

Qualitative and Quantitative Analysis of Green Supply Chain Management (GSCM) Literature from 2000 to 2015

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Abstract— In the past several decades, Green Supply Chain Management (GSCM) has been rapidly evolving in academia and industry and investigation in all countries and nation growing dramatically. The significant impact of GSCM is visible by the rate of academic publications in recent years. With the increased attention paid to environmental aspects of green supply chain management, finding new directions by critically evaluating the research and identifying future directions becomes important in advancing knowledge for the field. Both Qualitative and quantitative are applied to examine global scientific production of green supply chain management in Science Citation Index (SCI-Index) and Social Sciences Citation Index (SSCI-Index) documents to develop a viable green supply chain study. The analytical results of this study illustrate the study evolution over time and eventually provide a systematic mapping of the field that helps to identify of research interests and potential directions for future research.

Keywords— Green Supply Chain Management; environmental; literature review; SCI-Index; SSCI-Index.

1. Introduction

When Supply chain management has matured from a field that addressed only economic and operational Issues to one that comprehensively considers the social and environmental matters that face firms, academia and organizations of today therefore the concepts of supply chain management

and environmental management have been receiving increased attention to gain competitive advantage as strategic organizational practices.

Realizing that integration of environmental, economic and social sustainability can drive the improvement of the firms through improved market share and achieved competitive advantages as strategic weapons. Following this industry trend, the interest of academia on sustainability has also begun to increase substantially for at least 20 years and is well into its third decade of investigation [1].

This growing interest sparked a series of new lines of research dealing with various supply chain activities that have important environmental implications which includes activities such as storing, handling, acquiring and recycled materials.

In the past few years, number of literature reviews on green supply chain have been completed. Some of them have been general and comprehensively covered entire field [2, 3] whilst others have focused on specific aspects of green supply chain such as performance measurement [4], analytical models of GSCM [5] or supplier selection in GSCM [5].

These reviews have identified various topical issues. They have been relatively straightforward in their analyses, providing summary aggregate statistics of the number of papers and topical areas [5, 6]. Each study has provided insight into the field, but additional analysis of green supply chain management literature using rigorous bibliometric tools can provide further insights not previously fully grasped or evaluated.

In this paper, we have considered a comprehensive evaluation of the field, focusing on forward green supply chain practices. Since, green supply chain is a relatively broad term, it can refer to many different papers therefore this study starting with a pool of over 2005 published studies and filtering this pool to more influential works and investigators. The aim of this paper is to analysis qualities and quantities of the researches done during the last two decades.

2. Methodology and Materials

The significant aim of literature review is evaluating the body of knowledge to identify potential research gaps and highlight the boundaries of them [7]. The literature reviews usually done an iterative cycle of defining appropriate search keywords and literatures and finally completing the analysis [8, 9].

Rowley and Slack [10] suggested a structured methodology for searching and scanning resources, structuring the literature by mind map designing and finally writing and building the bibliography. In this study with a similar approach, we use a several-step methodology for data collection and comprehensive evaluation of the field aiming, determine the topical areas of research and provide insights for current research interests and directions for future research in the field. All papers were accessed from the database of the Science Citation Index (SCI), obtained by subscription from the ISI, Web of Science, Philadelphia, PA, USA.

2.1 Quantitative Analysis

For the quantitative analysis, the SCI are systematically searched for green supply chain related materials published from 2000 to 2015. Selected documents included Supply Chain, Green, Ecological and Environmental. Three combinations of these keywords were used including

- Green AND Supply Chain
- Environmental AND Supply Chain
- Ecological AND Supply Chain

Analysed parameters included authorship, document type, patterns of international collaboration, journal, research address, reprint author's address and number of times cited. Citation analysis was based primarily on the impact factor as defined by the Journal Citation Reports (JCR) and on Citations per Publications (CPP), which are used to assess the impact of a journal

relative to the entire field. It is defined as the ratio of the number of citations the publication has received to since it is published.

