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Green supply chain management (GSCM): a structured literature review and research implications

Rakesh Kumar Malviya Ravi Kant

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# Green supply chain management (GSCM): a structured literature review and research implications

Rakesh Kumar Malviya and Ravi Kant
*Department of Mechanical Engineering,*
*S.V. National Institute of Technology, Surat, India*

## Abstract

**Purpose** – The purpose of this paper is to examine the status of green supply chain management (GSCM) research in terms of how the field is represented along a number of dimensions including journal, year, country, university, publishing house, authors, research design, research methods, data analysis techniques, multi criteria decision-making methods, research topics/issues and major industries actively involved.

**Design/methodology/approach** – A range of online databases from 1998 to August 2013 were searched containing the word "green supply chain" in their title and in the phrases to provide a comprehensive listing of journal articles on GSCM. Based on this a total of 177 articles were found and the information on a series of variables was gathered. Each of these articles was further reviewed and classified. The review and classification process was independently verified. All papers were allocated to the main and sub-categories based on the major focus.

**Findings** – The major findings shows that survey research holds greater credibility and the trend in survey research is moving from exploratory to model building and testing. GSCM research related to organizational practices, environmental issues, process, performance and sustainability were found to be most widely published topics within the GSCM domain.

**Research limitations/implications** – This paper is limited in reviewing those articles which contains the word "green supply chain" in the title and the phrases of the articles.

**Originality/value** – The present review will provide increased understanding of the current state of research and what still needs to be investigated in the GSCM discipline.

**Keywords** Literature review, Green supply chain management, GSCM, Research implications

**Paper type** Literature review

## 1. Introduction

The environmental issues and resource depletion problems now a day were contributed by the economic growth which increases the level of energy and the material consumption. The environmental and economic performance is balanced by the organizations facing regulatory, competitive and community pressures were increases significantly (Shultz and Holbrook, 1999). Environmental sustainability is the matter of concern for going green which is the strategy that most of the organizations adopted in their business. Their adoption towards green technology results in the greater benefits that will also affects customer and their suppliers. Environmental legislation is one of the prime concerns for manufacturer across the world economy (Ninlawan *et al.*, 2011). Hence, it is essential to develop the new, systematic and emerging environmental approach for whole supply chain (SC) commonly known as green supply chain management (GSCM). It is used by the fastest growing and green thinking business organizations (Zhu and Sarkis, 2004). GSCM is the integration of environmental thinking into SC which includes manufacturing process, material sourcing and selection, product design and delivery of the final product to the consumers as well as end-of-life management of the product after it useful life (Srivastava, 2007). It is an

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important strategy to integrate the environmental management practices and SC for increasing the business profit and market share for achieving the competitive advantage and maintaining the greener SC (Rao and Holt, 2005). GSCM is consider as "closing the loop" as it ranges from green purchasing to integrated SC starting from supplier, to manufacturer, to customer and reverse logistics (Zhu and Sarkis, 2004).

There were many definitions exist in the GSCM literature (Ahi and Searcy, 2013). Gilbert (2000) defined GSCM is integrating environmental thinking into SCM. Srivastava (2007) defined as GSCM is adding "green" component to SC. Zhu and Sarkis (2007) defined as GSCM covers all phases of a product's life cycle from design, production and distribution phases to the use of products by the end users and its disposal at the end of product's life cycle. GSCM is an approach for improving performance of the processes and products according to the requirements of the environmental regulations (Hsu and Hu, 2008).

The objective of this paper is to examine the GSCM research in terms of how the field is represented along a number of dimensions including journal, year, country, university, publishing house, authors, research design, research methods, data analysis techniques, multi criteria decision-making methods (MCDM), research topics/issues and major industries actively involved. A range of online databases between 1998 to till 2013 were searched containing the word "green supply chain" in their title and in the phrases of the articles to provide a comprehensive listing of journal articles on GSCM. Control over quality was achieved by limiting the search to peer-reviewed publications only. Full bibliographic details of the 177 articles selected for analysis are shown in the Appendix in order to make present research processes transparent, and allow independent assessment of classification and analysis. These articles were structured first as per the research methodology and then databases of article were developed for further analyse. The present research is focused to analyse the main characteristics of GSCM literature in order to the research carried out in terms of what, how, where and by whom. The answers to these questions will allow us to do the deep and extensive literature. This will also helps to determine what still needs to be investigated and what to be offer to those who wants to begins the research on GSCM.

This paper is organized as follows: Section 2 describes earlier reviews of literature on GSCM Section 3 describes the scheme and methodology of review. Section 4 presents the summary of review and discussion. Section 5 is the last section dedicated to conclusion includes three subsections presenting the gaps identified in the research, significant findings of the report and future directions of the research.

## 2. Existing literature reviews of research paper on GSCM

It was found out during the current research that five literature reviews on GSCM have been done in the past. The different reviews in chronological order are as follows:

(1) Ahi, P. and Searcy, C. (2013), "A Comparative Literature Analysis of Definitions for Green and Sustainable Supply Chain Management", *Journal of Cleaner Production*, Vol. 52, pp. 391-341.

(2) Sarkis, J. (2012), "A boundaries and flows perspective of green supply chain management", *Supply Chain Management: An International Journal*, Vol. 17 No. 2, pp. 202-216.

(3) Min, H. and Kim, I. (2012), "Green supply chain research: past, present, and future", *Logistics Research*, Vol. 4 Nos 1-2, pp. 39-47.

(4) Sarkis, J., Zhu, Q. and Lai, K.H. (2011), "An organizational theoretic review of green supply chain management literature", *International Journal of Production Economics*, Vol. 130 No. 1, pp. 1-15.

(5) Srivastava, S.K. (2007), "Green supply-chain management: a state-of-the-art literature review", *International journal of management reviews*, Vol. 9 No. 1, pp. 53-80.

The outcomes of available GSCM literature review articles are discussed (see Table I).

Further, a comparison among above available GSCM literature review articles is made using certain attributes (see Table II). The attributes considered for comparisons are as follows:

(1) focus and objectives: this refers to a brief coverage of the publications in terms of the content and the applicability;

(2) number and type of publications covered: the number of publications listed in journal papers; and

(3) review methodology: this looks at the way in which the literature has been reviewed and classified.

| Sl. No. | Title of paper | Outcome |
|---|---|---|
| 1. | A comparative literature analysis of definitions for green and sustainable supply chain management | A total of 22 unique definitions for GSCM were identified in the search. A total of 12 unique definitions for SSCM were identified in the search. The paper thus provides a needed reference point on the great variety of definitions published in these areas |
| 2. | A boundaries and flows perspective of green supply chain management | The research literature can be integrated into comprehensive multi-dimensional frameworks, which also provide opportunities as vehicles for future research. Research directions are described utilizing the framework presented in this paper. The literature reviewed in this paper focuses almost exclusively on peer-reviewed journals |
| 3. | Green supply chain research: past, present and future | This paper describes the past development and current state of GSCM research, synthesizes the focused areas of GSCM research, captures the emerging perspectives of GSCM research, and points the directions for future research opportunities |
| 4. | An organizational theoretic review of green supply chain management literature | This paper categorizes and review recent GSCM literature under nine broad organizational theories, with a special emphasis on investigation of adoption, diffusion and outcomes of GSCM practices |
| 5. | Green supply chain management: a state-of the-art literature review | 1990-2007 papers were reviewed, The area throws various challenges to practitioners, academicians and researchers. This will help academicians, practitioners and researchers to understand integrated GSCM from a wider perspective |

