



## A review on green supply chain aspects and practices

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**Abstract:** *The field of green supply chain is expanding rapidly, and new authors are venturing in this field to conduct further research. Although some literature reviews have been conducted over time, a complete list of green supply chain practices is not available. Hence, the objective of this study is to present an up-to-date list of green supply chain practices. To achieve this, the study employed structured review process, as well as critically examined the contents to ensure that the data are filtered from high-quality peer-reviewed journals and from influential authors in this field. 91 high-quality papers were selected from top ten journals in GSCM area to produce the list. A total of 58 green supply chain practices comprising 15 aspects were featured, e.g. reverse logistics, industrial symbiosis, green information technology, green design, carbon management etc. This paper contributes to the existing literature by providing a comprehensive list of aspects and practices of the green supply chain. Finally, limitations and directions for future studies are provided in the conclusion section.*

**Keywords:** green supply chain; green supply chain practice; GSCM; literature review; sustainable practice; green practice.

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### Introduction

Green supply chain (GSC) is an important issue for competition and for changing the competitive landscape in many industries. Current demand for value creation efforts, i.e. environmental and industrial sustainability, green and sustainable innovations have increased attention on the concept of GSC. Consequently, GSC has been integrated as a firm's innovative strategy which may lead a firm to achieve competitive advantage (Bititci et al., 2012). However, not many firms have integrated GSC practices. Although GSC has been acknowledged over a couple of decades, there are inconsistent arguments and

inconclusive findings from the existing supply chain literature. Due to these shortcomings, the existing literature fails to understand what constitute the overall GSC practices.

The emergence of green supply chain management (GSCM) took place about a couple of decades ago, and now in its third decade for further discovery of knowledge in this field. When researchers started to integrate the environmental concerns into the supply chain, the concept of green supply chain emerged. The integration of economic, environmental and social facets has been at the forethought of sustainability in today's operations management due to the successful implementation of green supply chain which eventually has led to overall sustainability of firms. Therefore, the concept of green supply chain management received escalating attention in the last decade, and has uncovered ample opportunities for research in this area.

Researchers conducted a number of literature reviews on green supply chain management (Fahimnia et al., 2015; Govindan et al., 2015; Igarashi et al., 2013; Malviya and Kant, 2015; Min and Kim, 2012; Srivastava, 2007; Soda et al., 2016). Some of the authors tried to address the methodology part of the GSCM literature (Govindan et al., 2015; Soda et al., 2016) while others focused on the entire field of GSCM literature (Srivastava, 2007; Malviya and Kant, 2015). Additionally, few authors mixed the term green with sustainability in reviewing GSCM literature (Fahimnia et al., 2015). However, none of these reviews highlighted the comprehensive list of green supply chain practices. Though few authors attempted to address this issue in the past (Srivastava, 2007), those reviews were done many years back. By this time many green initiatives and developments have taken place in this field. Hence, the research work in GSCM is growing exponentially. Under this circumstance, researchers are finding difficulties to explicate what constitutes green supply chain practices. A comprehensive list of green practices is necessary in order to expedite future research in this field. Overall, the objective of this paper is to present a comprehensive list of green supply chain practices (GSCP).

In order to develop a comprehensive list of GSCP, an extensive literature review has been conducted. The title containing the term "green supply chain" was targeted and the range of databases was 1998 to 2016. The screening process included a rigorous initial screening of limited number of papers to ensure that data are coming from high-quality peer-reviewed publications only. A total of 91 articles were selected for review for developing the list. This list was arranged according to different aspects or categories, and each aspect then has a list of practices. However, this study did not include the aspects and lists of sustainable supply chain management because green supply chain focuses only environmental and economic issue, while sustainable supply chain focuses on social, economic and environmental issues.

Finally, the theoretical and managerial contributions of this paper are twofold: first, this article contributes to the existing literature by providing a comprehensive list. Second, researchers, academicians, managers and policy makers can get the full lists of GSCP for further investigations and research.

The rest of the paper begins with the definition of green supply chain management in Section 2; Section 3 outlines the structured methodology used in this study to identify the GSCM aspects and lists. An intensive literature review on green supply chain aspects and lists has been presented in section 4 along with the targeted list. Section 5 identifies some limitations and directions for future research.