2.2 Qualitative analysis

In this study the historical method was used to qualitative analysis. In historical method we able to gain a better understanding by investigating and reviewing the places, time and contexts in which events occur and develop. This method to qualitative analysis was employed in investigating the initiation and development of green supply chain management as documented in publications in the SCI from 2005 to 2015. This study employed historical review method to explore green supply chain study trend for a longitudinal literature review and forecast possible future developments based on this review results.

3. Results and Discussion

3.1 Number of Publications and Citations

According to the data obtained from ISI Web of Knowledge in 26 October 2016, as presented in figure 1, it shows the number of publications about green supply chain generation in a period of 10 years. From the figure 1, it is concluded that the research about this topic have just been published from 2005. Therefore, it is observed that research in supply chain (green supply chain) for improving the environment and ecology is new topic.

In addition, there were fewer than 18 papers published from 2000 to 2005 so these years haven't included in our study. Only after 2011 this research became a hot topic among researchers. Obviously, there was rapid increase in number of publications and citations in 2015. The citation trend shown in figure 2 indicates that the number of citations increased rapidly, especially in last three years. Thus, the promising future of green supply chain is guaranteed.

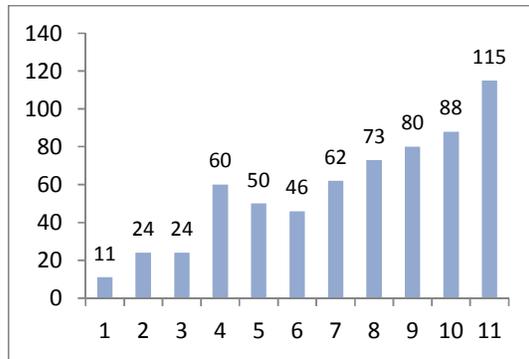


Figure 1. Number of published paper each year

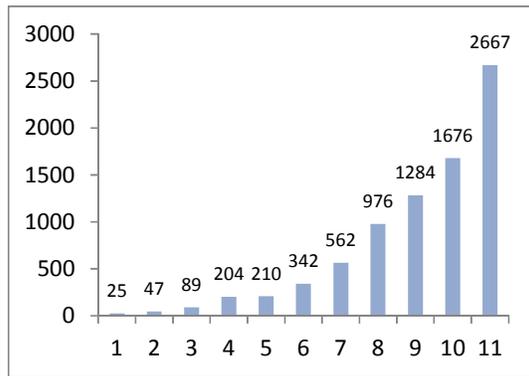


Figure 2. Number of citations each year

The total citation count was obtained from SCI, web of science, on 24 October, 2016. It is worth mentioning that papers related to Greening and Environmental topic had a relatively higher number of citations than many other scientific fields in supply chain management area. It must be pointed out that the number of citations in single article was highly correlated with the length of time since its publication. As it can be seen in figure 2, the average number of times that the paper receives citations increases as the time goes on since its publication. Therefore, average number of citation per year was used to compare the papers in different years.

From 2006 to 2015, the annual number of Citation articles according to figure 3 the scatter plot was growing at a stable rate. The fit produced a high

determination coefficient from the collected data ($R^2 = 0.8119$). The best fit to forecast green supply chain generation was found to be:

$$Y = 229.15x - 459866$$

Where y is the article number and x is the number of years. Extrapolating from the model, the number of articles about green supply chain in the following years could be forecasted.

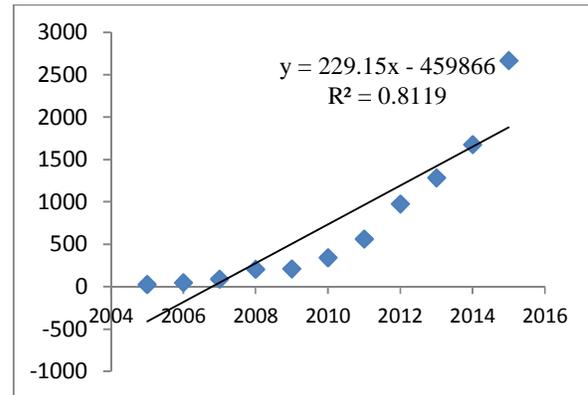


Figure 3. Scatter plot of GSCM citations

3.2 Distribution by Source Titles & Research Area

According to table 1, most of the papers in this field are published in JOURNAL OF CLEANER PRODUCTION, which has ranked 10 in categories of ENGINEERING, ENVIRONMENTAL, with 39 papers. Following by abstracts the best publisher in field is INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS with 34 papers. According to the fourth column of table 1, ENGINEERING with 340 papers, followed by BUSINESS ECONOMICS with 234 and OPERATIONS RESEARCH MANAGEMENT SCIENCE with 207, are three best research area.