**Table I.**
Outcomes of earlier literature reviews of the articles

**Table II.**
Detailed summary previous literature review articles on GSCM

| Review paper | Title | Authors | Published in | Focus and objectives | Number of publication covered | Type of publication covered | Methodology |
|---|---|---|---|---|---|---|---|
| 1. | A comparative literature analysis of definitions for green and sustainable supply chain management | Ahi and Searcy (2013) | *Journal of Cleaner Production* | a) The purpose of this paper is to identify and analyse the published definitions of green supply chain management (GSCM) and sustainable supply chain management (SSCM)<br>b) A total of 22 distinctive definitions for GSCM were acknowledged in the search. A total of 12 unique definitions for SSCM were identified in the search. The paper thus provides a needed suggestion point on the great variety of definitions published in these areas | 80 | Paper | The literature review focused on a search of all articles published in the Scopus database Published research in peer-reviewed journals is evaluated using a new framework of nine non-exclusive, interrelated boundaries and five flows of resources related to green supply chains and supply chain management |
| 2. | A boundaries and flows perspective of green supply chain management | Sarkis (2012) | *Supply Chain Management: An International Journal* | The comprehensive boundaries and flows framework can be valuable for identifying barriers to study and implementation of the interdisciplinary green supply chain management topic based on recent published literature. This paper aims to provide a framework to recognize and understand the relationships of various research streams and topics in this field | 137 | Paper | |
| 3. | Green supply chain research: past, present and future | Min and Kim (2012) | *Logistics Research* | This paper traces the evolution of green supply chain research, synthesizes the past and current research efforts to develop a possible green supply chain strategy, and then proposes hopeful future research themes related to this strategy | 18 | Paper | Literature search media, The taxonomy of the GSCM literature, |
| 4. | An organizational theoretic review of green supply chain management literature | Sarkis *et al.* (2011) | *International Journal of Production Economics* | To review the literature on GSCM with a focus on identifying pertinent and descriptive organizational theories that has been utilized to enlarge indulgent and understanding of this research field | 176 | Paper | Organizational theory |
| 5. | Green supply chain management: a state-of the-art literature review | Srivastava (2007) | *International Journal of Management Reviews* | To present a complete integrated view of the published literature on all the aspects and facets of GSCM, taking a "reverse logistics angle" so as to facilitate further study, practice and research | 227 | Paper | Defining unit of analysis, Classification context, Material evaluation, Collecting publications and delimiting the field. Literature highlighting the importance of GSCM; literature on green design; and literature on green operations |

Apart from these unique attributes, certain common parameters like, the name of publication, author(s), year of publication, journal of publication are also used (see Table II). The detailed information and discussion has been carried in Tables II and III.

| Attributes | Descriptions |
|---|---|
| *Journals used* | |
| It is based on the journals which contains the articles related GSCM area | |
| *Year of articles publication* | |
| It is based on the years in which the articles were published to know awareness among organizations and suppliers | |
| *Country of publication* | |
| It is based on the countries which are paying more attention towards environmental issues and aspects | |
| *University of publication* | |
| It is based on the universities interestingly working on the GSCM area | |
| *Publishing house* | |
| It is based on the renowned publishers involved to explore and published the peer research on GSCM | |
| *Authors* | |
| It is based on the active involvement of the researchers in the field of GSCM | |
| *Research design applied* | |
| Empirical quantitative | Survey research |
| Empirical qualitative | Case study and action research approaches |
| Desk quantitative | Mathematical model, fuzzy logic, etc. |
| Desk qualitative | Conceptual models, archival studies, developing propositions for future research, etc. |
| Empirical triangulation | Multi method approach i.e. when two or more methods were applied |
| *Research methods* | |
| Survey | Direct or mail based survey |
| Interviews | Verbal or written, structured interview |
| Interviews + survey | Both survey and interviews were conducted simultaneously |
| Conceptual model | Theoretical research |
| Case study | Theoretical or empirical case study |
| Mathematical model | Developing mathematical model for real life situation |
| Case study + mathematical model | Both case study and mathematical models were used simultaneously |
| Simulation | It is based on to check the validity and applicability of the proposed models |
| *Data analysis techniques* | |
| It is based on the summarizations of the large data. Major techniques used for data analysis such as factor analysis, correlation and regression analysis, analysis of variance (ANOVA), Structural equation modeling (SEM), cluster analysis, path analysis, data envelopment analysis (DEA), linear programming, etc. | |
| *Multi-criterion decision makings (MCDM) methods* | |
| It is based on the decision making methods used in the analysis. It includes AHP, ANP, TOPSIS, MICMAC, ISM, DEMATEL, etc. | |
| *Major research areas* | |
| It represents the various aspects of specialized categories and broadly classified on the core topics | |
| *Major industries focused* | |
| It is more over mainly concern with the implementation and adoption of the core areas in the industries | |

**Table III.**
Attributes used in the analysis

After thorough review of these articles, no review articles found which have covered all the articles of GSCM containing the word "green supply chain" in the title and in the phrases of the articles. Hence, there is necessary requirement of such type of review. This paper aims to review and understand the trends of the GSCM articles published between 1998 to August 2013. Now it is very essential that attempt to this paper should be different from the earlier reviews and covers deep literature. Besides these, this paper is also covering the following objectives:

(1) classification of research articles;

(2) arranging all the published articles in orderly manner; and

(3) gap identification, findings and future directions.

Keeping these observations in mind the authors decided to approach the review process in a different way, as illustrated in the next section of the paper.

## 3. Scheme and methodology of review

### *3.1 Prelude to literature review*

Literature review may be considered as the primary method of synthesizing previous research on GSCM. Structured literature review considers the GSCM research that can be applied both in qualitative and a quantitative way. The structured review represents an effective tool for analysing a sample of research document in a systematic and rule-governed way. Over the past three years, the authors had several opportunities to collect and study the literature concerning to GSCM. There were two main reasons:

(1) interactions with the organizations with focus on GSCM; and

(2) one of the authors is pursuing doctoral in the field GSCM implementation.

### *3.2 Scheme of literature review*

As per the agenda of present research it was decided to classify and analyse the literature in detail. The course of action included the following steps:

(1) The collection of the data for literature has been reviewed from 1998 to August 2013 ensuring that database is as current as possible.

(2) For extensive literature, the data from Scopus were specifically used to find current and pertaining literature on GSCM. Electronic search in World Wide Web were made to ensure the collection of complete database of GSCM. It has been tried to include most of the articles in best possible way; however, the present research do not claim that the database is complete or exhaustive in nature. The research has been carried out in English language and employed the following electronic databases:

- Elsevier science direct – www.sciencedirect.com/;
- Emerald full-text – www.emeraldinsight.com/;
- Taylor and Francis – www.tandfonline.com/;
- Wiley inter-science – www.wiley.com/;
- Springer link – www.springer.com/; and
- IGI global publication – www.igi-global.com/.

(3) The literature review is based on a search for the "Green supply chain" in the title and in the phrases of the above mentioned online databases.

(4) Developing a classification scheme was the next step. First a bibliographical list of all publications was developed and a file was created in Excel spread sheet.

