A review of green supply chain management: from bibliometric analysis to a conceptual framework and future research directions

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Abstract

This study reviews the green supply chain management (GSCM) literature and proposes a comprehensive view of the structural associations amongst the GSCM factors, viz. drivers, practice indicators and performance measures. The HistCite software was used to perform bibliometric citation meta-analysis on a sample of 1,523 articles, obtained from the ISI Web of Science database. Influential journals, institutions, and trending articles in the GSCM research are revealed. Co-citation analysis coupled with content analysis of the 39 most cited articles identified six underlying research streams, namely (a) conceptual development and sense-making, (b) GSCM impact on performance, (c) integration of green and sustainable operations in the supply chain, (d) green supplier development, (e) GSCM implementation drivers, and (f) review and future research directions. This further led to proposing a comprehensive conceptual framework with logically grouped factors, and directing relationships among the groups. Finally, future research directions claimed by the trending articles in the field were aligned with the findings of the key papers, and an approach to perform non-myopic GSCM research in the future is suggested.

Keywords: *green supply chain management, environmental sustainability, conceptual framework, literature review, bibliometric analysis*

1. Introduction

Since the supply chain revolution of the 1990s, environmental management framework in companies has changed; sustainability goals have become the core of many organizations' vision, and companies have realized that integration of environmental management practices across all departments of organizations is necessary for the best outcome (Srivastava, 2007). Such change was a customer-driven process along with pressure from the stakeholders and competitors of focal company supply chains (Seuring et al., 2005). Some companies addressed environmental management as a good business practice and initiated environmentally sustainable practices voluntarily. Being environmentally friendly is not only about driving costs, but creating value for business (Wilkerson, 2005) and improving financial performance (Zhu and Sarkis, 2004). From this standpoint, companies are considering lifecycle implications of their strategic decisions. Such an implication of green supply chain management (GSCM) is demonstrated by Sarkis (2003).

A number of literature reviews on green supply chain management (Fahimnia et al., 2015; Sarkis et al., 2011; Sharma et al., 2017; Srivastava, 2007) and sustainable supply chain management exist today (Carter and Liane Easton, 2011; Hassini et al., 2012; Rajeev et al., 2017; Seuring, 2013). In a review of definitions of GSCM and sustainable supply chain management (SSCM), Ahi and Searcy (2013) differentiated between both the terminologies. According to Ahi and Searcy (2013), the most cited definition of GSCM is "integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life" (Srivastava, 2007, p. 54-55); and the most cited definition of SSCM is "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements" (Seuring and Müller, 2008, p. 1700). These definitions are important as most of the existing GSCM studies are relying on both of them simultaneously (e.g. Vachon, 2007; Zhu and Sarkis, 2004; Zhu et al., 2013).

Existing literature reviews have focused on different aspects of GSCM and SSCM. For instance, in GSCM, applications of organizational theories (Sarkis et al., 2011), state-of-the-art review (Srivastava, 2007), bibliometric analysis (Fahimnia et al., 2015), performance indicators in the agro industry (Sharma et al., 2017) and directing future research directions (Dubey et al., 2017). SSCM review studies cover issues like evolution of SSCM studies (Rajeev et al., 2017), performance measures (Hassini et al., 2012), modelling techniques (Seuring, 2013) and conceptual framework development (Seuring and Müller, 2008). Among these studies, only Fahimnia et al. (2015) presented key journals, impactful articles and influential institutions in GSCM research. However, they used the total citation and PageRank measures to identify the impactful articles, which often ignore recent articles due to a lower number of citations. Using other measures and covering recent articles, the first research question this study addresses is: *(RQ1) what are the key journals, influential institutions, impactful and trending articles in GSCM research?* Further, Srivastava (2007) demonstrated the evolution timeline of GSCM, which is more than 10 years old and a significantly high number of articles related to GSCM have been published meanwhile. Hence, the next research question of this study is: *(RQ2) how have the key GSCM studies evolved over time building on each other, and what are the underlying research streams*? Although Dubey et al. (2017) proposed a comprehensive framework of GSCM, they based it on systems theory and knowledge-based view theory. But the current study proposes a conceptual framework based on content analysis of the key papers. Thus, the last research question is: *(RQ3) Based on the key papers - how can GSCM drivers, practices and performance measures be integrated and aligned in one comprehensive framework, and what learnings be derived?*

To answer the stated research questions, we used the HistCite software developed by the founder of the Institute for Scientific Information, Eugene Garfield as well as the content analysis approach. For RQ1, we relied on the bibliometric citation analysis metrics. For RQ2, citation mapping technique was employed coupled with content analysis. For RQ3, we adopted the knowledge synthesis approach.

Results of RQ1 will help researchers in the GSCM field to identify potential research collaborations or employment opportunities while also highlighting the key journals that researchers should consider to publish their most significant work. Findings of RQ2 will help researchers interested in this field to gain an overview of how key articles have been built on each other articulating the prominent underlying research streams and an overview of most used methods. The result of RQ3 presents the relationships among GSCM drivers, practice indicators and performance measures in a comprehensive conceptual framework. Moreover, a summary of learnings for future research has been presented based on the trending and most cited articles.

The rest of this study is organised as follows: Section 2 presents the methodology of this study and results of bibliometric citation analysis. Section 3 depicts the citation mapping of GSCM literature and a brief discussion on the six underlying research streams identified. The comprehensive conceptual framework is developed and presented in Section 4. Section 5 offers the future research agendas, and Section 6 concludes the study with a stepwise guideline to conduct future research.

2. Methodology

The aim of literature review papers can be twofold: (a) summarizing existing literature of a topic through identifying key themes and issues, and suggesting grounds for future research (Seuring et al., 2005); (b) enfolding any scientific literature against existing knowledge and theories (Saunders et al., 2009). There exist different types of literature review techniques — systematic literature review, content analysis, meta-analysis, bibliometric analysis etc. Bibliometrics is a method that includes statistical analysis of published articles and citations therein to measure their impact. The current study employs a combination of bibliometric citation analysis and content analysis technique to analyse the GSCM literature. We used the HistCite software for bibliometric analysis, which has been widely used by other studies in the management domain, e.g. Alon et al. (2018), Christensen and Gazley (2008), provides timeline visualization of citations, pinpoints the most-cited articles and indicates the subsequent impact of those citations (Garfield, 2009; Thelwall, 2008).

Figure 1 illustrates the research methodology adopted in this study. Data is collected from the ISI Web of Science database, a database used by many other published bibliometric studies e.g. Coronado et al. (2011) and Fetscherin and Heinrich (2015).

The importance of literature search technique for review articles is highlighted by Vom Brocke et al. (2009). The literature search approach of this study is similar to an impactful GSCM bibliometric analysis (Fahimnia et al., 2015), while the source database and article coverage differs. A three-step approach was followed to collect the data sample. First, we performed a Boolean search for articles on GSCM using a combination of the keywords: (a) green = *"green"* OR (b) environmental sustainability = *("environmental" and (sustainable OR sustainability))* AND (c) supply chain = *("supply chain" OR "supply-chain" OR "logistic")* in the ISI Web of Science database (limited to topic, which covers title of articles, their abstracts and keywords) — the most reputable academic research database. The Web of Science Core Collection database, used in this study, covers more than 20,300 journals, books and conferences with over 71 million records (as of July 2018 from clarivate.libguides.com). The results were then filtered by language (English), document type (articles) and research areas (engineering, environmental sciences, ecology, business economics, science technology other topics, operations research management science, transportation, computer science), resulting in 2,400 articles initially. In the second step (through a review by two of the authors), 1,523 out of these 2,400 articles were identified relevant to GSCM and/or SSCM by reviewing their titles, abstracts and keywords. In the final step, for these 1,523 articles, article title, author name(s) and affiliation, journal name, number, volume, pages, date of publication, abstract and cited references were extracted for bibliometric analysis.