Table 1. Top ten source titles and research areas in green supply chain of environment and ecology

Source title	N	% of 652	Research Area	N	% of 652
JOURNAL OF CLEANER PRODUCTION	39	5.982 %	ENGINEERING	340	52.147 %
INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	34	5.215 %	BUSINESS ECONOMICS	234	35.890 %
INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	20	3.067 %	OPERATIONS RESEARCH MANAGEMENT	207	31.748 %

			SCIENCE		
TRANSPORTATION RESEARCH PART E LOGISTICS AND TRANSPORTATION REVIEW	20	3.067 %	ENVIRONMENTAL SCIENCES ECOLOGY	134	20.552 %
ADVANCED MATERIALS RESEARCH	17	2.607 %	COMPUTER SCIENCE	114	17.485 %
RESOURCES CONSERVATION AND RECYCLING	15	2.301 %	SCIENCE TECHNOLOGY OTHER TOPICS	56	8.589 %
APPLIED MECHANICS AND MATERIALS	13	1.994 %	TRANSPORTATION	44	6.748 %
SUPPLY CHAIN MANAGEMENT AN INTERNATIONAL JOURNAL	13	1.994 %	MATERIALS SCIENCE	33	5.061 %
COMPUTER AIDED CHEMICAL ENGINEERING	12	1.840 %	ENERGY FUELS	22	3.374 %
INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING AND ENGINEERING MANAGEMENT IEEM	12	1.840 %	MATHEMATICS	17	2.607 %

3.3 Distribution by Web of Science Categories and 10 Top countries in GSCM

Table 2 shows the Web of Science Categories. According to distribution by web of science categories, OPERATIONS RESEARCH MANAGEMENT SCIENCE with 207 papers (19% of 100%), MANAGEMENT with 177 (16% from 100%) and ENGINEERING INDUSTRIAL with 132 papers (12% of 100%), are the three categories, which publish most of the papers, so more than 47% of those papers published in those three categories. Column four shows the number of published papers in top ten countries. So people of china with 206 articles, is the country with most published paper in this field second is USA with 107 and third is Taiwan with 52 articles. More than 68% papers in this field published in three top countries.

3.4 Top ten papers in GSCM

The most frequently cited articles for the period of 2005 to 2015 are presented in table 3. Three of the most frequently cited articles were published in INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS and two of them

published in JOURNAL OF CLEANER PRODUCTION and TRANSPORTATION RESEARCH PART E LOGISTICS AND TRANSPORTATION REVIEW published two article either. The most frequently cited articles (among them the top four listings) originated in the China respectively. An interesting aspect, presented as the sixth column in Table 3, is the average number of citations per year (AC). Although this observation is not consistent, it appears that the number of citations per year tends to increase with the number of years since publication. Pointing to a possible snowball effect when it comes to the acceptance of novel research results published papers involved international collaborations. A summary of the 10 most frequently cited articles revealed that four papers were published in which has high impact factor in the category of management. The four journals with the most articles in this category were JOURNAL OF CLEANER PRODUCTION, INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, and INTERNATIONAL JOURNAL OF MANAGEMENT REVIEWS.