**Literature review**

***Defining green supply chain management (GSCM)***

The practice of GSCM is getting popularity among operations managers especially with those who are pursuing the environmental performance of their operation. GSCM had a significant development and a geometric growth in academic publications over the last few decades, particularly during the late 1980s and early 1990s varying from primarily practical and conceptual advances in empirical and theoretical studies (Seuring and Müller, 2008; Srivastava, 2007). Previous studies indicated that the relative importance of these practices can be simply traced back to the beginning of environmental management movement during the late 1960s (Sarkis et al., 2011). According to Seuring and Müller (2008) the field of GSCM has commenced to be further formal and established particularly after the 1990s.

The Green Supply Chain Management (GSCM) concept is broad and there is no clear holistic definition available to describe it. Since the concept is defined differently by researchers, it is difficult to describe GSC by a single definition (Ahi and Searcy, 2013). The following table provides a list of GSC definitions in a chronological order. Based on table 1, researchers have used various keywords in defining GSC. Although defined differently, the meanings of GSC shown in the table involve the usage of several terms such as sustainable supply network management, supply and demand sustainability in corporate social responsibility networks, sustainable supply chains, green purchasing and procurement, supply chain environmental management, green logistics and environmental logistics, and environmental purchasing. Yet, based on the previous definitions, GSCM can be safely defined as integrating environmental concerns into the inter-organizational practices of supply chain management during a product’s life cycle.

**Table 1.** *Compilation of GSCM definitions*

Source	Definition
(Handfield et al., 1997)	Application of environmental management principles to the entire set of activities across the whole customer order cycle, including design, procurement, manufacturing and assembly, packaging, logistics, and distribution.
(Zhu et al., 2005)	An important new archetype for enterprises to achieve profit and market share objectives by lowering their environmental risks and impacts while raising their ecological efficiency.
(Hervani et al.,	Green Purchasing + Green Manufacturing/Materials Management + Green

2005)	Distribution/Marketing + Reverse Logistics
(Sheu et al., 2005)	Combination of both the product manufacturing supply chain and used-product reverse logistics chain.
(Srivastava, 2007)	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.
(H'Mida and Lakhal, 2007)	The practice of monitoring and improving environmental performance in the supply chain during a product's life cycle.
(Lakhal et al., 2007)	Olympic green supply chain characterized by five-circled flag of the Olympics as zero emissions, zero waste in activities, zero waste of resources, zero use of toxic substances, zero waste in product life-cycle, in addition to green inputs and green outputs.
(Srivastava, 2008)	Integration of sound environmental management choices with the decision-making process for the conversion of resources into usable products.
(Lee and Klassen, 2008)	A buying organization's plans and activities that integrate environmental issues into supply chain management in order to improve the environmental performance of suppliers and customers.
(Albino et al., 2009)	A strategic approach addressed to extend environmental measures to the whole supply chain.
(Wee et al., 2011)	Integration of environment considerations into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the greening products.
(Gavronski et al., 2011)	The complex of mechanisms implemented at the corporate and plant level to assess or improve the environmental performance of a supplier base.
(Lorentz et al., 2011)	Integrating environmental thinking into closed-loop supply chain management.
(Guiffrida et al., 2011)	The environmental dimension of sustainability in a supply chain context.
(Wu and Pagell, 2011)	An approach that aims to integrate environmental issues into SC management procedure starting from product design, and continuing through material sourcing and selection, manufacturing processes, the final product delivery and end-of-life management.
(Yeh and Chuang, 2011)	Management between suppliers, their products and environment, that is to say, the environment protection principle is brought into suppliers' management system. Its purpose is to add environment protection consciousness into original products and to improve competitive capacity in markets.
(Sarkis et al., 2011)	Integrating environmental concerns into the inter-organizational practices of SCM including reverse logistics.
(Kim et al., 2011)	A set of practices intended to effect, control and support environmental performance by allocating possible human material resources and redefining organizational responsibilities and procedures.
(Parmigiani et al., 2011)	A way for firms to achieve profit and market share objectives by lowering environmental impacts and increasing ecological efficiency.
(Andiç et al., 2012)	Minimizing and preferably eliminating the negative effects of the supply chain on the environment.

Source: Ahi and Searcy (2013).