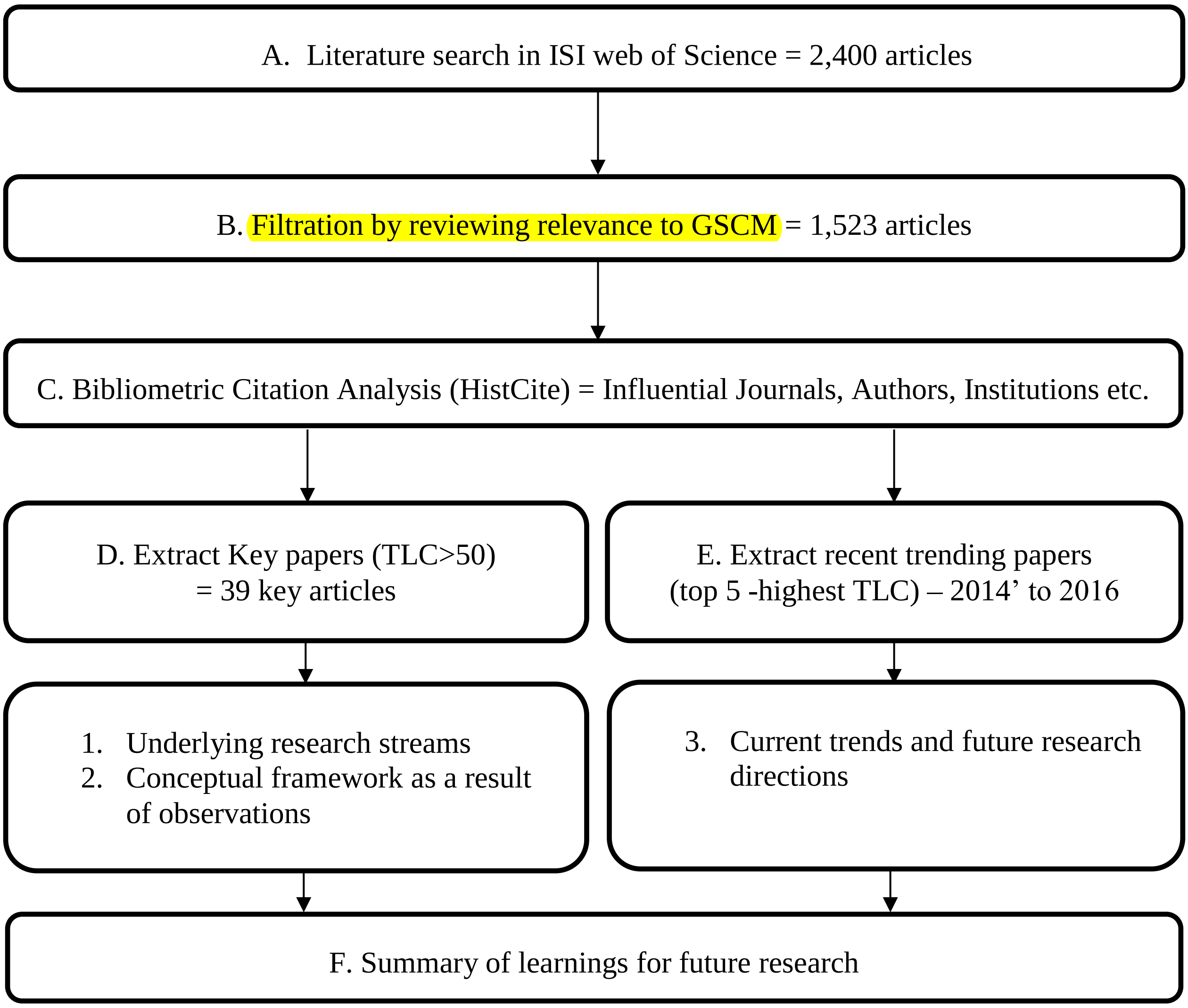

Figure 1: Research methodology

TLC refers to total local citations.

The article is the unit of analysis in a bibliometric analysis, and it is deliberated to demonstrate interconnections amongst the articles and research topics by looking at how many times an article is cited and co-cited by other articles. It should be noted that bibliometric co-citation analysis relies on the assumption that published articles in scholarly journals build their research on similar articles published before (van Raan, 2012). A basic descriptive analysis of yearly aggregated level publications and citations of about 1,478 articles, until end of 2016 (excluding 45 recent articles from early 2017), are shown in Figure 2. The number of articles published (PSC) is depicted through a line graph plotted on the secondary axis. Total local citations (TLC), that is, the number of citations articles published in that year received from the sample of 1,523 articles; and total global citations (TGC), that is, the total number of citations articles published in that year received from the entire Web of Science database, are depicted through bar graphs plotted on the primary axis. It is observed that there has been a steady rise in the number of articles since the beginning (1997) and a sharp rise from 2009 onwards. The years 2011 and 2012 have received highest TLC and TGC. Meanwhile, articles published in recent years have not received many citations as it takes some time for articles to create impact after publication. A staggering 86.9% of the total articles, that is, 1,320 out of 1,523 articles, were published in the last 8 years (since 2010). Also as many as 330 research articles concerning GSCM were published in 2016 alone. This indicates the kind of attention this field has achieved recently and is likely to increase in upcoming years due to a growing awareness of environmental sustainability worldwide.

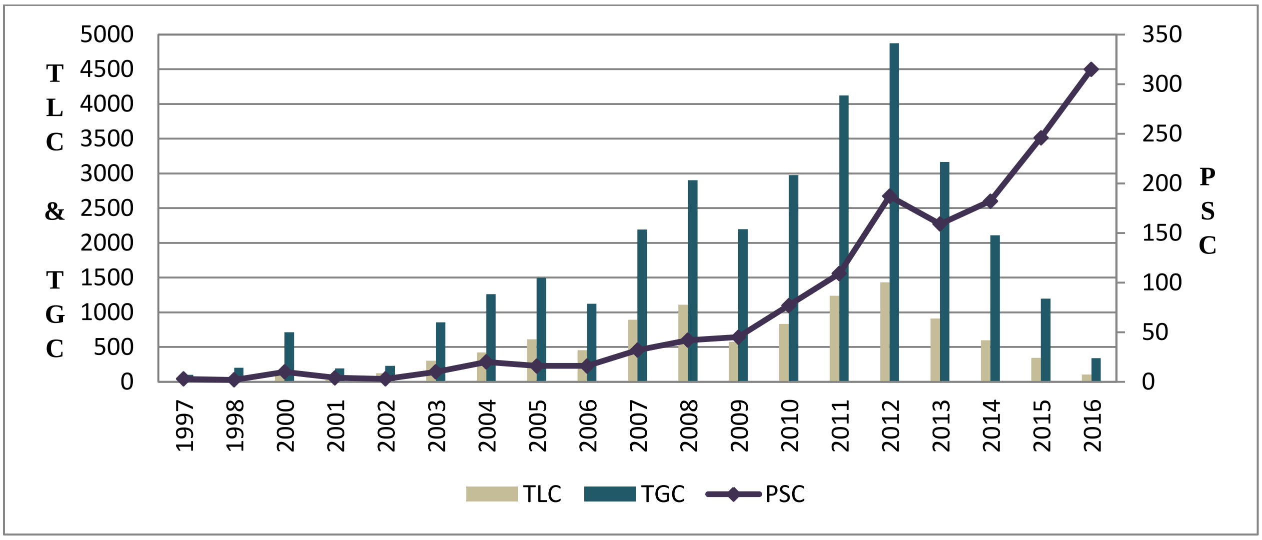

Figure 2 . Number of publications and citations

Source: Author's own compilation based on ISI Web of Science database

P_{SC} = Number of total articles published, TLC= Total local citations received, TGC= Total global citations received.

Bibliometric citation analysis is a useful tool to evaluate journal performance. In the broad field of supply chain management (SCM), different journals focus on different sub-fields of SCM research. In Table 1, the leading journals in the GSCM research are presented. Journals are ranked in terms of P_{SC}, the total number of published article related to GSCM, and TLC/t, total local citations received per year since publication. Among the top 10 journals, the Journal of Cleaner Production, International Journal of Production Economics, and International Journal of Production Research are the top three journals respectively both in terms of P_{SC} and TLC/t. Interestingly, while Sustainability (SUST), and Business Strategy and the Environment (BSE) journals are in the top 10 of P_{SC} ranking, they do not take a place in the list when ranked by TLC/t. Both the journals are low GSCM impact journals (see Figure 3). Moreover, SUST is a relatively new journal inaugurating in 2009, and it takes some time for journals to get attention and create impact.