Table 2. Number of published paper according to WOS Categories and Countries/Territories

Web of Science Categories	N	% of 652	Countries/Territories	N
OPERATIONS RESEARCH MANAGEMENT SCIENCE	207	39.877 %	PEOPLES R CHINA	206
MANAGEMENT	177	27.147 %	USA	107
ENGINEERING INDUSTRIAL	132	20.245 %	TAIWAN	52
BUSINESS	116	17.791 %	ENGLAND	44
ENVIRONMENTAL SCIENCES	111	17.025 %	INDIA	27
ENGINEERING MANUFACTURING	107	16.411 %	CANADA	26
ECONOMICS	79	12.117 %	MALAYSIA	22
ENGINEERING ENVIRONMENTAL	73	11.196 %	AUSTRALIA	20
GREEN SUSTAINABLE SCIENCE TECHNOLOGY	50	7.669 %	ITALY	19
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	47	7.209 %	DENMARK	18

Table3. Top high citation papers in field green supply chain generation

Author	Title	J	C	NC	AC
[3]	Green supply-chain management: A state-of-the-art literature review	INTERNATIONAL JOURNAL OF MANAGEMENT REVIEWS	India	636	63.60
[11]	Environmental management and manufacturing performance: The role of collaboration in the supply chain	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	Canada	284	31.56
[12]	An organizational theoretic review of green supply chain management literature	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	China	284	31.56
[13]	Green supply chain management in China: Pressures, practices and performance	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT	China	226	45.67
[14]	Green supply chain management: pressures, practices and performance within the Chinese automobile industry	JOURNAL OF CLEANER PRODUCTION	China	196	19.60

[15]	Confirmation of a measurement model for green supply chain management practices implementation	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS	China	184	20.44
[16]	An inter -sectoral comparison of green supply chain management in China: Drivers and practices	JOURNAL OF CLEANER PRODUCTION	China	179	16.27
[17]	The moderating effects of institutional pressures on emergent green supply chain practices and performance	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	China	171	17.10
[18]	An integrated logistics operational model for green-supply chain management	TRANSPORTATION RESEARCH PART E- LOGISTICS AND TRANSPORTATION REVIEW	ENGLAND	164	13.67
[19]	Green supply chain management implications for "closing the loop"	TRANSPORTATION RESEARCH PART E LOGISTICS AND TRANSPORTATION REVIEW	China	139	15.44

J: Journal, C: Country, NC: Number of citation, AC: Average citation

In table 4, methods and key findings of them described in summery. Most of the articles wrote about application of green supply chain in china so we can conclude that China as a leader country in this field pays much attention to use green and

environmental method for improving the industry of china. The third column shows the key words used in top 10 articles so keywords such as: Supply chain management, Environmental management and Manufacturing used more than the others.

Table 4. Overview top ten papers in GSCM

Method	Key finding /result	keywords
Various mathematical tools/techniques used in literature vis-a-vis the contexts of GSCM	Interpretations of GSCM researches are summarized, and the main research issues and opportunities are highlighted.	Green supply chain management; Environmental, Empirical study; Literature review
Examines the impact of environmental collaborative activities on manufacturing performance.	Upstream practices were more closely linked with process-based performance, while downstream collaboration was associated with product-based performance.	Environmental management; Manufacturing performance; Supply chain management
Categorize and review GSCM literature under nine broad organizational theories, with a special emphasis on investigation of adoption, diffusion and outcomes of GSCM practices.	Identify GSCM research questions that are worthy of investigation and organizational theories which was considered valuable for future GSCM research.	Green supply chain management; Organizational theory; Literature review
An empirical study using survey research using literature and industry expert input and evaluation and comparative analysis with previous research findings..	Increased Chinese enterprise environmental awareness due to regulatory, competitive, and marketing pressures and drivers.	Green marketing, Supply chain management, International relations, Operations management

