned with the dynamics of supply chain management. Scholars within this school have examined the so-called green supply chain from the viewpoint of societal and ecological concerns. Clearly, this cluster highlights the details of SCM implementation—or, in other words, the focus of this cluster is also on the reverse logistics approach (e.g., reuse of products and parts in manufacturing and production). The authors in this cluster include Govindan [55,56,61], Wang [75], and Diabat [83–85].

The last group of thought, in green, has focused on green supply chain measurement and indicators thereof. These scholars have, for example, initiated and raised the profile of closed-loop supply chain and remanufacturing and are led by Gunasekaran [61], van Wassenhove [50], Searcy [2,67,71], and Li [36]. This group has processes by which to increase the efficiency and effectiveness of S-SCM.

Stepping back and examining the map from a broader perspective, the red and blue clusters are the largest, both in terms of the number of scholars and the magnitude of impact (i.e., node size). The map also visualizes the impact of Sarkis, Seuring, Zhu, Govindan, Klassen, and Carter. Finally, the ACA map also visualizes the potent role that Sarkis has played as a boundary-spanning scholar who integrates concepts across the schools. This author’s node has far more links to all three of the schools—more than any other author on the map.

4.4. Topical Foci of the Sustainable Supply Chain Management Knowledge Base

The final set of analyses addresses RQ4, which enquires into the topical foci that have gained the attention of S-SCM scholars. We first used co-word analysis to identify frequently co-occurring keywords in the titles, abstracts, and indices of the review documents; from there, we used a “temporal overlay” to link keywords to the dates of their source documents. This temporal co-word analysis was used to identify the “research front” [5] of the S-SCM literature.

For this analysis, the VOSviewer threshold was set to at least 20 co-occurrences per keyword. The initial analysis focused on identifying the most frequently studied topics in this literature. After setting aside the keywords used in our search, we found that the most frequently studied topics were decision-making, environmental impact, environmental management, manufacturing, life-cycle, carbon emissions, green SCM, life-cycle assessment, environmental sustainability, food supply chain, and logistics. These keywords highlight the interest in how SCM interacts with internal processes and impacts the environment.

A temporal co-word map was generated (Figure 5) that is interpreted according to the same guidelines used with the ACA map. The only difference is that the colors in this temporal map do not refer to thematic similarity; instead, as the legend indicates, the colors are coded to reflect how relatively recently the keywords have appeared in documents within this body of literature. Thus, a keyword represented by a yellow or bright green node will have appeared in documents concentrated in the most recent period of the review; therefore, it can be interpreted as a topic of current interest for S-SCM scholars. Large yellow nodes would, therefore, represent the so-called hot topics within the field.

With these guidelines in mind, one can see that the hot topics in S-SCM research largely overlap the above list of hot topics. This is due to the fact that the S-SCM literature is concentrated in the most recent period of the review. Moreover, government rules and regulations as well as global norms (e.g., sustainable development goals) increasingly emphasize environmentally friendly SCM, along with the concepts of climate change and global warming. Thus, the temporal map clearly shows a picture wherein there is increasing interest in and concern about S-SCM and its various dimensions.
The most frequently studied keyword topics from 2016 onwards include environmental impacts (e.g., carbon emission and greenhouse gases), food waste, and the food supply chain. These findings speak to the impacts of environmental changes, food supply and production at the global level, various decision-making processes (including sensitivity analysis), and how supply chain businesses can optimize themselves and find the best means of achieving their S-SCM goals and coping with macro-level environmental changes. Furthermore, these findings imply that, given growing concerns vis-à-vis negative impacts on the environment, it is highly crucial that more attention be directed to improving S-SCM’s sustainable decision-making processes; such efforts would help derive “true” S-SCM and tangible S-SCM performance.

Figure 5. Temporal overlay on a keyword co-word occurrence map for sustainable supply chain management documents published from 1995 to 2020 (threshold 20 co-occurrences, display 191).

This temporal map can also be used to chart the evolution of S-SCM research. That is, three periods can be discerned based upon the colors of the nodes. Then, we can synthesize the topics into themes by time period. As Figure 6 shows, the evolution of S-SCM has shifted from strategic competitiveness (2010–2013) and environmental concerns (2014–2016) to sustainable decision-making (2017 onward) in SCM. Clearly, changes in research focus respond to external forces (e.g., environmental impacts) and organizational adjustments so as to align with the environment (e.g., the adoption of S-SCM tools and practices). In addition, there are some new approaches arising in the S-SCM filed, such as big data analysis [86–89] and blockchain application [90–92].
were from Asia (i.e., two from China and one from Hong Kong).

Publishing on this topic, the United States and the United Kingdom clearly predominated. Of the top 20 high-impact scholars (Table 5), 17 were from either North America or Europe; only three authors were from Asia (i.e., two from China and one from Hong Kong).

5.2. Interpretation and Implications of the Findings

The interpretation and implications of the findings necessitate the use of scholarly knowledge, wherein one already has a comparatively sound knowledge of the writing. Zupic and Cater [24] perceived that the interpretation of co-citation analysis results is, by definition, challenging. Obtaining appropriate co-citation analysis results was not a straightforward process. Obtaining appropriate co-citation analysis results is, by definition, challenging. Zupic and Cater [24] perceived that the interpretation of co-citation analysis results necessitates the use of scholarly knowledge, wherein one already has a comparatively sound knowledge of the writing.