Table 1. Leading journals in GSCM research

Ranked by P_{SC}				Ranked by TLC/t			
Rank	**Journal**	**P_{SC}**	**TLC/t**	**Rank**	**Journal**	**P_{SC}**	**TLC/t**
1	JCP	236	258.65	**1**	JCP	236	258.65
2	IJPE	135	237.32	**2**	IJPE	135	237.32
3	IJPR	61	83.43	**3**	IJPR	61	83.43
4	SUST	55	4.30	**4**	IJOPM	28	75.17
5	SCM-IJ	48	64.76	**5**	SCM-IJ	48	64.76
6	IJPDLM	36	59.78	**6**	IJPDLM	36	59.78
7	TR-LTR	35	59.28	**7**	TR-LTR	35	59.28
8	RCR	35	52.77	**8**	RCR	35	52.77
9	BSE	33	22.02	**9**	JOM	7	46.37
10	IJOPM	28	75.17	**10**	JSCM	16	39.34

P_{SC} = Number of total articles published, TLC/t= Average local citations received per year.

***(Journal Name and Abbreviation)** Business Strategy and the Environment (BSE), Corporate Social Responsibility and Environmental Management (CSREM); International Journal of Operations & Production Management (IJOPM); International Journal of Physical Distribution & Logistics Management (IJPDLM); International Journal of Production Economics (IJPE); International Journal of Production Research (IJPR); Journal of Cleaner Production (JCP); Journal of Environmental Management (JEM); Journal of Operations Management (JOM); Journal of Supply Chain Management (JSCM); Omega - International Journal of Management Science (OIJMS); Production and Operations Management (POM); Resources Conservation and Recycling (RCR); Supply Chain Management - An International Journal (SEM-IJ); Sustainability (SUST); Transportation Research Part E - Logistics and Transportation Review (TR-LTR)*

To scrutinize the journal impacts further, they were divided into four quadrants in Figure 3: (A) high focus on GSCM and high impact; (B) low focus on GSCM but high impact; (C) low focus on GSCM and low impact; and (D) high focus on GSCM but low impact. For visualization and readability purpose, only top 20 journals (sorted by TLC/t) were considered for quadrant mapping. To make the quadrants, P_{SC} was used as a proxy for focus on GSCM and TLC/t a proxy for impact. In a 2 x 2 matrix, the TLC/t of each journal was plotted on the X-axis and the P_{SC} on the Y-axis. In Figure 3, the red line parallel to the X-axis is the mean of number of published articles ($P_{SC}M$ = 40.20) and the green line parallel to the Y-axis is the mean total citations received (TLC/tM = 59.99).

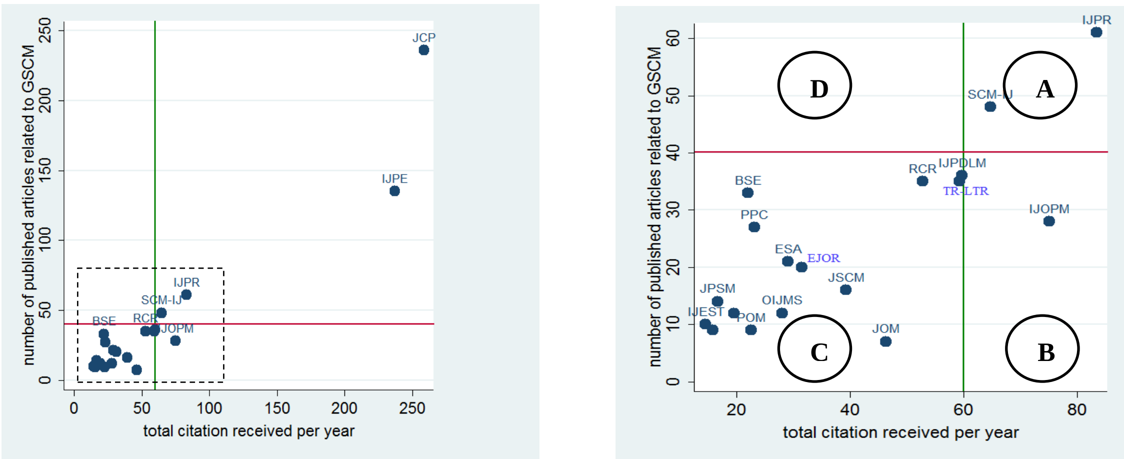

Figure 3: Journal focus and impact on GSCM research

Source: Authors' compilation based on top 20 journals sorted by yearly total local citations (TLC/t).

Among the 20 journals, only four – JCP, IJPE, IJPR and SCMIJ – belong to the quadrant A, with higher P_{SC} and TLC/t than the average. IJOPM is the only journal in quadrant B with higher than average TLC/t but lower than average P_{SC}. However, IJPDLM, and TR-LTR fall on the cut-off point of the quadrant B. With no journals in the quadrant D, 13 out of 20 top journals fall in the low focus and low impact quadrant — the quadrant C. For better detail, journals in the quadrants B and C are labelled in the right part of the Figure 3.

Similarly, from the bibliometric results concerning author's affiliation in terms of the number of publications (in parenthesis), Hong Kong Polytechnic University (63), Clark University (40), University of Southern Denmark (37) and Dalian University of Technology (34) lead the list. However, in terms of TLC, Clark University (1,994 citations), Dalian University of Technology (1,636) and Hong Kong Polytechnic University (1,099) dominate the list, followed by University of Western Ontario (763) and Asian Institute of Management

(342). Clark University can be stated to have a greater impact due to the higher number of citations, both local and global, per paper published.

Table 2: Trending articles in green supply chain management (2014-2016)

No.	Article	TLC	TLC/t	LCR
1	Govindan et al. (2014)	41	10.25	18
2	Kannan et al. (2014)	25	6.25	31
3	Pagell and Shevchenko (2014)	21	5.25	12
4	Kumar et al. (2014)	21	5.25	7
5	Mathiyazhagan et al. (2014)	19	4.75	24
6	Rostamzadeh et al. (2015)	16	5.33	35
7	Kannan et al. (2015)	12	4	12
8	Hashemi et al. (2015)	10	3.33	16
9	Govindan et al. (2015)	9	3	61
10	Dubey et al. (2015)	9	3	21
11	Jabbour and de Sousa Jabbour (2016)	7	3.5	27
12	Wu and Barnes (2016)	6	3	30
13	Trapp and Sarkis (2016)	5	2.5	12
14	Govindan et al. (2016)	4	2	30
15	Laari et al. (2016)	4	2	27

TLC= Total local citations received, TLC/t= Average local citations received per year and LCR= local cited reference.

Finally, to have a glimpse of the currently trending articles in the GSCM domain, the five most cited articles (that is, articles with high TLCs) published each year during 2014 - 2016 are identified and presented in Table 2. In case of multiple articles with the same TLC in a particular year, those articles were ranked in terms of local cited reference (LCR), which indicates higher relevance to the field. In the context of this study, LCR of an article refers to the number of articles from the sample of 1,523 cited in the article. To highlight the trending and emerging issues in GSCM research, a number of future research questions are identified based on the articles depicted in Table 2 and presented in the future research directions section.

3. Citation mapping and content analysis

To demonstrate the evolution of GSCM research over time, a citation map has been created, as shown in Figure 4. The ‘Graph Maker’ tool of the HistCite software has been used to visualize reciprocal citations of the published articles. This tool facilitates identifying key research themes within a topic, in this case GSCM. Due to the large number of articles gathered relevant to GSCM, for simplicity and usability, articles with at least 50 TLCs were considered for the citation mapping (competing maps with TLC ≥ 45 and TLC ≥ 55 were also examined). Filtering with TLC ≥ 50 provided 39 articles, which can be regarded as the most cited ones within the GSCM literature. From the literature coverage point of view of Cooper (1988), this can be interpreted *central*, that is, reviewing key literature of a topic. In Figure 4, publication years (with the total number of publications in parenthesis) are shown on the vertical axis, and each of the nodes represents one of the 39 articles, with a unique numerical ID (record number from the repository of 1,523 articles).