**Research methodology**

The well prepared literature reviews are usually developed through a reiterated process of defining proper keywords for search, searching the literature, and finalizing the analysis (Saunders, 2011). The purpose of literature reviews by illustrating and assessing the literature is to indicate latent research gaps along with highlighting the knowledge limitations (Tranfield et al., 2003). Furthermore, a structured methodology emphasizes on scanning the resources, planning the mind map to structure the literature review, writing the study and constructing the bibliography (Rowley and Slack, 2004). This study used a five-step methodology in a similar approach for collecting data and evaluating comprehensively. Based on this method, this study evaluated the field aiming to provide insights into current research interests and guidelines for future studies.

**Keywords used in search engine**

At the beginning the keywords used in the search engine included “green”, “supply chain”, “green practices”, “environmental”, “GSCM”, and “GSCP”. The combinations of search keywords used in google scholars were (1) green supply chain; (2) environmental and supply chain; and (3) GSCM. Operations and designs are the main two perspectives of the green supply chain. Therefore, it was ensured that the keywords completely cover both perspectives. This study did not consider sustainable supply chain and closed-loop supply chains as green supply chain.

**The result of the initial search**

Google Scholars provided ample range of related journals. Since USM's library already subscribed to all the major databases, integrated with Google Scholar, it was efficient to use this search engine for initial search. Our search keywords were restricted to the title of the paper. Initially the result of the search included conference papers, books, and books chapter but later we excluded them from our consideration. At first 31889 articles were derived using three combinations of keywords. Table 2 represents the result of initial search of Google Scholar.

**Table 2.** *The initial results of search in Google Scholar*

Keywords	Results (no. of articles)
Green Supply Chain	2270
Environmental AND Supply Chain	789
GSCM	130
Total	3189

Source: Authors’ own research.

**Refinement of the search results**

Referring to table 2, many papers appeared in more than one search category. 2380 papers remained after eliminating these duplications. Among the excluded papers were short non-

refereed articles, while others were not regarded as scientific contributions. Further refinement has been performed to remove insignificant commercial magazine papers, non-refereed articles, and those with unknown author names. In the end, 180 journal articles were critically selected from peer-reviewed and trusted publishers for our evaluation; these articles were published between 1998 and 2016.

### ***Data statistics***

In order to ensure the reliability of the data, this study collected its data from the top journals. Articles published between 1998 to 2016 by influential authors have been considered for evaluation. A total of 91 articles were selected from the top and most cited journals. The initial statistics showed that 59 journals have contributed to the publication of 180 papers. It was found that top 10 journals have published approximately 50% of all articles published, and they are the most cited journals in the field. For example, the Journal of Cleaner Production and International Journal of Production Economics are the top one and two journals respectively. Hence, the sources used for this study were proven to be reliable and top notch.

**Table 3.** *The top 10 popular journals in GSCM area based on no of publications*

<b>Name of the journals</b>	<b>No. of articles</b>
Journal of Cleaner Production	18
International Journal of Production Economics	14
International Journal of Production Research	11
Business Strategy and the Environment	8
Supply Chain Management: An International Journal	7
Environmental Science and Technology	6
Computer Aided Chemical Engineering	6
Ecological Economics	5
International Journal of Physical Distribution and Logistics Management	5
International Journal of Life Cycle Assessment	4
Journal of Industrial Ecology	4
Sustainability	3
Total	91

Source: Authors' own research.

### **Green supply chain management (GSCM) practices**

Scholars discussed green supply chain practices from different aspects. Tseng et al. (2015) mentioned interrelationships among suppliers to reduce hazardous materials. Govindan et al. (2015), Rao and Holt (2005), Srivastava (2007), Walker et al. (2008) and Chen et al. (2011) identified GSCM practices that consist of reverse logistics, product recovery and reuse of used products, green design, green purchasing, and collaboration with suppliers and customers. Additionally some other scholars discussed internal management support

(Zhu and Sarkis, 2004), customer environmental collaboration (Lawson et al., 2006), green manufacturing (De Giovanni, 2012), green packaging (González-Torre et al., 2004) and even green marketing (Van Hoek, 1999) while referring to GSCM practices of firms. Therefore, successful implementation of green supply chain can be done through various practices and initiatives (Rao and Holt, 2005) and (Srivastava, 2007). The practices and initiatives of green supply chain that have been discussed in the previous literature can be categorized into following aspects:

### ***Reverse logistics***

Reverse logistics is a significant practice of green supply chain. Logistics is forward activity, i.e. goods are delivered to customers from manufacturers or distributors. In contrast, in case of reverse logistics goods are moving back from customers to manufactures or distributors. As some parts of most of the products remain in the hand of customers after the end of its life, companies should have a system to recollect those items from the consumer to ensure an environment friendly world. This practice has been an important solution to operation management to recollect defective and unused items from the customers. In short, reverse logistics refers to collecting unused items, sorting and inspecting them, then recycling, reusing, remanufacturing, and disposal. The objectives of this practice are to protect environment from pollution by companies' unused items or end of life items, maximize the value of the unused items and minimize cost (Rao and Holt, 2005). GSCM not only focuses on environmental issues but also economic aspects too. An appropriate reverse logistic system should be designed to achieve efficiency and, thereby, achieve economic benefit for the company (Büyüközkan and Çifçi, 2012; Govindani et al., 2015; Srivastava, 2007).

### ***Industrial symbiosis***

The concept of industrial symbiosis refers to the association between two or more companies within industries in which the wastes of one partner become the raw materials for another. Firms can achieve competitive advantages in business management through eco-innovation, and industrial symbiosis makes a major contribution to achieving win-win status in supply-chain networks (Tseng and Bui, 2016). Industrial symbiosis is all about saving money and reducing consumption by working together to maximize the outputs that can be generated from resources. It is one approach to realizing a circular economy and achieving green growth (Berlina et al., 2016). The implementation of industrial symbiosis in the economy represents an innovative method to promote green economy and to create a new culture of economic growth (Albu, 2017).

### **Green information technology and systems (GITS)**

Information Technology and Systems (ITS) are an important avenue to drive environmental footprints and sustainable practices (Bai and Sarkis, 2013; Koo and Chung, 2014; Molla et

al., 2014; Sarkis et al., 2013). However, there has been a visible neglect of the IT function in environmental evaluation programs over the years (Savita, Dominic, and Ramayah, 2014). In the mining industry, equipment and employees use ITS. ITS use results in significant environmental footprints (Faucheux and Nicolai, 2011; Uddin and Rahman, 2012). Green ITS can help mitigate these environmental footprints (Bhadauria et al., 2014) and optimize overall energy consumption of mines (Bilal et al., 2014). The use of eco-friendly hardware and data center, reducing waste of unused hardware, collaborative group software to minimize cost, and introducing telepresence to increase flexibility and buying eco-labeling of IT products are considered as green practices.

### ***Green design***

According to Fiksel and Fiksel (1996) and Tseng et al. (2013), green design reflects the design of products or services with certain environmental consciousness. It entails a systematic consideration of design issues, such as waste management, resource conservation and pollution prevention. Lin (2013) was in agreement by stating that green design is closely related to product safety, environmental risk management, resource conservation, waste management and pollution prevention. Along similar lines, Büyüközkan and Çifçi (2012) and Jabbour and Jabbour (2009) said that a well-designed product does not use hazardous or restricted materials during manufacturing and should minimize waste during production. In reference to today's green economy, Tseng et al. (2013) stated that the design of disassembly will be the strong base for the design of remanufacturing and recycling. This statement is supported by Tibben-Lembke (2002) stating that green design measurements include tracking all material and reverse flow of a product. In other words, green design should be able to trace and manage the retrieval of raw materials out of the environment, the disposal of the product back into the environment.

### ***Carbon management***

In 2009, the World Resource Institute announced a shocking truth. With increasing environmental and climate change worries in the green supply chain, 80% of carbon emissions were found to be produced through the supply chains (Hsu et al., 2013). Hence, carbon issues were quickly being recognized as an important element in GSCM; thus, many companies aimed to build a competency framework for carbon management (Lee, 2011). Lee (2011) further explained that companies began to monitor carbon footprints, and discover benefits such as decreased manufacturing costs, reduced total energy consumption, as well as impelling the consequences of carbon footprints externally. These were done especially to manage risks of climate change as well as increasing market share. Dwyer et al. (2009) emphasized 'carbon management' where suppliers engage to announce greenhouse gas emissions and set up reduction objects to manage their carbon emissions. To help with this, Sundarakani et al. (2010) forwarded a model for carbon emission



computation and control across companies' supply chain to reduce the carbon footprint. In relation to that, Hsu et al. (2013) have summarized the main criteria for green supplier selection to facilitate carbon management program.