### *3.3 Review methodology*

The aim of review was to capture a snapshot of the diversified research being conducted in the field of GSCM. For this purpose all the articles published in peer-reviewed journal containing the word "Green supply chain" in the title as well as in the phrases are reviewed. These journals are from above listed well-reputed publishers. These articles were divided into categories namely journal wise publication, year of articles publication, country of publication, worldwide university of publication, publisher wise, authors actively involved in the publication, research design used, according to the research methodology used, data analysis techniques, multi-criterion decision-making (MCDM) methods applied, major areas of research and types industries using GSCM (Figure 1).

## 4. Summary of review and discussion

This section contains the summary of review as per the scheme and methodology of review. The complete details are discussed as follows.

### *4.1 GSCM according to journals*

A total of 177 papers are published of GSCM containing the word "green supply chain" in the title and in the phrases from 66 publishing outlets as shown in the Table IV. The Table IV suggests that journal of cleaner production appeared the highest numbers i.e. 19, containing the word green supply chain in their title and in the phrases. The least

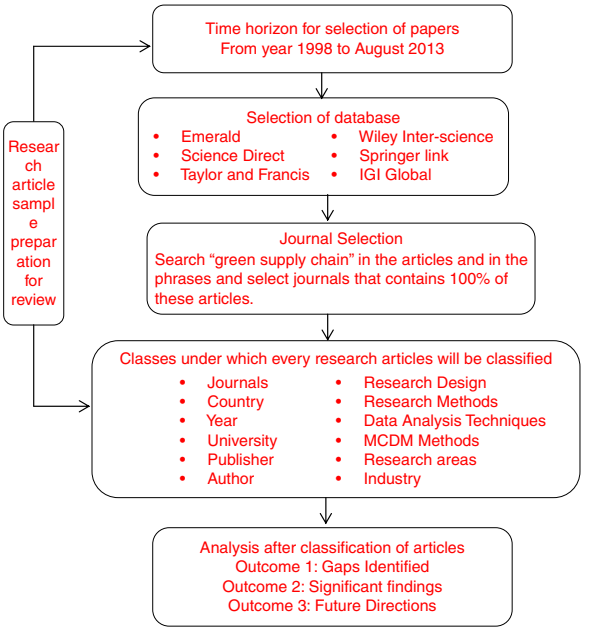


**Figure 1.**
General methodology for structured literature review

| Name of journals | No. of papers | % |
|---|---|---|
| *Journal of Cleaner Production* | 19 | 10.7 |
| *International Journal Production Economics* | 15 | 8.47 |
| *Supply Chain Management: An International Journal* | 13 | 7.34 |
| *International Journal of Production Research* | 10 | 5.65 |
| *Business Strategy and the Environment* | 9 | 5.08 |
| *Benchmarking: An International Journal* | 7 | 3.95 |
| *Resources, Conservation and Recycling* | 7 | 3.95 |
| *Expert Systems with Applications* | 6 | 3.39 |
| *Industrial Marketing Management* | 6 | 3.39 |
| *Transportation Research Part E* | 6 | 3.39 |
| *Greening the Supply Chain* | 5 | 2.82 |
| *Management Research Review* | 5 | 2.82 |
| *International Journal of Operations and Production Management* | 3 | 1.69 |
| *International Journal of Physical Distribution and Logistics Management* | 3 | 1.69 |
| *Journal of Manufacturing Technology Management* | 3 | 1.69 |
| *Journal of Purchasing and Supply Management* | 3 | 1.69 |
| *Production Planning and Control: The Management of Operations* | 3 | 1.69 |
| *Applied Mathematical Modelling* | 2 | 1.13 |
| *Decision Support Systems* | 2 | 1.13 |
| *Enterprise Networks and Logistics for Agile Manufacturing* | 2 | 1.13 |
| *International Journal Environment Science and Technology* | 2 | 1.13 |
| *Journal of Loss Prevention in the Process Industries* | 2 | 1.13 |
| *Advanced Engineering Informatics* | 1 | 0.56 |
| *Applied Soft Computing* | 1 | 0.56 |
| *Clean Technology Environmental Policy* | 1 | 0.56 |
| *Computer Science and its Applications* | 1 | 0.56 |
| *Computers and Mathematics with Applications* | 1 | 0.56 |
| *Corporate Social Responsibility and Environmental Management* | 1 | 0.56 |
| *Digital Enterprise Technology* | 1 | 0.56 |
| *Advances in Intelligent and Soft Computing* | | |
| *European Business Review* | 1 | 0.56 |
| *European Journal of Innovation Management* | 1 | 0.56 |
| *European Journal of Operational Research* | 1 | 0.56 |
| *European Journal of Purchasing and Supply Management* | 1 | 0.56 |
| *Human and Ecological Risk Assessment: An International Journal* | 1 | 0.56 |
| *IIMB Management Review* | 1 | 0.56 |
| *Industrial Management and Data Systems* | 1 | 0.56 |
| *International Business Review* | 1 | 0.56 |
| *International Journal of Applied Logistics* | 1 | 0.56 |
| *International Journal of Computer Integrated Manufacturing* | 1 | 0.56 |
| *International Journal of Hospitality Management* | 1 | 0.56 |
| *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management* | 1 | 0.56 |
| *International Journal of Management Reviews* | 1 | 0.56 |
| *International Journal of Purchasing and Materials Management* | 1 | 0.56 |
| *Journal of Business Ethics* | 1 | 0.56 |
| *Journal of Engineering and Technology Management* | 1 | 0.56 |
| *Journal of Environmental Economics and Management* | 1 | 0.56 |
| *Journal of Environmental Management* | 1 | 0.56 |

(*continued*)

**Table IV.**
Journal wise papers

| Name of journals | No. of papers | % |
|---|---|---|
| *Journal of Environmental Policy and Planning* | 1 | 0.56 |
| *Journal of Fashion Marketing and Management* | 1 | 0.56 |
| *Journal of Modelling in Management* | 1 | 0.56 |
| *Journal of Operations Management* | 1 | 0.56 |
| *Journal of Supply Chain Management* | 1 | 0.56 |
| *Journal of Sustainable Development* | 1 | 0.56 |
| *Journal of Technology Management in China* | 1 | 0.56 |
| *Journal of Transport Geography* | 1 | 0.56 |
| *Knowledge Discovery and Data Mining* | 1 | 0.56 |
| *Knowledge-Based Systems* | 1 | 0.56 |
| *Logistic Research* | 1 | 0.56 |
| *Logistics Information Management* | 1 | 0.56 |
| *Measuring Business Excellence* | 1 | 0.56 |
| *Omega* | 1 | 0.56 |
| *Scientia Iranica* | 1 | 0.56 |
| *Systems Engineering – Theory and Practice* | 1 | 0.56 |
| *The Asian Journal of shipping and logistics* | 1 | 0.56 |
| *The International Journal of Logistics Management* | 1 | 0.56 |
| *Transportation Research Part D* | 1 | 0.56 |
| Total | 177 | 100 |

**Table IV.**

number of articles published is one in many journals. There were other journals that have published significant amount of articles on GSCM includes *International Journal of Production Economics* (15), *Supply Chain Management: An International Journal* (13), *International Journal of Production Research* (10), *Business Strategy and the Environment* (9), *Benchmarking: An International Journal and Resources*, *Conservation and Recycling* published seven articles each and three journals, namely, *Expert Systems with Applications*, *Industrial Marketing Management* and *Transportation Research Part E* published six articles each. However there are more journals which contain articles related to GSCM supporting the topic areas (see Table IV). This highlights and upholds the cross-disciplinary nature of GSCM research and also helps the researchers and practitioners to know about the various journals in which GSCM research has been published.