There are a few techniques of bibliometric citation analysis: bibliometric coupling, co-citation, co-authorship, co-word and co-occurrence analysis (Zupic and Čater, 2015). Co-citation analysis reflects the frequency at which two articles are cited together by other articles (Small, 1973). Based on the citation links in Figure 4, we identified co-cited articles. This is useful to identify research sub-streams in a research field (Fetscherin and Heinrich, 2015), which was also supported by an in-depth content analysis of all the articles in Figure 4.

Content analysis serves “to identify and record relatively objective (or at least intersubjective) characteristics of messages” (Neuendorf, 2002, p. 141). Hence, the results of content analysis are plausible and reliable if multiple researchers are engaged in the process (Duriau et al., 2007). Therefore, systematic reviews of contents of the 39 articles are conducted by two researchers to confirm underlying sub-themes in GSCM. To facilitate the content analysis, a concept matrix was formulated (Salipante et al., 1982), which consists of article title, authors, year of publication, keywords, research question(s), methodology, theory, article category, sub-category and key findings of the 39 articles. Initially, the five major GSCM research clusters by Fahimnia et al. (2015) were considered as potential categories for each of the articles in the concept matrix. However, as the analysis progressed, article categories and sub-categories were defined through an iterative analysis of the contents of the 39 articles. As a result, six key research streams in GSCM have been identified: (1) conceptual development and sense-making, (2) GSCM impact on performance, (3) supply chain integration, (4) green supplier development, (5) GSCM implementation drivers, and (6) literature review and future research directions. In the next sub-sections, the key theories, methods and findings of the articles depicted in Figure 4 are discussed briefly in the context of their respective research streams and sub-streams.

3.1. Conceptual development and sense-making

In an attempt of sense-making and to eradicate ambiguity about the importance of GSCM practices, Carter et al. (2000) empirically investigated the relationship between environmental purchasing and net income, and cost of goods sold (COGS). They remark that environmental purchasing reduces COGS while it increases net income. Rao (2002) revealed that when leading edge firms undertake GSCM initiatives, they not only enhance their economic performance but also encourage their suppliers to undertake GSCM initiatives, thereby leading to better environmental performance and competitiveness. To further enhance conceptual developments in GSCM, Sarkis (2003) presented a strategic decision framework for managerial decision making, incorporating components and elements of GSCM. Collaboration and evaluation from the customer side was not focused until Klassen and Vachon (2003) found that customer-initiated collaborative activities play a significant role in pollution prevention through increased investment in firm-level environmental management. All other research streams in the upcoming sections are built on the further investigation of the findings of this stream.

3.2. GSCM impact on performance

In the early 1990s, GSCM was considered as a Corporate Social Responsibility (CSR) activity. Only in the mid-2000s, research focusing on the impact of GSCM practice on a firm's environmental and economic performance truly flourished. Zhu and Sarkis (2004) revealed that the total quality management (TQM) principle enhances the relationship between external GSCM practice and positive economic performance. They also found that 'existence of TQM' changes the positive relationship between internal GSCM practice and negative economic performance into a negative one. Therefore, it may be inferred that TQM reduces the economic burden of implementing internal GSCM practice significantly. On the other hand, just-in-time (JIT) principle of a firm negatively influences the relationship between internal GSCM practice and environmental performance (Zhu and Sarkis, 2004). This relationship is controversial and requires further attention. Zhu et al. (2005) performed an exploratory factor analysis (EFA) to group GSCM pressures, practice and performance. While the previous two articles were based on Chinese manufacturers, Rao and Holt (2005) investigated manufacturers located in South East Asia. They argued that greening different phases of a supply chain lead to an integrated GSCM. Moreover, the relationship between

GSCM practices and performance may differ in different industries. For instance, while investigating Chinese automobile industry, Zhu et al. (2007a) found that GSCM implementation slightly improves operational and environmental performance but does not have any significant impact on economic performance. Furthermore, it may be noted that implementing GSCM practices requires integration with different supply chain partners and functions.

3.3. Supply chain integration

Having the seed of integration rooted in the previous stream, the need for supply chain integration of green and sustainable operations is explored in this section. Based on functions involved, supply chain integration has been divided into the following two sub-streams.

3.3.1. Collaboration (with suppliers and/or customers)

Profit, people and planet: the triple bottom line (3BL) principle coined by John Elkington in 1994 (Elkington, 2004) is the core of this sub-stream. The 3BL perspective challenged the integration of environmental, health and safety into the supply chain through green-product design, and lean and green operations management (Kleindorfer et al., 2005). In addition to economic gains, aspects such as trust of employees, customers and communities are also important for the long-run success of a firm. Vachon and Klassen (2006a) found that increased environmental collaboration and monitoring is a result of technical integration with customers and primary suppliers. Further, increased interaction with customers about green projects is positively related to flexibility, quality and environmental performance while supplier collaboration is positively associated with delivery performance (Vachon and Klassen, 2006b). Collaboration with suppliers was found to increase investment into environmental technology but collaboration with customers reduces investments in management systems (Vachon, 2007). Further implications of sustainable integration for government policy, contemporary production operations and new business models are discussed by Linton et al. (2007). Collaboration with suppliers and customers is also a key to one of the main GSCM functions – reverse logistics system.

3.3.2. Reverse logistics

In this research sub-stream, the focus has been on greening the supply chain backwards, that is, starting from the downstream supply chain towards the upstream. Sheu et al. (2005) proposed a multiple attribute theory method for integrating re-use and recycling throughout the product lifecycle that yields better utility for the supply chain. To integrate logistics operational problems into GSCM, Kainuma and Tawara (2006) used an optimization model based on the linear multi-objective programming model. The used-product return ratio imposed by government organizations was taken into account in the model formulation. Moreover, the authors found that a 21.1% improvement in aggregate net profit to be achieved from the environmental performance initiatives. However, researchers in this stream do not address the issue of developing green suppliers to collaborate in GSCM practices such as reverse logistics.

3.4. Green supplier development

As the benefits of 'collaboration with suppliers' from economic, operational and environmental performance perspectives were well observed, researchers then put emphasis on the development of green suppliers. Application and expansion of complex methodologies for green supplier selection and development is noticeable in this sub-stream. The analytic network process (ANP) was applied by Hsu and Hu (2009) for supplier selection, incorporating hazardous substance management. Extended rough set theory was employed by

Bai and Sarkis (2010b) and Bai and Sarkis (2010a). The authors argued for rough set theory to be a more practically applicable method for green supplier selection and development. Moreover, an artificial neural network (ANN) in combination with the multi-attribute decision analysis (MADA) model was developed by Kuo et al. (2010) for green supplier selection. However, not all these efforts for GSCM practice implementation were voluntary.