#### ***Supplier environmental collaboration***

Vachon and Klassen (2006) identified that in effort to reduce environmental impact and seek for environmental solutions, organizations develop cooperative activities to handle environmental activities within the supply chain. Activities such as joint environmental planning, shared environmental knowledge, green product development and innovations which have a positive effect on delivery and supplier performance address the added value that can emerge from the direct collaborative interaction between organization and supply chain members (Bowen et al., 2001; Eltayeb et al., 2011; Govindan et al., 2015; Rao, 2002; Vachon and Klassen, 2007). These environmental collaboration helps companies manage suppliers' environmental performance, ensuring that the purchased materials are environment-friendly and produced using green processes (Lin, 2013; Rao and Holt, 2005; Zhu and Sarkis, 2007). Apart from that, this green practice intensifies the level of supply chain integration as other non-green supply chain practices involved with supplier collaboration do by enhancing the ability to organize operations in different supply chain tiers. Consequently, this practice could raise customer satisfaction, and reduce business waste and supply chain cost simultaneously (Azevedo et al., 2011; Gunasekaran et al., 2008).

#### ***Customer environmental collaboration***

By managing collaborative interactions between organization and supply chain members, organizations build cooperative tasks to deal with environmental activities to decrease negative environmental effects within the supply chain (Lin, 2013). Customer environmental collaboration includes direct involvement of a firm to ensure better environmental performance for its customers. Eltayeb et al. (2011), Rao (2002) and Vachon and Klassen (2007) suggested activities like interchanging technical information between a company and its customers, customer education, customer support, and joint ventures which will eventually enhance environmental performance for customers in terms of green products and innovations development. An effective customer relationship, as explained by Azevedo et al. (2011), will allow environmental cost reduction, improve responsiveness to customers' environmental worries, increase customer satisfaction and reduce business waste.

#### ***ISO 14001 certification***

In effort for enhancing their environmental performance, companies employ Environmental Management Systems (EMS) which include principles describing policies, procedures, and audit protocols to evaluate the environmental impact of an organization's operations. Among the most recognized EMS, as suggested by Nawrocka et al. (2009) and Robert (2000), is International Organization for Standardization (ISO) 14000 series. Driven by stakeholders, community and regulators under strict environmental regulations, ISO 14000

standards were developed to prepare a direction towards developing a comprehensive method for environmental management and standardize the primary environmental tools (ISO, 2010; Prajogo et al., 2012). ISO 14001 can also act indirectly affecting all supply chain members to select more environmentally friendly practices. In addition, Azevedo et al. (2011) and Nawrocka et al. (2009) said it provides a basis for a systematic approach to reduce adverse environmental effects of organizations, decrease resource consumption and waste, and finally contribute to quality improvement.

### ***Internal management support***

Internal management support is crucial as it encompasses overall initiatives employed by an organization's top manager to implement green practices in the supply chain. As GSCM strategy is closely related to top management decisions, internal management support is vital (Olugu et al., 2011; Rao and Holt, 2005). The relationship between GSCM practices and internal management commitment has been emphasized by many researchers (Beamon, 1999; Hervani et al., 2005; Rao, 2002; Tsoufas and Pappis, 2008). As an example, Carter et al. (1998) conducted an empirical study to consider GSCM practices, and it was found that management support and organization goals were essential to implementing GSCM practices successfully. Zhu and Sarkis (2004) and Lun (2011) identified factors affecting the internal environment namely 1) management liability from senior managers; 2) support from mid-level managers; and 3) cross-functional collaboration from environmental improvement. Olugu et al. (2011) added that the main measures of this practice comprise of: 1) accessibility of environmental evaluation systems; 2) availability of mission statements on sustainability; 3) the number of environmental management practices; 4) availability of environmental award systems; and 5) the management's attempt to motivate employees, customers and suppliers on sustainability.

### ***Green purchasing***

Green purchasing represents an ecologically conscious purchasing initiative that aims to ensure procured materials or components meet firms' eco-friendly goals. The purchasing process can manifest firms' environmental preferences if it includes green purchasing criteria (Carter and Ellram, 1998; Carter et al., 2000; Saghiri and Hill, 2014). Carter and Ellram (1998) argued that green purchasing also should reflect efforts to reduce, reuse, and recycle materials. For instance, to implement green principles into purchasing, companies can provide design instructions for suppliers. These designs could include the concept of environmental necessities like energy saving, cost reduction, using recyclable item, and such. Thus, purchasing decisions have significant influences on the sustainable supply chain (Yang et al., 2013) through the procurement of raw materials and components.