### *4.2 GSCM studies according to year of articles publication*

A longitudinal literature survey published within the field of GSCM is being predicted in the Table V, which indicates that the number of articles published on GSCM has potentially increased. Based on the citation of the article, 62 articles were appeared in the year 2012, eventually followed by 2011 with a total 32 articles with 20 articles in 2010 and 2013 counts a total of 16 articles up to august 2013. Likewise the numbers of articles published are decreasing as down to years, with no articles appearing in selected journals during some years at all. While it may be argued that increasing number of articles suggest the increased level of interest towards research activities in the subject area. The point especially applicable to the earlier years considers the lack of articles prior to this time may be because of a number of reasons, such as not all journals were being published in each year in the present research. A large number of organizational environmental based initiatives may have included a GSCM strategy

| Year | No. of papers |
|---|---|
| 2013 | 16 |
| 2012 | 62 |
| 2011 | 32 |
| 2010 | 20 |
| 2009 | 5 |
| 2008 | 12 |
| 2007 | 7 |
| 2006 | 8 |
| 2005 | 5 |
| 2004 | 2 |
| 2003 | 1 |
| 2002 | 2 |
| 2000 | 1 |
| 1999 | 3 |
| 1998 | 1 |
| Total | 177 |

**Table V.**
Year wise list of papers



due the rapid increase of articles from the year 2000 onwards, as it was a period of global internet boom and because of environmental awareness among organizations and suppliers globally.

*4.3 GSCM studies according to the country*

The purpose of analysis of GSCM studies according to the country is to create awareness among researchers and practitioners as well as society about which countries are paying more attention towards GSCM research and also to create awareness in the society about the environmental issues, aspects and challenges. The finding on GSCM research across the 177 publications has covered 31 major countries around the world as shown in the Table VI. Out of 177 articles Taiwan contributed most number of articles. Apart from Taiwan many other countries like as China, USA, UK, Australia, Canada, Germany, India, Turkey, Italy, the Netherlands, Denmark, Iran, Korea, etc., as shown in the Table VI are also the major countries responsible for a substantial number of publications (see Table VI).

In the countries such as Egypt, Europe, France, South Korea, Spain, etc., are the locations of GSCM research where numbers of publications were low (see Table VI). This indicates that there were ample opportunities in these countries to do research and further expand the GSCM base. The majority of research on GSCM is actually being carried out by Asian countries, closely followed by those in the UK and USA, then the Europe. But what about the undeveloped countries? These are the regions where most of the multi-national companies were targeting either as new market for their products or for sourcing the raw material due to the low cost. It would be better if the researchers would focus on these countries (Figure 2).

*4.4 GSCM studies according to universities*

For publishing the 177 articles, a total of 127 institutions/universities have affiliated authors who analysed on the GSCM study. The most active university appears in the GSCM research is shown in the Table VII. The contributions from each university varies from one to19 articles overall in numbers. The Table VII clearly shows that Dalian

| Name of country | No. of papers | % |
|---|---|---|
| Taiwan | 27 | 15.254 |
| China | 27 | 14.689 |
| USA | 23 | 12.994 |
| UK | 18 | 10.734 |
| Canada | 7 | 3.9548 |
| Germany | 7 | 3.9548 |
| India | 7 | 3.9548 |
| Turkey | 7 | 3.9548 |
| Australia | 6 | 3.3898 |
| Italy | 6 | 3.3898 |
| The Netherlands | 5 | 2.8249 |
| Denmark | 3 | 1.6949 |
| Iran | 3 | 1.6949 |
| Korea | 3 | 1.6949 |
| Malaysia | 3 | 1.6949 |
| Sweden | 3 | 1.6949 |
| United Arab Emirates | 3 | 1.6949 |
| Brazil | 2 | 1.1299 |
| Greece | 2 | 1.1299 |
| Hong Kong | 2 | 1.1299 |
| Japan | 2 | 1.1299 |
| Portugal | 2 | 1.1299 |
| Singapore | 2 | 1.1299 |
| Egypt | 1 | 0.565 |
| Europe | 1 | 0.565 |
| France | 1 | 0.565 |
| South Korea | 1 | 0.565 |
| South east Asia | 1 | 0.565 |
| Spain | 1 | 0.565 |
| Switzerland | 1 | 0.565 |
| Total | 177 | 100 |

**Table VI.**
Papers country wise

university of technology, Dalian, China has got the highest number of publications with 19 publications. Hence it is the largest contributor in terms of number of articles publications and therefore can be seen as a leading centre of GSCM research followed by Erasmus University, Rotterdam, the Netherlands and Lung Hwa University of Science

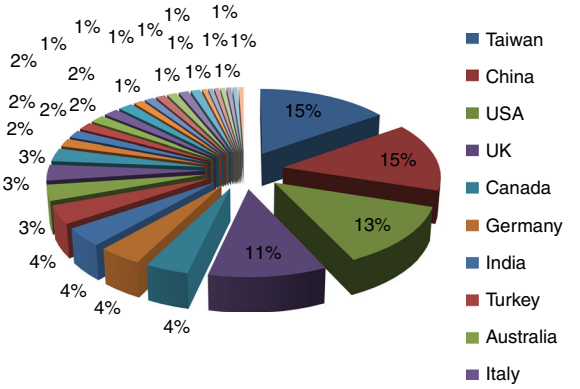


**Figure 2.**
Country wise reviewed papers

| Name of university | No. of papers |
|---|---|
| Griffith University, Queensland, Australia | 2 |
| University of Melbourne, Melbourne, Australia | 2 |
| Universidade do Vale do Rio dos Sinos, Cristo Rei, São Leopoldo, Brazil | 2 |
| Ryerson University, Toronto, Canada | 2 |
| Dalian University of Technology, Dalian, China | 19 |
| Tianjin University, Tianjin, China | 2 |
| The Hong Kong Polytechnic University, Hong Kong | 2 |
| National Institute of Technology,Tiruchirappalli, India | 2 |
| Indian Institute of Technology, Orissa, India | 2 |
| Universiti Sains Malaysia, Penang, Malasiya | 2 |
| Erasmus University, Rotterdam, The Netherlands | 4 |
| National University of Singapore, Singapore | 2 |
| Chung Yuan Christian University, Chungli, Taiwan | 2 |
| Lung Hwa University of Science and Technology, Taiwan | 4 |
| National Chiao Tung University, Taipei, Taiwan | 2 |
| National Taipei University of Technology, Taipei, Taiwan | 3 |
| National Tsing Hua University, Taiwan | 2 |
| National Yunlin University of Science and Technology, Taiwan | 2 |
| Masdar Institute of Science and Technology, Abu Dhabi, UAE | 2 |
| Aston University, Birmingham, UK | 3 |
| University of Bath, Claverton Down, Bath, UK | 2 |
| University of East Anglia, Norwich, UK | 2 |
| Bowling Green State University, Bowling Green, Ohio, USA | 2 |
| Clark University, Worcester, USA | 3 |
| Florida State University, Florida, USA | 2 |
| University of Tennessee, Knoxville, Tennessee, USA | 2 |

**Table VII.**
University wise list of papers

and Technology, Taiwan with four articles publication each, which is far away from the Dalian University of Technology, China. This is then closely followed by National Taipei University of Technology, Taipei, Aston University, Birmingham, UK and Clark University, Worcester, USA with three articles each. There are various other numbers of universities are the source of a number of articles publications over the years, including 20 universities contributed two articles each, while 101 universities (not listed) were the source of just only one article publication. Such type of analysis will helps researchers and practitioners to know which universities across the globe are working and paying attention towards GSCM research.