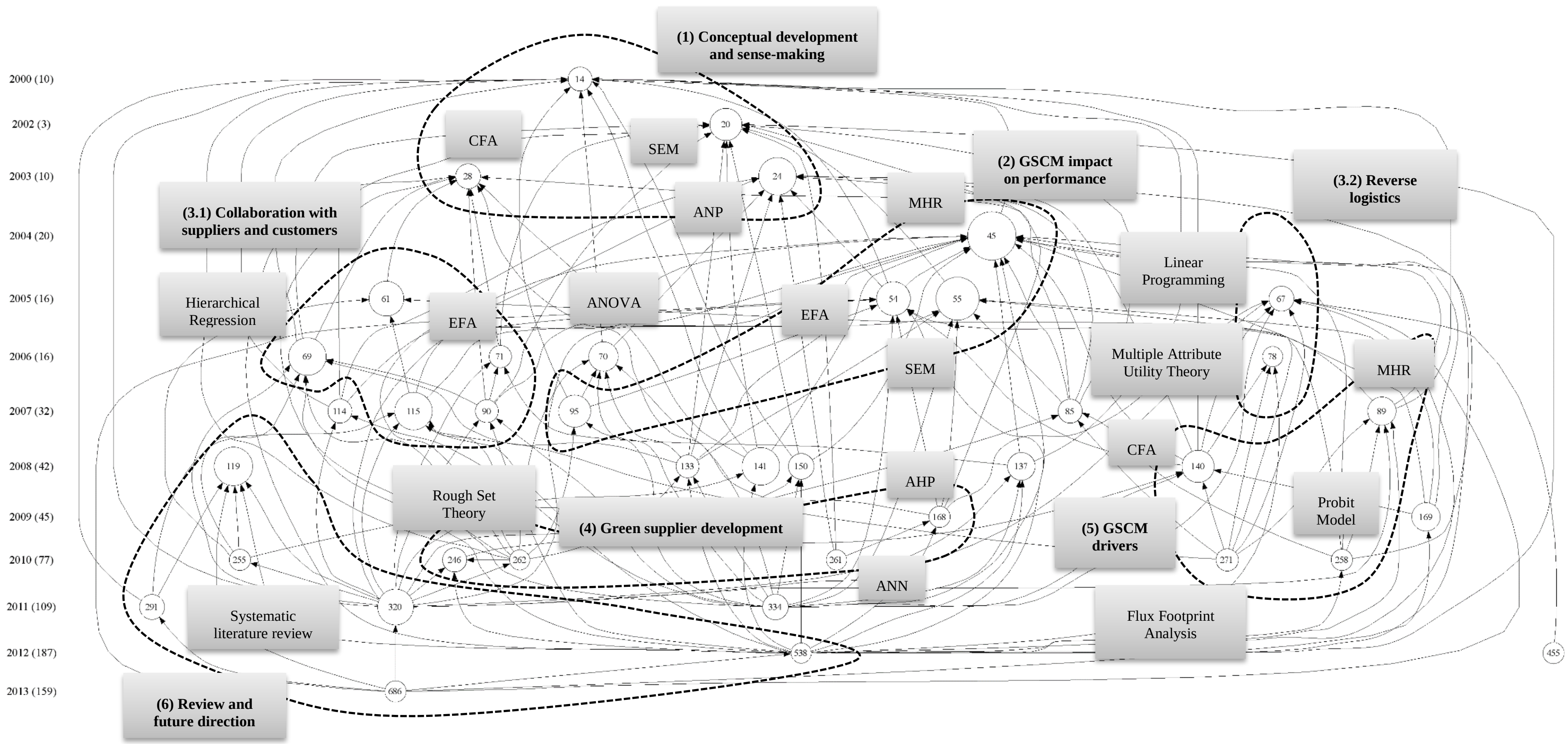

Figure 4. Citation mapping of the most influential papers in GSCM research

(Node. Article) 14. Carter et al. (2000), 20. Rao (2002), 24. Sarkis (2003), 28. Klassen and Vachon (2003), 45. Zhu and Sarkis (2004), 54. Zhu et al. (2005), 55. Rao and Holt (2005), 61. Kleindorfer et al. (2005), 67. Sheu et al. (2005), 69. Vachon and Klassen (2006a), 70. Zhu and Sarkis (2006), 71. Vachon and Klassen (2006b), 78. Kainuma and Tawara (2006), 85. Simpson et al. (2007), 89. Zhu and Sarkis (2007), 90. Vachon (2007), 95. Zhu et al. (2007a), 114. Zhu et al. (2007b), 115. Linton et al. (2007), 119. Carter and Rogers (2008), 133. Lee (2008), 137. Zhu et al. (2008c), 140. Zhu et al. (2008b), 141. Vachon and Klassen (2008), 150. Zhu et al. (2008a), 168. Hsu and Hu (2009), 169. Pagell and Wu (2009), 246. Bai and Sarkis (2010b), 255. Gold et al. (2010), 258. Testa and Iraldo (2010), 261. Kuo et al. (2010), 262. Bai and Sarkis (2010a), 271. Sundarakani et al. (2010), 291. Carter and Liane Easton (2011), 320. Sarkis et al. (2011), 334. Diabat and Govindan (2011), 455. Chaabane et al. (2012), 538. Hassini et al. (2012), 686. Ahi and Searcy (2013).

(Abbreviations. Full Form) ANN (Artificial Neural Network), AHP (Analytic Hierarchy Process), ANP (Analytic Network Process), ANOVA (Analysis of Variance), CFA (Confirmatory Factor Analysis), EFA (Exploratory Factor Analysis), SEM (Structural Equation Modelling), MHR (Moderated Hierarchical Regression)

3.5. GSCM implementation drivers

It has been mentioned earlier that GSCM initiatives were considered corporate social responsibility in the 1990s. Further, with the confirmation of GSCM implementation measures (Zhu et al., 2008b) and rapidly changing role of stakeholders; it had become relevant to investigate the role of institutional pressures towards GSCM implementation. It was revealed by Zhu and Sarkis (2007) that existence of regulative and market pressure improves the environmental performance of a firm to some extent, particularly when firms adopt eco-design and green purchasing as a result of such pressure. However, Testa and Iraldo (2010) argued that GSCM implementation is only complementary to other advanced management practices. Meanwhile, new knowledge in the field of GSCM has continuously been generated in larger volume as depicted in Figure 2, which led researchers to review existing knowledge and find gaps for future research.

3.6. Review and future direction

This stream covers literature reviews of articles published in all sub-streams and draws the path for future research directions. Initially, Carter and Rogers (2008) proposed five propositions based on transaction cost economics, resource dependence theory, population ecology and the resource-based view, which are worth further investigation. Rooting in the resource-based view, the ‘collaborative paradigm’ is highlighted by Gold et al. (2010) for ensuring simultaneous environmental, economic and social performance over a product’s total life-cycle. A review of the applications of different organizational theories is conducted by Sarkis et al. (2011), where applications of stakeholder theory and transaction cost economics are noticeable. GSCM metrics were focussed upon by Hassini et al. (2012) and a review of definitions of green and sustainable supply chain management was conducted by Ahi and Searcy (2013).

4. Towards a conceptual framework

"Early sustainability initiatives tended to focus on environmental issues but, as time goes on, they are increasingly adopting a triple bottom line (i.e., environment, economic, and social) approach to sustainability. As this approach involves a higher number of interacting factors, a higher degree of complexity can be expected" (Ahi and Searcy, 2013, p. 329). Moreover, key findings from content analysis of the highly cited papers repeatedly lead to the impression that the constructs used to relate GSCM items (such as drivers, practices and performance measures) have not been inclusive, and were mostly dealt with myopically. Therefore, a clear mapping of structural relationships within and across the drivers, practices and performance measures in GSCM is claimed necessary to (a) reduce the complexity, and (b) render a holistic view. Thus, this part of the study proposes a comprehensive conceptual framework to address the aforementioned matter.

The conceptual framework is proposed by means of a knowledge synthesis approach, which can be facilitated by the use of quantitative data followed by qualitative analysis (Seuring and Gold, 2012; Seuring et al., 2005). Accordingly, the key papers that were first selected based on quantitative data (i.e., TLC $\geq$ 50) are now taken for qualitative (content) analysis. Described in the following Section 4.1, the 39 key papers were scrutinized to identify and enlist all the items in the three factors (drivers, practices and performance measures) based on frequency of appearance, and segregate them into groups. Then, as explained in Section 4.2, these groups were aligned within and across categories to derive a comprehensive framework. Furthermore, an attempt is made to demonstrate the framework by collecting only the statistically significant (to the 5% level) relationships revealed by hypothesis testing studies of the 39 articles.

4.1. Grouping the factors viz., GSCM drivers, practice indicators and performance measures

Since there are a large number of terminologies, of which some are overlapping and some synonymous, grouping of the factors was the first step to drastically reduce the complexity. The grouping was a product of several iterative discussions amongst the authors until a unanimous agreement was arrived at for each of the factors. The common and shared intention of all the authors, was to narrow down such groups that are (a) inclusive with respect to different terminologies and their measurement items proposed in the key literature, and (b) relevant to practice and practitioners. Tables that illustrate the items, groups, and their sources are summarized in the Appendix.