### ***Green manufacturing***

Research and development can design specifications for environmentally friendly products, and firms can re-engineer their manufacturing and production processes to rely on the

addition of recyclable materials as part of the process. Green manufacturing considers environmental impacts throughout the product lifecycle including the sale of used, unsold, or returned products in secondary markets (Van Hoek, 1999). Green manufacturing entails the environmentally conscious production of a product with the goal of minimizing its negative environmental impacts throughout its entire life cycle as well as promoting positive ecological business operation practices such as recycling and reusing products (Walker et al., 2014). That is, green manufacturing considers environmental impacts in every stage of the product lifecycle (De Giovanni, 2012) to minimize the environmental impacts of manufacturing processes, generate minimum waste, and reduce environmental pollution. Pursuing green manufacturing also helps firms lower their raw material costs, gain production efficiency, reduce environmental and occupational safety expenses, and improve their corporate image (Zhu and Sarkis, 2007). Thus, green manufacturing helps firms achieve profit growth and increase their market share.

### ***Green packaging***

Examining current packaging can reveal possible changes and the potential of gathering leftover packaging or using less packaging (González-Torre, Adenso-Dí, and Artiba, 2004). Green packaging addresses all packaging issues including size, shape, and materials. Because reverse logistics entails a process of continuously taking back products or packaging materials to avoid environmental damages, it entails not just the use of recycled or recyclable materials but also the impacts of packaging on distribution arrangements such as loading and handling efficiency and space utilization. The packaging used must be less costly, easy to handle, and environmentally friendly (H.-J. Wu and Dunn, 1995). Finally, green packaging is the environmentally conscious packaging of a product to minimize the associated negative environmental impacts. Packaging contributes directly to product success in supply chains because it can enable the efficient distribution of products as well as lower environmental impacts due to spoilage or waste. Increased attention to global climate change has made green packaging a primary focus area to reduce waste and improve air quality because different packaging characteristics (e.g. size, shape, materials) have different impacts. (Hsu et al., 2016) indicated that green packaging includes considerations of cost (materials and shipping), performance (adequate protection of the product), convenience (easy to use), compliance (with legal requirements), and environmental impact (Lin et al., 2013; Liu et al., 2013).

### ***Green logistics***

González-Benito and González-Benito (2006) and Murphy and Poist (2000) stressed that among the green initiatives, green logistics received the least importance. While transportation systems actually have the most significant impacts on the environment, there are insufficient studies done on this from the standpoint of green logistics. The fatality and dangerousness of gas emissions resulting from transportation has never been a

mystery for firms. Salimifard et al. (2012) confirmed that 15% of greenhouse gases and 23% of CO<sub>2</sub> emissions are the direct results of the transportation sector alone. For 17 years since 1990, a recorded 45% worldwide increase in CO<sub>2</sub> emission was registered. It was then predicted that another 40% increase will take place until 2030 endangering the health of all life forms on earth. Therefore, companies can achieve various economic benefits, e.g. through fuel efficiency, route and warehouse optimization and some value of environment/society by avoiding any activities that cause unnecessary carbon emissions (Karia and Asaari, 2016).

**Green outsourcing**

Tseng et al. (2011) said that for original equipment manufacturing (OEM) firms, green outsourcing performance (GOP) will be used as fundamental enablers and criteria for competitiveness. However, for practical adoption of GOP, there are not many studies which could provide integrated competitive advantages, enablers and criteria (called measures). In an intensive market, the firms should implement measures starting from competitive advantages to internal processes. Since green issues related to carbon mapping and greenhouse gases are important for all firms, responsible energy management is a crucial business capability as discussed by Babin and Nicholson (2011). For all outsourcing agents, environmental issues and the ability to demonstrate the environmentfriendly practices are becoming vital. Brown (2008) added to the discussion by stating that the influence of consumer and investor opinions for green corporate accountability as well as the creation of new government regulations for protecting the environment have pushed green issues onto the boardroom agenda and outsourcing vendors' growing plate of priorities.