### *4.5 GSCM studies according to publishing house*

The finding on GSCM research across the 177 publications has covered six publishers, namely, Science Direct/Elsevier, Emerald publication, Taylor and Francis, Wiley inter-science, Springer link and IGI global publication and these publishers published the major research articles on GSCM study. The Table VIII shows that science Direct/Elsevier published 89 articles on GSCM research, followed by Emerald publication with 44 articles. There were more publishers published articles on GSCM such as Taylor and Francis (16) articles, Springer link (14) articles, Wiley inter-science (13) articles and IGI global published only one article. These are the renowned publishers which are actively participate to explore and published the peer research that has researched by the researchers and practitioners in the area of GSCM (Figure 3).

*4.6 GSCM studies according to the authors actively involved in GSCM research*

GSCM research in being also studies by knowing the active involvement of the authors, who were participated in the publications of the articles. A total of 362 authors contributed to the 177 articles on GSCM research. All the authors from 177 articles including main author and co-author are taken. Table IX shows the top 16 authors with three or more articles each, which are most active in publishing and conducting GSCM research. Qinghua Zhu with 18 articles appears to be most productive author in terms of journal publication across the journals in GSCM research, and closely followed by Joseph Sarkis with 17 articles. Kee-hung Lai contributed 11 articles, Kannan Govindan with seven articles, Stephan Vachon and Yong Geng contributed five articles each followed by Ali Diabat, Jiuh-Biing Sheu and Robert D. Klassen with four articles each. Thereafter seven authors (A. Noorul Haq, Gulcin Buyukozkan, Hing Kai Chan, Ming-Lang Tseng, Roohollah Khodaverdi, Ru-Jen Lin and S.C. Lenny Koh) contributed three articles each.

From 362 authors, 39 authors contributed two articles each while the vast majority of the authors i.e. 307 have contributed to only one article in the search data. These authors were not listed in the Table IX because of the limitation of space. These results show that the field GSCM is limited in terms numbers of articles publication in the area of GSCM and the active involvement of the researcher. Moreover, the results show that large amount of research have been done in the Asia Pacific region.

*4.7 Research design*

The methodology applied for research design in this paper is based on the empirical work or desk research. The articles have been categorized into five major sections such

| Name of publishers | No. of papers | % |
|---|---|---|
| Science Direct | 89 | 50.28 |
| Emerald Publication | 44 | 24.86 |
| Taylor and Francis | 16 | 9.04 |
| Wiley inter-science | 13 | 7.345 |
| Springer link | 14 | 7.91 |
| IGI global publication | 1 | 0.565 |
| Total | 177 | 100 |

**Table VIII.**
Publisher wise papers

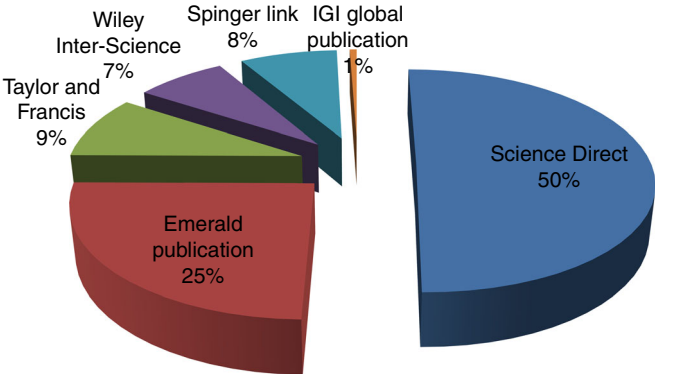


**Figure 3.**
Publisher wise review of papers

| Sl. No. | Name of authors | No. of papers |
|---|---|---|
| 1 | Qinghua Zhu | 18 |
| 2 | Joseph Sarkis | 17 |
| 3 | Kee-hung Lai | 11 |
| 4 | Kannan Govindan | 7 |
| 5 | Stephan Vachon | 5 |
| 6 | Yong Geng | 5 |
| 7 | Ali Diabat | 4 |
| 8 | Jiuh-Biing Sheu | 4 |
| 9 | Robert D. Klassen | 4 |
| 10 | A. Noorul Haq | 3 |
| 11 | Gulcin Buyukozkan | 3 |
| 12 | Hing Kai Chan | 3 |
| 13 | Ming-Lang Tseng | 3 |
| 14 | Roohollah Khodaverdi | 3 |
| 15 | Ru-Jen Lin | 3 |
| 16 | S.C. Lenny Koh | 3 |

**Table IX.** Author wise distribution of papers

as empirical qualitative, empirical quantitative, desk qualitative, desk quantitative and empirical triangulation. The articles in each category of research design per year, the Table X will provide all the information. This shows that empirical quantitative (72) has got the highest number of articles published in peer-reviewed journals and they are mostly based on the survey. The empirical qualitative research is done in 43 articles indicating that case study; action research approaches were less popular. A multi method approach also called as empirical triangulation is also used in 16 articles in which more than two methods were used to formulate the required models. The desk quantitative (25) containing mathematical modeling, fuzzy logic, etc., is more popular than the desk qualitative (21) containing conceptual models, archival studies, future research propositions, etc., (Figures 4 and 5).

### *4.8 Research methods*

Each article of GSCM was observed, analysed and the research methods were noted down. The major research articles focus on the methods such as survey, interviews, mathematical modeling, simulation, case studies and conceptual models. The methods like simulation, math modeling, surveys are coming under all sewn up models. These models are dominated by the logistics and GSCM discipline.

Information about all the research methods found is shown in the Table XI. The most common method used for GSCM is survey (55), followed by the articles on case study (30). The combination of survey and interview includes 28 articles.

| Research design | No. of papers | % |
|---|---|---|
| Empirical quantitative | 72 | 40.7 |
| Empirical qualitative | 43 | 24.3 |
| Desk quantitative | 25 | 14.1 |
| Desk qualitative | 21 | 11.9 |
| Empirical triangulation | 16 | 9.04 |
| Total | 177 | 100 |