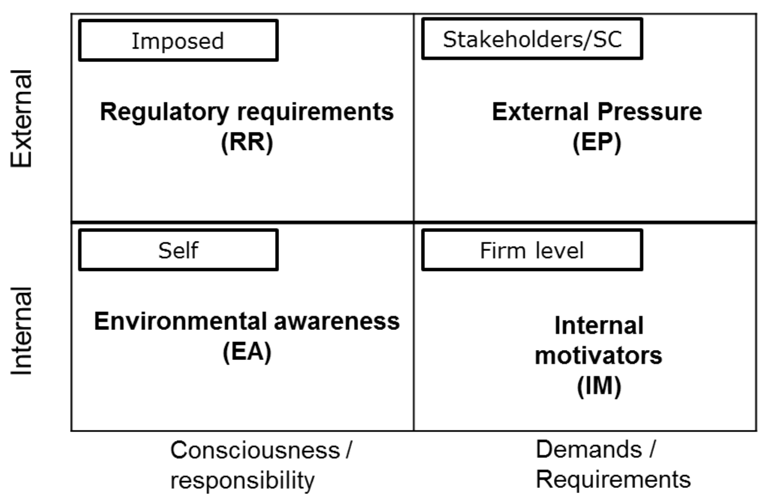

Figure 5. Grouping of GSCM drivers

4.1.1. GSCM drivers or triggers

After a careful review of drivers' items derived from the 39 key papers, they were segregated into the following groups, built against two dimensions (a) **responsibility**: self-consciousness, or demanded requirement, and (b) **source of motivation**– internal, or external with respect to the firm**.** As demonstrated in Figure 5, **Environmental Awareness (EA)** *refers to the self-consciousness of firms*. Competitive advantage (20.), corporate image (258.) and social or environmental responsibility (14.) etc., fall under this category[1]. **Regulatory Requirements (RR)** *refers to the imposed consciousness on firms*. A majority of those are imposed regulations that stimulate GSCM practices. **Internal Motivators (IM)** – *are a firm's internal demands.* This group entails firm level strategies or targets that prompt adoption of green practices. **External Pressure (EP)** *refers to the supply chain demands*. Typically, these are direct or indirect requirements by supply chain stakeholders.

4.1.2. GSCM practices or practice indicators

The identified GSCM practices' items are proposed to be classified in a similar way as were supply chain practices, classified by the SCOR model (Li et al., 2011): **Green-Plan (GP), Green-Source (GS), Green-Make (GM), Green-Deliver (GD), Green-Return (GR) and Green-Enable (GE)**. The authors agree that this grouping based on operational reference model enables GSCM-cognizant people, both researchers and practitioners, to align and comprehend green practices in harmony to supply chain practices. The Supply Chain Council (SCC), who has lately merged with American Production and Inventory Control Society (APICS), proposed to integrate environmental elements into the SCOR model framework, too.

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[1] Starting from here, the numbers in parenthesis refer to an article in Figure 4.

Following this, ‘Green-Plan’ encompasses all the strategic level programs and plans; such as eco-design (45., 54., 140., 95., 89., 137., 114.), environmental initiatives (20., 71.), investment in environmental technologies (28, 71) etc., that firms in a supply chain undertake with respect to GSCM. These practices might induce further operational level green practices. ‘Green-Source’ relates to greening the upstream SCM operations. Practices such as external GSCM (45., 34.), environmental collaboration (69., 141., 90.), environmental monitoring (69., 90.) etc., were proposed to be split and considered on both upstream and downstream sides. ‘Greening inbound’ and ‘greening outbound’ as proposed by Rao (2002), already find their place in ‘Green-Source’ and ‘Green-Deliver’ respectively in the SCOR model based classification. Reverse logistics, which is a widely covered topic in academia, is covered under the ‘Green-Return’. Certain practices under ‘greening outbound’ (as proposed by Rao, 2002) such as ‘taking back packaging’ are moved to the group ‘Green-Return’. It might be noted that, ‘Green-Return’ appears twice in the Figure 6 to distinctly indicate *return in sourcing phase* (upstream) and *return in delivery phase* (downstream). Finally, the ‘Green-Enable’ group comprises management systems and methods such as ISO 14001 (85.), environmental management system (EMS; 246., 258.), management and organizational practices (262.) etc., which enable the firms to promptly practice GSCM.

4.1.3. GSCM performance measures

Initially, researchers paid attention to the impact of GSCM practices mostly on environmental and economic performance measures, besides a little on operational performance. This led to a biased focus on the other performance measurement items such as social performance. Therefore, performance measures may be broadly classified into the three groups, economic performance, environmental performance and social performance, assuming the global reporting initiative (GRI) standards framework deeply grounded in triple bottom line with social, economic and environmental pillars (www.globalreporting.org/standards/gri-standards-download-center/). Green practices with tangible or intangible results can, therefore, be appropriately associated with the social, economic and/or environmental performances. Furthermore, operational performance measures such as improved efficiency (55.), productivity (55.), delivery (141., 71.) etc., may be translated to and considered under economic performance.

4.2. Setup of the framework

Developing a new theory in any discipline is difficult; thus, contributing to an existing theory is rather more common in management studies (Boer et al., 2015). Similarly, in an attempt of proposing a conceptual framework for GSCM with a comprehensive view, the contribution of this paper, to some extent, relies on extending the conceptual framework of SSCM by Seuring and Müller (2008). While their framework has three separate parts, the one proposed here is a comprehensive one. This could be viewed as a step forward towards theory building (Weick, 1995). Figure 6 exhibits the proposed comprehensive conceptual framework, and the identified structural associations from the hypothesis testing studies of 39 highly cited papers, in support of it. The rest of this section describes the relationships (only statistically significant at 5% level) as extracted from the key papers and demonstrates how they fit into the framework.

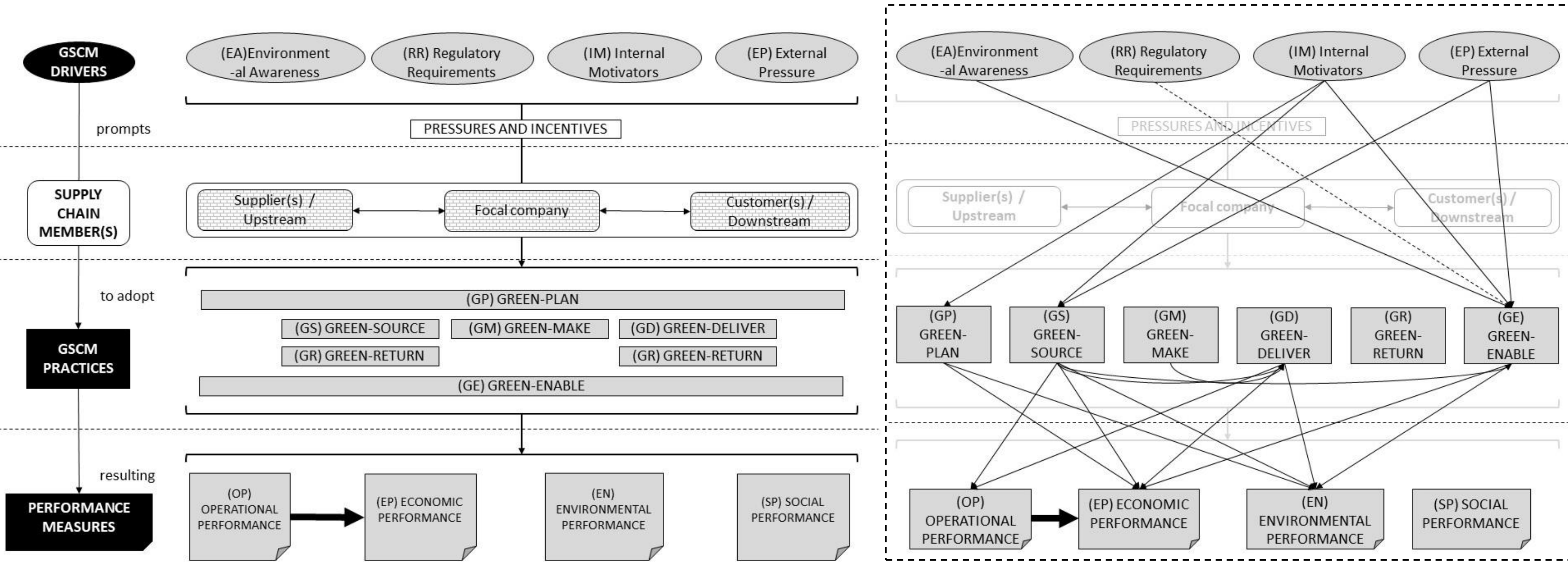
The driver group 'environmental awareness' (EA) was found to have a positive effect on GSCM practices in 'Green-Enable'. Corporate image positively affects the environmental management system (EMS) and encourages suppliers to adopt environmental measures (258.). So it may be inferred that self-consciousness of firms make supply chains cultivate the 'Green-Enable' practices. Moreover, both EMS and 'encouraging suppliers to adopt environmental measures' show positive improvement in environmental performance (use of natural resources, waste production, and wastewater effluent) as well as economic performance (258.).