5.1. Limitations

The current study is not without some limitations. The concept of SCM can be investigated in a variety of fields, such as construction and fisheries; nonetheless, this study focused on comprehensive conceptualizations of practical S-SCM, as seen in Figure 2 [1,2,5,7,9,40,42]. Therefore, despite our best efforts, some articles may not have been included in our examination.

Additionally, irrespective of the quantitative rigor of our bibliometric analysis, clarifying the contents of our co-citation maps was not a straightforward process. Obtaining appropriate co-citation analysis results is, by definition, challenging. Zupic and Cater [24] perceived that the interpretation of co-citation analysis results necessitates the use of scholarly knowledge, wherein one already has a comparatively sound knowledge of the writing.

5.2. Interpretation and Implications of the Findings

This study garnered knowledge pertaining to related S-SCM documents, including details on the discipline’s growth trajectory, from where in the world its scholars come, its top authors, its most cited documents, and its top co-cited documents and top journals; it also determined the evolution of topics and keywords relevant to the S-SCM field. Our findings can guide other researchers as they develop the methods and guidelines that will be used in future investigations.
As to the current study’s implications, we indicated that the majority of S-SCM studies emerged from either North America or Europe. This suggests that more research needs to take place in Asia, where the number of inquiries has quickly grown in past decades; additionally, researchers in other continents (such as Africa) should be encouraged to conduct more research to identify best practices and share and exchange knowledge vis-à-vis S-SCM practices. We also found that after 2016, rapid growth in S-SCM studies was seen in only two continents—namely Europe and Asia—while such growth in North America was demonstrably lower (Figure 2). These findings may reflect the relatively greater concerns towards sustainable supply chain practices or organizations in Europe and Asia [56,82].

With regard to the leading journals in the field of S-SCM, our findings align with those of past studies [1–4], where the Journal of Cleaner Production, International Journal of Production Economics, Supply Chain Management, International Journal of Production Research, and International Journal of Operations & Production Research led knowledge growth in this area. Furthermore, the three most influential (i.e., high-impact) authors—whose names appeared in both citations and co-citations—were Seuring, Sarkis, and Govindan; the three most important S-SCM foci comprised the green supply chain, the sustainable supply chain, and supply chain performance.

- Additionally, comparing to the past research studies, this research has demonstrated the longer period of time and the much larger database on the sustainable supply chain management literature [1–4].
- In addition, whereas past studies [1–4] reviewed the documents during different ranges of time periods, such as 1994–2007 [1], 1992–2013 [3], and 2002–2016 [4], the major changes in SSCM literature occurred later than 2016. The current research discovered that the paradigm shift occurred in this field during 2016–2018 (as shown in Figure 2). In Figure 2, the keyword of sustainable supply chain management has surged significantly, and this may be due to the trend of environmental friendliness and the changes in government regulations on supply chain management practices around the world [93–95].
- Some of the analyses adopted were similar to past research studies, such as top journals [2,4], scope of research areas [1–4], top cited documents [3], and geographical distribution of documents [3]. However, the unique contributions of the current study are as follows. Firstly, this study is the first to highlight the most influential scholars contributing to both top citations and top co-citations. Secondly, the current study provided a detailed comparison among past studies in bibliometric review. Thirdly, this review uniquely offered a temporal overlay for the development of the keywords in SSCM from past to present, identifying the upcoming topics and the fading areas of research focus. Fourthly, this paper offered the lists of both the highly cited documents and highly co-cited documents, representing the important foundations of SSCM research.
- Furthermore, the study synthesized the knowledge base of SSCM and offered three important schools of thoughts in SSCM, namely sustainable supply chain management [5,7,33,34], dynamics of sustainable supply chain management [8,9,11,22], and green supply chain measurement and indicator [2,36,48]. The first school, sustainable supply chain management, covered the theoretical frameworks, principles, and guidelines for conducting the sustainable practices. Secondly, the school of dynamics of sustainable supply chain management highlighted the changing conditions and environments from both internal (e.g., organizational structure, sizes, organizational focus) and external factors (e.g., technology and economic forces). The last school of thought, green supply chain measurement and indicators, raised important issues for the development of tools and measurements for sustainable supply chain management to ensure that the sustainable directions of supply chain management practices are appropriate for the SSCM performance. The derivation of these three schools of thought can support researchers to conceptualize empirical research studies in the future.
- This research achieved its objectives by speaking to the historical development of sustainable supply chain management (S-SCM) and the geographical distribution of its knowledge, highlighting those
documents and journals considered important in the field, elucidating the intellectual structures of the S-SCM knowledge base, and chronicling the relevant topics that have emerged in recent years. The study of S-SCM through a science mapping approach represents the most comprehensive investigation to date. The current research highlights the evolution of the concept of supply chain management into S-SCM in the present era—an evolution that began, in earnest, in 1995. Future researchers will find that they can leverage our results and findings as guidance in their own S-SCM investigations.

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