**Table X.** Research design applied for GSCM

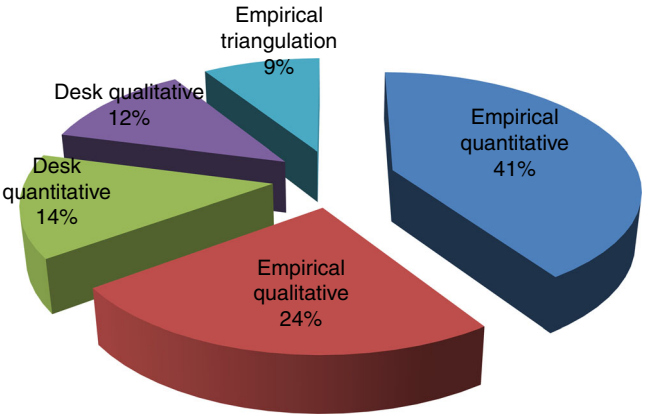


**Figure 4.**
Research design wise distribution of papers

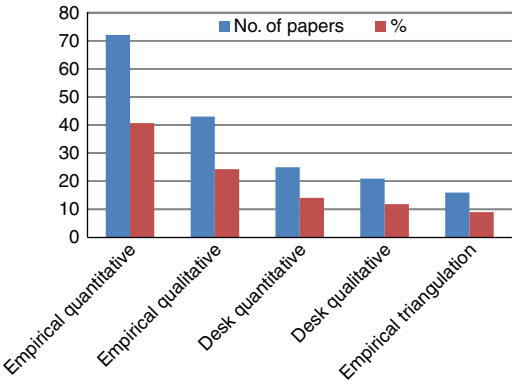


**Figure 5.**
Research design wise comparison of papers

To investigate the specific aspects through in-depth and limited-scope study, the best methodology used will be the case study as in this the operations are studied in their natural settings and theories are generated directly from the data. The articles on math modeling (17) are medium in numbers as this implies the various decision-making

**Table XI.**
Research methods applied

| Research methods | No. of papers | % |
|---|---|---|
| Survey | 55 | 31.07 |
| Interviews | 11 | 6.215 |
| Survey + interviews | 28 | 15.82 |
| Conceptual model | 16 | 9.04 |
| Case study | 30 | 16.95 |
| Mathematical model | 17 | 9.605 |
| Case study + mathematical model | 11 | 6.215 |
| Simulation | 9 | 5.085 |
| Total | 177 | 100 |

methods and by using these methods a mathematical models are constructed. The combination of mathematical model and case study includes 11 articles while conceptual modeling is done in 16 articles. Simulation (9) is often used to check the validity of these models to examine the efficiency of these heuristics models present in the articles. There were many articles in which mathematical approach were supported by the examples to prove their importance. All the methods are susceptible, their needs are more and their permissibility is proven. By enlarging the collection of methodologies for making the true contributions to both research and practices, apply for those which are most efficient, appropriate and effective (Figures 6 and 7).

### *4.9 Data analysis techniques*

To summarize the large amount of data, the researcher will take the help of data analysis techniques. There are various ways of data analysis techniques to summarize the data such as questionnaire development, understanding the effect of number of variables on the final outcome, it helps the researcher in minimizing the spurious effects inherent in most questionnaire data, and it also enables the effects of alternative future scenario to asses to the researcher. There were many major techniques used for data analysis such as factor analysis, correlation and regression analysis, analysis of

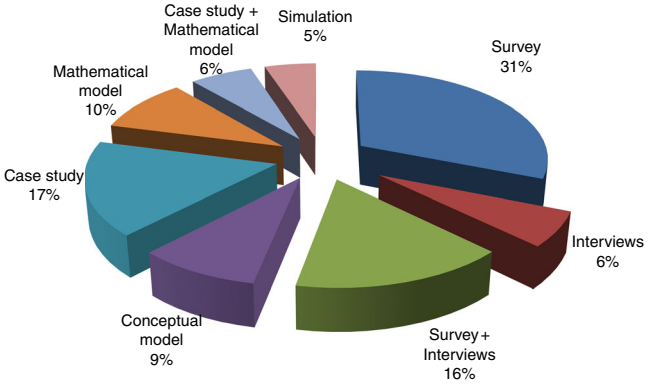


**Figure 6.**
Research method wise distribution of papers

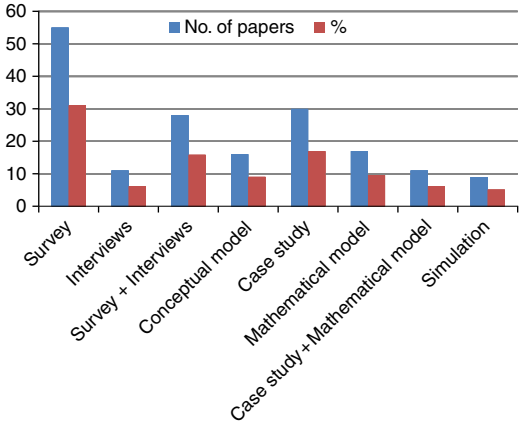


**Figure 7.**
Research methods wise comparison of papers

variance (ANOVA), set theory, game theory, Structural equation modelling (SEM), diffusion innovation theory, quantitative analysis, cluster analysis, path analysis, data envelopment analysis (DEA), linear programming, etc.

Information about data analysis techniques used within the articles for data analysis has been shown in the Table XII. For more advanced data analysis techniques are needed for improving in persuasive findings of survey research as suggested by Mentzer and Kahn (1995), Such as path analysis, regression, ANOVA, etc. The extension of multiple regression analysis is the path analysis for examining the significance and the magnitude of causal connections between a set of variables. It is also the subset of a more elaborative technique called SEM.

The Table XII shows that out 177 articles, correlation analysis has been done in most articles (34), followed by factor analysis with 31 articles, while regression analysis has been done in 24 articles, ANOVA in 12 articles and in 11 articles sensitivity analysis has been done, followed by set theory with ten articles and game theory contains seven articles. SEM with five articles, path analysis with four articles, while cluster analysis and diffusion innovation theory includes three articles each. While linear programming have been done in two articles. Data analysis techniques such as DEA and Quantitative analysis contains one article each. Inspite of these techniques, 29 other articles were there which contains other techniques such as case studies, literature review, etc., (Figures 8 and 9).

### *4.10 MCDM methods*

MCDM methods are used by many researchers. The Table XIII shows various MCDM methods used across the 177 articles. A total of 39 articles out of 177 articles used MCDM methods. In this regards, the analytical hierarchical process (AHP) and analytical network process (ANP) are mostly used methods i.e. ten articles each, including Fuzzy AHP and Fuzzy ANP. Techniques for order preference by similar to ideal solution (TOPSIS) methods and MICMAC methods are used in four articles, while Decision-making trial and evaluation laboratory (DEMATEL) and MCDM methods

| Techniques | No. of papers | % |
|---|---|---|
| *Data analysis techniques* | | |
| Correlation analysis | 34 | 19.21 |
| Factor analysis | 31 | 17.51 |
| Regression | 24 | 13.56 |
| ANOVA | 12 | 6.78 |
| Sensitivity analysis | 11 | 6.215 |
| Set theory | 10 | 5.65 |
| Game theory | 7 | 3.955 |
| SEM | 5 | 2.825 |
| Path analysis | 4 | 2.26 |
| Cluster analysis | 3 | 1.695 |
| Diffusion innovation theory | 3 | 1.695 |
| Linear programming | 2 | 1.13 |
| DEA | 1 | 0.565 |
| Quantitative analysis | 1 | 0.565 |
| Others | 29 | 16.38 |
| Total | 177 | 100 |

**Table XII.**
Data analysis techniques used

covers three articles each. Interpretive structural modelling (ISM) method is used in two articles while in Graph theoretic and matrix, Multi-attribute utility theory and Grey relational analysis one article is used in each method. These methods will help organizations to take decisions regarding whether to initiate GSCM inhibit adoption or undertake remedial improvements. Moreover, MCDM methods are also used to analyse data, to develop various models and to know the cause and effects of the variables related to GSCM (Figure 10).