'Regulatory requirements' (RR), 'government regulation' (20., 334., 28., 71.) and 'government involvement' (133.) were often mentioned as drivers of GSCM practice. Therefore, Zhu et al. (2005) and Zhu et al. (2007a) investigated the impact of regulatory pressure on GSCM practices but did not find any strong evidence in support of driving GSCM practice implementation in the Chinese automotive industry. However, as regulatory pressure significantly moderates the relationship between investment recovery and economic performance, regulatory requirements could possibly have a significant impact on the 'Green-Enable', and this relationship should be studied further.

'Internal motivators' (IM) have an effect on the 'Green-Plan' (GP), as organizational learning mechanisms and management support are found to have a strong positive impact on eco-design (150.). Internal factors (95.), organizational learning mechanisms and management support (150.) also increase investment recovery, that is, 'Green-Plan'. Furthermore, GP viz., eco-design and investment recovery positively affect environmental performance (EN), and both the positive and negative economic performance (45.). However, the relationship between economic performance (EP) and eco-design is negatively moderated, and that between environmental performance and eco-design is positively moderated by environmental pressure from customers (89.). So, internal motivators are found to have an effect on environmental and economic performance through 'Green-Plan'.

On the other hand, 'internal motivators' also affect the 'Green-Enable' group. While product/ process development strategy drives the practices EMS and supplier encouragement to adopt environmental measures, both practices show positive improvement in environmental and economic performance (258.). Therefore, internal motivators can affect environmental, positive economic and negative economic performance (i.e., economic performance) through ‘Green-Enable’ practices.

‘Internal motivators’ were also found to drive the ‘Green-Source’ practices. Organizational learning mechanisms and management support are found to have a strong positive impact on external GSCM practice with suppliers (150.). ‘Green-Source’ affects operational (OP), economic and environmental performance positively. That is, environmental collaboration with suppliers improves operational performance aspects such as quality, delivery performance and flexibility (141.). Partnership with suppliers in green projects also improves delivery performance (71.). Also, greening inbound (20., 55.), environmental collaboration with suppliers (141.), green purchasing (14., 89., 95.) and external GSCM practice with suppliers (45.) have a positive effect on economic and environmental performance.



The left part of the figure presents the comprehensive conceptual framework that represents associations among the GSCM drivers, practice and performance measures. On the right part, an evidence of significant associations is generated from the top 39 most cited articles.

Figure 6: Towards a comprehensive conceptual framework for GSCM

The final driver-group: 'External pressure' was found to influence the 'Green-Delivery' through technical integration (69.), management support and organizational learning mechanisms (150.). Moreover, the 'Green-Delivery' was found to positively affect operational, economic and environmental performances simultaneously. This is supported by positive effects of: 'greening outbound' on operational performance (20.), 'environmental collaborations with suppliers' on quality, flexibility, cost and environmental performance (141.). However, 'environmental collaborations with suppliers' negatively affect delivery performance (141.).

Rao (2002) established that 'greening inbound' and 'greening production' impacts 'greening outbound', which in turn impacts operational performance, while 'greening inbound' also impacts economic performance (20. and 55.). Articles that studied impact of GSCM practices on social performance indicators were not among the 39 most cited papers.

Analysis of the impacts of moderators on the implementation of GSCM practices is also found (69.). Just-in-time (JIT) and total quality management (TQM) were used as moderators to study their effects on relationships between GSCM practices and measures (45., 85., and 150.). If this stream of identifying impactful enablers in a context of existing drivers and practices matures, then the stream of implementation barriers, at least partially, could be addressed.

Mapping linkages within and across all of the numerous items in the three categories (drivers, practices and measures) would be a significantly complex web structure and too chaotic to clearly understand their structural associations. Therefore, this comprehensive conceptual framework enables researchers and practitioners to organize the linkages in an aggregated manner (see Figure 6); and make sense of them in order to act upon then in the context of a region or industry. In addition, establishing reliable relationship linkages of all drivers to performance measures through the GSCM practices would help practitioners to focus on drivers objectively to target specific performance measures of interest. The development of simulation models (industry and region specific) based on such a comprehensive framework to implement GSCM as a system can be beneficial in advancing its applications.

5. Future research directions

In the last two decades, research in GSCM focused on the overall effect of GSCM practices mostly on environment and economic performances. Following the development in GSCM activities, different industries such as electronic/electrical, thermal power, automotive industry etc. were investigated separately by Zhu and Sarkis (2006). However, geographic locations of the companies under investigation really matter when it comes to GSCM activities. For instance, German purchasing managers were more involved in environmental purchasing than U.S. counterparts (Murphy and Poist, 2000). Future research may compare other GSCM practices, for example, eco-design, R & D management etc. of firms based on their geographic locations.

Diabat and Govindan (2011) have considered aspects such as green design, ISO certification, re-using and recycling and reverse logistics as drivers of GSCM, which instead are green practice indicators. Such mixing-up of GSCM drivers and practice indicators are common in the existing literature. In addition, it is noticed that for operationalizing GSCM driver, practice or performance measure constructs, unstandardized measurement items were used by the researchers. Different researchers continued to use different constructs they originally coined and did not adapt to any standard version. For instance, the environmental collaboration / cooperation construct in Vachon and Klassen (2006a) and Zhu et al. (2008a) uses different measurement items. Also, while improved efficiency, quality management, and productivity improvement were considered as ‘competitiveness’ by Rao and Holt (2005), similar items were taken to develop the ‘operational performance’ by Zhu et al. (2007a) and ‘manufacturing performance’ by Vachon and Klassen (2008). In future research, a standardized approach inclusive of all GSCM constructs should be followed. In view of this, grouping measurement items in each of the categories viz. drivers, practices and measures have been recommended in Section 4.1 (also see the Appendix).

Further, in this attempt to build a comprehensive overview of structural associations, certain observations have been made that might provoke further debate also on the methodology front. Most of these studies that dealt with relationships relied purely on survey data collected using the Likert scale. It would be useful to start using real-world data (from ERP systems) and employ data analytics (e.g. big data analytics, machine learning) instead of surveys to refer to operational, environmental, economic and social performances. This might help understand and further the research of GSCM and performance measures. Finally, a sound theoretical background is lacking in most of the highly cited GSCM articles, which should be taken into account in future research (Seuring and Müller, 2008).

On one hand, while we have earlier analysed the founding/key papers in the GSCM domain and identified the underlying research streams, it would also be of interest to look at the currently trending articles to review their observations and understand the contemporary focus of on-going GSCM research. The aforementioned motives give us an excellent opportunity to obtain some specific future research agendas presented in Table 3.

Table 3: Future research agendas from the trending papers*

Classification	Future research agendas
Conceptual development and sense-making (1) and (5)	• Performing AHP based ranking for drivers, practices, barriers, and performance measures for different regions (1), (5).
GSCM impact on performance; GSCM implementation drivers (9), (10) and (15)	• Develop relationship models with drivers and barriers (9). • Replicate existing models in other regions and sectors (9), (10), (15). • Consider social performance measures (10). • Focus on small and medium size enterprises (15). • Impact of customer driven GSCM on operational performance and economic performance (15). • Impact of competitive strategy of firms as driver on GSCM practices (15). • Use of other theories, for example, vested interest theory (10). • Evaluate GSCM practices' relationship to performance under fuzzy sets environment (9).
Green supplier development (2), (4), (6), (7), (8), (12), (13)	• Extend the works to other industries, regions and analysis methods, and to compare results (2), (4), (6), (7), (8). • Include political factors in GSS criteria (8). • Expand scope by analysing interrelationships within criteria — practices/ performance measures (8). • Incorporate supplier perspective so suppliers can identify attributes to become preferred suppliers (12).
Supply chain integration, and reviews (3), (11) and (14)	• Consider social aspects while evaluating sustainable supply chains (3). • Level of analysis — higher product/service level to include more stakeholders (3). • Essential to develop analytical / simulation models to make GSCM research proactive than reactive (3). • Small enterprises to be studied as they can be source of inspiration to do things differently (3). • Developing countries to be focussed (14), (3). • More research is required looking into the aspects of SC relationships, investigating governance mechanisms, and exploring innovations, which can foster more effective and efficient sustainable SCM (14). • Suggestions for a research agenda providing insights into how Green Human Resource Management can support GSCM by reducing barriers (11).