<p>Explores the GSCM pressures/drivers (motivators), initiatives and performance of the automotive supply chain using an empirical analysis of automotive enterprises within China.</p>	<p>The Chinese automobile supply chain enterprises have experienced high and increasing regulatory and market pressures and at the same time have strong internal drivers for GSCM practice adoption.</p>	<p>Environmental sustainability; Green supply chain management; Automotive supply chain; China</p>
<p>data collected from 341 Chinese manufacturers, two measurement models of GSCM practices implementation were tested and compared by confirmatory factor analysis</p>	<p>Both the first-order and the second-order models for GSCM implementation are reliable and valid.</p>	<p>Green supply chain management; Construct; Practice measurement; Confirmatory factor analysis; Manufacturers</p>
<p>compares drivers and practices of GSCM in one developing country, China, focusing on three typical sectors, the automobile industry, the thermal power plants and the electronic/electrical industry</p>	<p>Chinese companies in different industries have differing drivers and practices also tend to confirm that globalization and China's entry into the world trade organization have helped promote GSCM practices in manufacturing enterprises.</p>	<p>Green supply chain management; Manufacturing practices; Empirical study</p>
<p>moderated hierarchical regression analysis of data provided by 341 Chinese manufacturer respondents was completed to examine the relationships between GSCM practice, environmental and economic performance, incorporating three moderating factors market, regulatory, and competitive institutional pressures</p>	<p>Chinese manufacturers have experienced increasing environmental pressure to implement GSCM practices; the existence of market and regulatory pressures influences organizations to have improved environmental performance, especially when these pressures cause adoption of eco-design and green purchasing practices; manufacturers facing higher regulatory pressures tend to implement green purchasing and investment recovery; competitive pressure existence significantly improves the economic benefits from adoption of a number of GSCM practices with no deleterious influences on environmental performance; none of the institutional pressures contribute to or lessen possible "win-win" situations for organizations.</p>	<p>Green supply chain management, Moderated hierarchical regression, Institutional Theory, Empirical study</p>
<p>a linear multi-objective programming model is formulated that systematically optimizes the operations of both integrated logistics and corresponding used-product reverse logistics in a given green-supply chain.</p>	<p>using the proposed model, the chain-based aggregate net profits can be improved by 21.1%, compared to the existing operational performance in the particular case studied</p>	<p>Green-supply chain management; Integrated logistics systems; Systematic optimization; Reverse logistics</p>
<p>a cross-sectional survey with manufacturers in four typical Chinese industries, i.e., power generating, chemical/petroleum, electrical/electronic and automobile, to evaluate their perceived green supply chain management (GSCM) practices and relate them to closing the supply chain loop</p>	<p>capabilities of Chinese organizations on the adoption of GSCM practices in different industrial contexts and that these practices are not considered equitably across the four industries</p>	<p>Green supply chain management; Closed-loop supply chains; Empirical study; Sector comparison</p>

3.5 Top 10 Authors in GSCM

Table 5 shows the top authors in this field. SARKIS J with 25 articles is the author who published the most papers in this field. Followed by ZHU QH with 20 papers and LAI KH with 15 are the second and third authors.

Table 5. Top 10 Authors in green supply chain

Authors	N	References
SARKIS J	25	[20-22]
ZHU QH	20	[23-25]
LAI KH	15	[25-27]
GOVINDAN K	14	[28-30]
GENG Y	10	[24, 31, 32]
DIABAT A	9	[33-35]
XU A	8	[36-38]
JABBOUR ABLD	7	[39-41]
JI GJ	7	[42-44]
TSENG ML	6	[31, 44, 45]

4. Conclusion:

In this paper, we review the literature on GSCM with a focus on identifying applicable and explanatory organizational theories that have been utilized to expand understanding and knowledge of this research field. We find that researchers in GSCM have started to apply a number of organizational theories in explicit ways. Some of the research has also helped to further understand and strengthen some of these theories. We also expound on future possibilities for organizational theory development and linkages. We can make a number of observations of this initial review and integration of the literature. First, the organizational theory provides a very valuable source of theoretical underpinnings for investigating and furthering research in GSCM. Second, there are ample opportunities for future research and

investigation with theories that have already been applied. Significant questions still exist that require investigation. Third, there is also an ample room for new theories examining the GSCM management, introduction, and diffusion that have not seen significant investigations. Fourth, much of the literature on the applications and uses of theory in GSCM research has been relatively recent. This observation means that we are at the growth stages of GSCM and organizational theory linkage. Fifth, additional and emergent organizational theories may exist that can help address unforeseen and nascent GSCM issues. Finally, even though we identify some additional theories, researchers in GSCM could be able to develop theories that may explain other organizational phenomena. We believe that this paper can serve as a good foundation for those seeking to develop theories and broaden research in GSCM. We did not discuss various methodologies and tools that could be used to investigate the linkage of GSCM and the organizational theory. Methodological developments and application for supply chain and GSCM research are also promising areas for future studies. We believe that significant growth and opportunities to understand our world exist at the nexus of these important environmental-based organizational research fields.

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