### *4.11 Major research areas of GSCM*

This research has presented the various aspects of specialized categories within the GSCM literature. The major research areas are broadly classified on the core topics of GSCM. The findings shown in the Table XIV suggested that the large number of articles investigated are related to GSCM practices and environmental issues closely followed by GSCM processes implementation and sustainability. Supplier selection, performance measurement, waste, barriers and drivers of GSCM also play an important in creating interest towards research GSCM. These categories primarily deal with realization and in-context for implementation of GSCM within the organization. This type to analysis will help in exploring and identifying the major area where research on GSCM is still needs to be carried out. The researchers should closely observe and execute the GSCM research (Figure 11).

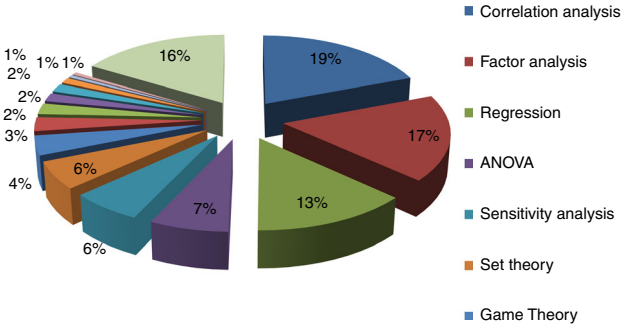


**Figure 8.**
Data analysis techniques wise distribution of papers

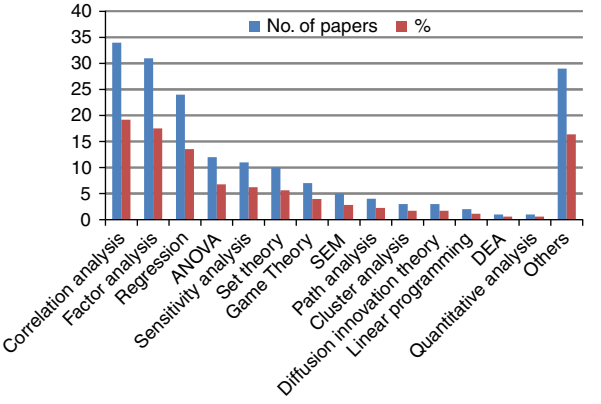


**Figure 9.**
Data analysis techniques wise comparison of papers

**Table XIII.**
MCDM methods used

| | Methods | No. of papers |
|---|---|---|
| MCDM methods | AHP | 10 |
| | ANP | 10 |
| | TOPSIS | 4 |
| | MICMAC | 4 |
| | DEMATEL | 3 |
| | MCDM | 3 |
| | ISM | 2 |
| | GTMA | 1 |
| | MAUT | 1 |
| | Grey relational analysis | 1 |

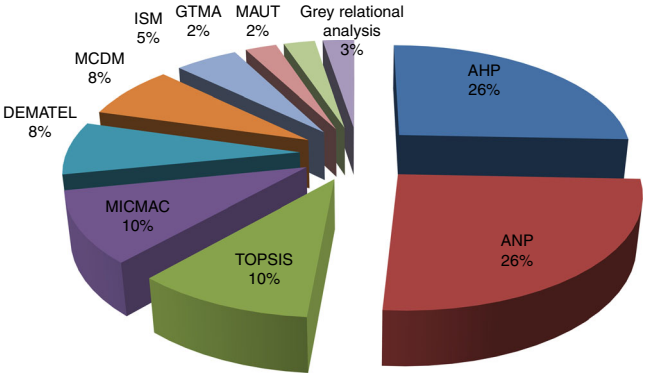


**Figure 10.**
MCDM method wise distribution of papers

*4.12 Major industries focused for GSCM research*

The industries are the important consideration to perform any research. The Table XV shows the major industries which were focused for GSCM research mainly concern with the implementation and adoption of GSCM. Automobile industries were focused in large number (15) followed by manufacturing industries (14) and electronics industry (11). Almost all the type of industries such as, fashion industry, food and beverage industry, logistics companies, Small- to medium-sized enterprises, textile and apparel industry, etc., are considered by various researchers and practitioners.

## 5. Conclusion

This paper presents insights into the conceptualization and methodological research bases of the GSCM. The review enables us to understand the state-of-art practices in the area of GSCM. This paper attempts to provide an overview of the body of the 177 articles covering 66 different peer-reviewed journals and having "green supply chain" in the title and in the phrases. The present research investigates the series of dimensions including the journals most often publishing articles on GSCM research, authors most active in the subject area (in terms of articles published), unit of analysis, research design applied, techniques used for analysing the data's, the theories and theoretical constructs utilized, and contexts examined. The empirical attest presented by authors in GSCM studies are often linked with the question and methodology used to conduct research. To some

| Sl. No. | Research issues | Variables | Frequency |
|---|---|---|---|
| 1 | Supplier selection | Green supplier, supplier management | 3 |
| | | Green supplier selection | 3 |
| | | Supplier evaluation | 2 |
| | | supplier networks | 1 |
| | | Supplier process improvement | 1 |
| | | Supplier relations | 9 |
| 2 | Waste | Waste, waste minimization | 4 |
| | | e-Waste | 1 |
| 3 | Performance | Green performance evaluation and measurement | 14 |
| | | Financial performance | 3 |
| | | Firm performance | 5 |
| | | Environmental performance | 12 |
| | | Logistics measurement and performance | 1 |
| | | Manufacturing performance | 2 |
| | | Operational performance | 1 |
| 4 | Barriers | Barriers | 2 |
| | | Battery recycling barriers | 1 |
| | | Dysfunctional conflict | 1 |
| | | International legislation | 1 |
| 5 | Practices | Benchmarking | 6 |
| | | Competitiveness | 1 |
| | | Corporate social responsibility | 3 |
| | | Distribution management | 3 |
| | | Eco-responsive supply chain | 1 |
| | | Green building | 2 |
| | | Green design | 3 |
| | | Green information systems | 2 |
| | | Green initiative | 5 |
| | | Green innovation | 2 |
| | | Green manufacturing | 2 |
| | | Green marketing | 7 |
| | | Green new product development | 6 |
| | | Green operations | 1 |
| | | Green procurement | 3 |
| | | Green purchasing | 1 |
| | | Green strategies | 6 |
| | | International standards | 1 |
| | | Lean management | 3 |
| | | Life cycle assessment | 6 |
| | | Practice measurement | 9 |
| | | Product recovery | 1 |
| | | Recycling | 3 |
| | | Remanufacturing | 5 |
| | | Resilient | 1 |
| | | Reverse logistics | 15 |
| 6 | Environmental issues | Carbon management | 2 |
| | | Eco-efficient supply chain | 1 |
| | | Eco-industrial park | 1 |
| | | Eco-labelling | 1 |
| | | Ecological modernization | 1 |

(*continued*)