**Each reference article number refers to article number in Table 2.*

6. Conclusions

In this study, a bibliometric analysis of GSCM research was conducted analysing 1,523 articles identified from the ISI Web of Science database. With the help of bibliometric analysis tools and techniques, key journals, influential institutions, impactful and trending articles were identified. Journal of Cleaner Production, International Journal of Production Economics and International Journal of Production Research are the leading journals (see Table 1). Among the most influential institutions, Hong Kong Polytechnic University, Clark University, and University of Southern Denmark stand out. Govindan et al. (2014), Rostamzadeh et al. (2015) and Jabbour and de Sousa Jabbour (2016) are the top trending articles from 2014, 2015 and 2016 respectively (see Table 2). Also, the unresolved research agendas from the top 15 trending articles are extracted (see Table 3). The most cited 39 articles were also identified (TLC>50). Citation mapping coupled with content analysis of those articles revealed six underlying research streams (see Figure 4), namely (1) conceptual development and sense-making, (2) GSCM impact on performance, (3) integration of green and sustainable operations in the supply chain, (4) green supplier development, (5) GSCM implementation drivers, and (6) review and future research directions. An attempt to group all the GSCM drivers, practice indicators and performance measures based content analysis of the 39 articles eventually led to proposing a comprehensive conceptual framework (see Figure 6).

Finally, based on critical observations from the most cited articles and the future research directions claimed by trending articles are merged to put forward the following stepwise guideline for conducting future research in GSCM.

Step 1: Choose context

- Industry: Attention required on other than manufacturing industries, and more small and medium size enterprises.
- Country / Region: Developing or low income countries can be more interesting.
- Level of analysis: Product lifecycle or supply chain level.
- Perspective: Supplier and other stakeholders' perspectives to be considered.

Step 2: Identify, rank (using ANP or other methods) and group GSCM aspects

- Group drivers, practices, barriers, moderators, performance measures (grouping proposed is this study can be used in future research).
- Focus more on social aspects and political aspects.

Step 3: Study relationships between GSCM groups

- The following relationships should be studied as a system and not myopically:
    - Drivers' groups → practices' groups,
    - Barriers → practices' groups,
    - Practices' groups → performance measures' groups,
    - Moderators' → on the association between (i) drivers' groups → practices' groups, (ii) barriers → practices' groups, and (iii) practices' groups → performance measures' groups.
- Real-world operational data from ERP systems should be used.
- Compare, and choose appropriate data analysis methods based on environment or characteristics of the context.

Step 4: Develop simulation models based on relationships or correlations drawn in step 3 to enable proactive research and decision making in GSCM

- Deploy data analytics and machine learning techniques.

Zott (2003) argued that "simulation models can provide superior insight into complex theoretical relationships among constructs, especially when challenging empirical data limitations exist" (p. 480). Therefore, our recommended approach counters the shortfalls observed in the existent GSCM literature such as inconsistent terminologies and constructs, usage of selective or limited factors, high bias towards economic performance, limited preference of methods (such as surveys) . Thereby, it attempts to pave the way towards proactive, future-oriented, integrated and non-myopic research in the GSCM field.

Like any other study, this study has a few limitations. For instance, to develop the conceptual framework presented in Figure 6, we analysed the most cited 39 articles, but some relevant studies may not be part of this sub-sample. Also, there exist studies that used social performance measures (for example, Das, 2017), but those were not part of our studied sub-sample. Thus, to further validate the framework, future research may conduct a meta-analysis only focusing on the relationships among drivers, practice indicators and performance measures. Moreover, HistCite software, used in this study, offers useful tools and bibliometric analysis metrics, but has some limitations. For example, it does not offer metrics such as Collaboration Index (CI), the degree of Collaboration (DC), Collaborative Co-efficient (CC), Or Relative Growth Rate (RGR). Also, the visualization tool of HistCite is not cutting-edge. Future bibliometric citation analysis on related topics as GSCM may use the 'bibliometrix' package in the R software for advanced analysis.

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Appendix: Grouping of GSCM drivers, practice indicators and performance measures

DRIVERS		
EA	**ENVIRONMENTAL AWARENESS**	**References**
1	Corporate image	258
2	Social/environmental responsibility	14
RR	**REGULATORY REQUIREMENTS**	**References**
1	Regulatory pressure	54, 95, 70, 271
2	Govt. regulation	20, 334, 28, 71
3	Government involvement	133
4	ISO 14001 certification requirement	334, 20, 71
IM	**INTERNAL MOTIVATORS**	**References**
1	Internal factor	54
2	Firm performance	14
3	Sustainable supplier selection	246
4	Cost saving strategy	258
5	Product/process development strategy	258
6	Organizational learning	150
7	Management support	150
8	Cost related pressure	54
EP	**EXTERNAL PRESSURE**	**References**
1	Market	95, 70, 54
2	Customer	70, 85, 28, 271
3	Following competitor	258
4	Competitive pressure	54
5	Supply chain pressure	54
6	Suppliers	95, 70
7	Competitors	70
8	Certification of suppliers' EMS	334
9	GSC readiness of suppliers	133
10	Buyer GSC practice	133

**References refer to the article node in Figure 4.*

PRACTICE INDICATORS

GP	GREEN - PLAN	References
1	Eco-design	45, 54, 140, 95, 89, 137, 114
2	Investment recovery	45, 54, 140, 95, 89, 137, 114
3	Investment in Environmental technologies	28, 71
4	Environment initiatives	20, 71
5	R&D management	168
6	Investment and resource transfer	262

GS	GREEN - SOURCE	References
1	External GSCM -suppliers	45, 54
2	Greening inbound	55
3	Green project partnership - Suppliers	71
4	Green purchasing	140, 95, 89, 137, 114, 14
5	Environmental collaboration- supplier	69, 141, 90
6	Environmental monitoring-supplier	69, 90
7	Green procurement	168
8	Incoming quality control	168

GM	GREEN - MAKE	References
1	Green production	55

GD	GREEN - DELIVER	References
1	External GSCM - customers	45, 54
2	Greening outbound	55
3	Cooperation with customers	140, 95, 89, 137, 114
4	Environmental collaboration - customer	69, 141, 90
5	Environmental monitoring - customer	69, 90
6	Green project partnership - Customers	71

GR	GREEN - RETURN	References
1	Greening outbound	55
2	Reverse logistics	67

GE	GREEN - ENABLE	References
1	Green knowledge transfer and communication	262
2	SCEM	20
3	Process management	168
4	ISO 14001	85
5	Internal EMS	45, 54, 140, 95, 89, 137, 114
6	Environmental management System (EMS)	246, 258, 168

7	Pollution controls	246
8	Pollution prevention	246
9	Measuring carbon emissions	271
10	Management and organizational practices	262
11	Encouraging suppliers to adopt environmental measures	258

**References refer to the article node in Figure 4.*

	PERFORMANCE MEASURES	
EP	**ECONOMIC PERFORMANCE**	**References**
1	Cost saving	55, 141
2	New market opportunities	55
3	Product price increase	55
4	Profit margin	55
5	Sales	55
6	Market share	55
7	Net income	14
8	Positive economic performance	54, 95, 89
9	Negative economic performance	54, 95, 89
10	Economic performance	20, 140, 114
11	Cost of goods sold (COGS)	14
12	Overall business performance	258
13	Cost to customer	78
OP	**OPERATIONAL PERFORMANCE**	**References**
1	Improved efficiency	55
2	Quality improvement	55, 141, 71, 78
3	Productivity improvement	55
4	Delivery	141, 71
5	Flexibility	141, 71
6	Operational performance	54, 140, 95, 114
7	Lead time	78
SP	**SOCIAL PERFORMANCE**	*None found in the most cited 39 articles.*
EN	**ENVIRONMENTAL PERFORMANCE**	**References**
1	Environmental performance	45, 141, 54, 20, 140, 95, 89, 114, 71, 258
2	Supplier environmental. performance	85
3	Resource consumption	246
4	Pollution production	246

**References refer to the article node in Figure 4.*