**Table XIV.**
Major research areas and variables on GSCM

| Sl. No. | Research issues | Variables | Frequency |
|---|---|---|---|
| | | Environmental audit | 1 |
| | | Environmental policy | 3 |
| | | Environmental and social standards | 1 |
| | | Environmental awareness | 2 |
| | | Environmental collaboration | 1 |
| | | Environmental effects | 6 |
| | | Environmental issue | 14 |
| | | Environmental management | 39 |
| | | Environmental practices | 2 |
| | | Environmental protection | 1 |
| 7 | Drivers | Green supply chain drivers | 3 |
| | | Institutional drivers | 1 |
| 8 | Process | Closed-loop supply chains | 2 |
| | | Competence-based perspective | 1 |
| | | Demand and supply integration | 1 |
| | | Event study | 1 |
| | | Government assistance programs | 1 |
| | | Green-component life-cycle value design | 1 |
| | | Inbound logistics processes | 1 |
| | | Process modelling | 2 |
| | | Product design processes | 1 |
| | | Simulation | 1 |
| | | System dynamics | 1 |
| | | Systematic optimization | 3 |
| | | Transport operations | 3 |
| | | JIT delivery | 1 |
| 9 | Sustainability | Sustainability | 23 |
| | | Sustainable development | 12 |
| | | Sustainable operations | 1 |
| | | sustainable production | 2 |
| | | Sustainable supply chain | 7 |
| | | Corporate sustainability | 1 |
| | | Economic sustainability | 1 |
| | | Environmental sustainability | 1 |

**Table XIV.**

concern the GSCM authors convince readers of their proffer, theories and there validity. The motivation behind this investigation is to provide a comprehensive examination and useful insights into the significant findings, current research gaps and future research directions.

*5.1 Significant findings*

- From the earlier literature review only five articles were found. First article contains 22 definitions on GSCM and 12 definitions on Sustainable supply chain management, second shows the boundaries and flows perspectives of GSCM, third shows research of past, present and future, fourth article categorizes and review recent GSCM literature under nine broad organizational theories and fifth article show state-of-art literature review on GSCM.
- *Journal of cleaner production* holds highest number of articles (19) followed by *International journal of production economics* (15), *Supply chain management: An International journal* (13) and *International journal of production research* (10).

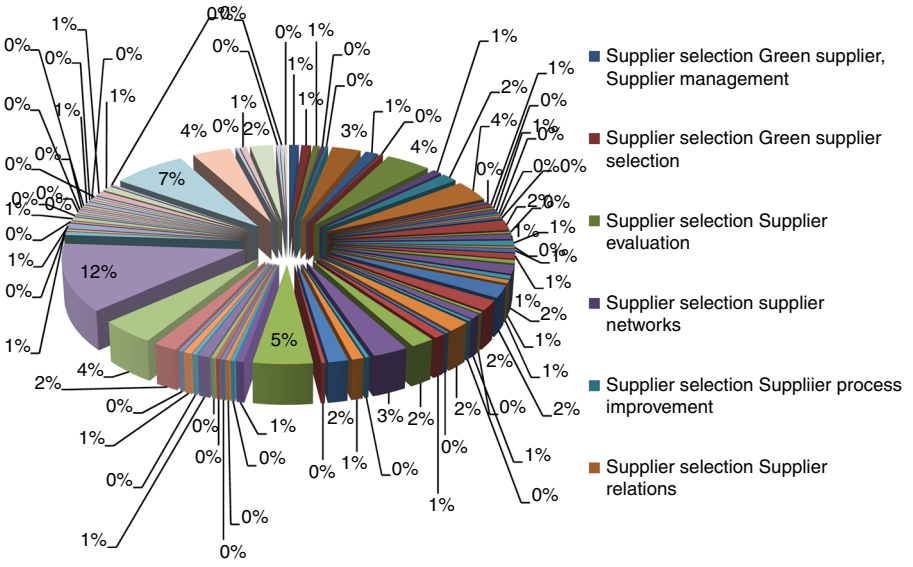


**Figure 11.**
Major research areas and variables of GSCM field gun

| Sl. No. | Name of industry | Frequency |
|---|---|---|
| 1 | Automotive industry | 15 |
| 2 | Manufacturing industries | 14 |
| 3 | Electronics industry | 11 |
| 4 | Chemical industry | 7 |
| 5 | Computer industry | 5 |
| 6 | Textile and apparel industry | 5 |
| 7 | Fashion industry | 4 |
| 8 | Logistics industry | 4 |
| 9 | Printing Industry | 4 |
| 10 | Small- to medium-sized enterprises | 3 |
| 11 | Apparel industry | 2 |
| 12 | Food and beverage industry | 2 |
| 13 | Ford Otosan | 2 |
| 14 | Hotels | 2 |
| 15 | Semiconductor industry | 2 |
| 16 | Pulp and paper industry | 2 |
| 17 | Service industry | 2 |
| 18 | Mining industries | 2 |
| 19 | Construction industry | 1 |
| 20 | EEE sector | 1 |
| 21 | Focus groups | 1 |
| 22 | Hand-tool industry | 1 |
| 23 | Motorcycle industry | 1 |
| 24 | Nuclear power generation | 1 |
| 25 | Mobile industry | 1 |

**Table XV.**
Frequency of GSCM research on focused industries

- Countries like Taiwan, China, USA and UK holds the greater credibility towards research on GSCM.
- Authors like Qinghua Zhu and Joseph Sarkis have done more research on GSCM followed by Kee-hung Lai, Kannan Govindan, Stephan Vachon and Yong Geng.
- Quantitative research methods such as survey, mathematical models, simulation, etc., are used in 65 per cent of the articles. Various data analysis techniques were applied in which correlation analysis and factor analysis is done in more number of articles. Survey Scores highest among all the research methods used in the discipline with 31.07 per cent articles. Survey research methodology is often used to capture data from business organizations. In the articles where survey methodology used includes the section on non response bias test, reliability and validity tests, which shows that research publishers are becoming stricter on reliability and validity tests.
- MCDM used by researchers includes AHP and ANP with ten articles each.
- The readers may be aware and benefited of how the various research approaches fit with different theories.

### *5.2 Gaps identified*

- Most of the articles are focused on the survey research. Simulation and mathematical models were used in very limited numbers of articles.
- Analytical research is done in fewer articles. In many articles the secondary data's were not used in an innovative way.
- Despite of many studies conducted in the area of GSCM, there was lack of mutual understanding of the discipline regarding theoretical and methodological dimensions.
- There is no study focused to understand the similarities and dissimilarities of GSCM practices across the different types of organizations.
- Although there are many articles are available on the GSCM implementation but lack the strategic planning to implement GSCM.
- GSCM research is the need to understand various relationships between GSCM processes, technical and social aspects of an organization and its impact on firm's performance measurements.

### *5.3 Future research directions*

This paper has shown the current status of GSCM research from standpoint of research methods, data analysis techniques, data sources and level of analysis. It has been shown that present research is more accurate than the past research. The following points offer some direction for future research:

- This article is limited in reviewing those articles which contains the word green supply chain in the title and the phrases of the articles and we fully acknowledge that there may numerous studies, which lack the keyword in the title, but still focus upon GSCM in the main context.

- This research is limited to the journals from science Direct/Elsevier, Emerald Publication, Taylor and Francis, Wiley inter-science, Springer link and one article from IGI global publication. But there were more journals which are well known and particularly devoted to GSCM research can be used.
- Although this research covered the maximum number of articles comparative to the other review articles on GSCM theme, but more comprehensive research can be done in future in order to provide a greater understanding of the subject area.

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**Corresponding author**
Dr Ravi Kant can be contacted at: ravi792002@gmail.com