**Green warehousing**

In an attempt to save cost and energy more firms have slowly understood the criticality of green warehousing. Many warehousing and fulfillment companies are looking to implement environmentally friendly practices that minimize their carbon footprint and reduce environmental pollution, and at the same time minimize their costs and increase social responsibility (Rostamzadeh et al., 2015). Although the number of green warehouses is increasing, the initial cost and time investment to convert to this kind of warehousing were considered huge by many firms.

**Summary of GSCM aspects and practices**

From the above discussion, the aspects and practices can be summarized. Table 4 presents the comprehensive lists of GSCM aspects and green practices.

**Table 4.** Summary table for aspects and practices

GSCM aspects	Practices	Sources
Reverse logistics	1. Recovery of the company's end-of-life	Büyükközkán and Çifçi (2012);

	<ul style="list-style-type: none"> <li>items</li> <li>2. Resale or reuse of used parts or components</li> <li>3. Old/obsolete items being used or replaced</li> <li>4. Recondition and refurbishing of used parts or components</li> </ul>	Govindan et al. (2015); Srivastava, (2007); Tseng and Chiu (2013, 2012)
Industrial symbiosis	<ul style="list-style-type: none"> <li>5. Sharing waste treatment plants</li> <li>6. Helping suppliers to establish their own environmental management system(EMS)</li> <li>7. Use of waste of other companies</li> </ul>	Berlina et al. (2016); Tseng and Bui (2016); Albu (2017). Puente et al. (2015); Mahmood et al. (2013); Tseng and Chiu (2012)
Eco-Innovation practices	<ul style="list-style-type: none"> <li>8. Substituting toxic inputs with environmentally friendly ones</li> <li>9. Switching from “dirty” to cleaner technologies</li> <li>10. Internal recycling of wastes</li> </ul>	Crum et al. (2011);Rao and Holt (2005)
<i>Green Information Technology and Systems</i>	<ul style="list-style-type: none"> <li>11. Use of energy efficient hardware and data centers</li> <li>12. Consolidating servers using virtualization software</li> <li>13. Reducing waste associated with obsolete equipment</li> <li>14. telepresence systems</li> <li>15. Collaborative group software</li> <li>16. Eco-labeling of IT products</li> </ul>	Boudreau et al. (2008); Jenkin et al. (2011); Chou and Chou (2012); Setterstrom (2008); Standing et al. (2008); Uddin and Rahman (2012)
Green design	<ul style="list-style-type: none"> <li>17. Design of products for reduced consumption of materials/energy</li> <li>18. Intend to reduce products' negative effects on the environment during its entire life cycle</li> <li>19. Design of products for reuse, recycle, recovery of materials, component parts</li> <li>20. Design the products to be easily set up for the users in the most energy saving ways</li> <li>21. Design for reduction of environmentally hazardous substances, design for recycling waste and design for remanufacturing aimed at returning it to a better condition</li> </ul>	Fiksel and Fiksel (1996); Gungor and Gupta (1999);Arena et al. (2003); Beamon (1999) ; Zhu et al. (2007); Eltayeb et al. (2011); Lin (2013); Tseng and Chiu (2012); Sarkis (1998)
Carbon management	<ul style="list-style-type: none"> <li>22. Carbon reduction targets</li> <li>23. Training related to carbon management</li> <li>24. Emphasized supplier engagement to announce greenhouse gas emissions and set up reduction objects to manage their carbon emissions.</li> </ul>	Govindan et al. (2015); Hsu et al. (2013); Lee (2011)
Supplier environmental collaboration	<ul style="list-style-type: none"> <li>25. Collaborate with suppliers to build programs to reduce or eliminate waste</li> <li>26. Share environmental management techniques and knowledge</li> <li>27. Monitor environmental compliance status and practices of supplier's operations</li> </ul>	Lawson et al. (2006); Vachon and Klassen (2006); Vachon and Klassen (2008); Gunasekaran et al. (2008)

	28. Collaborate with suppliers to manage reverse flows of materials and packaging 29. Communicate goals of sustainability to suppliers	
Customer environmental collaboration	30. Collaborate with customer to develop environmental management solutions 31. Collaborate with customer to manage reverse flows of materials and packaging	Lawson et al. (2006); Lin (2013); Azevedo et al. (2011)
ISO 14001 certification	32. Participating in environmental certification such as ISO 14001 certificate.	Nawrocka et al. (2009); Robèrt (2000); ISO (2010); Prajogo et al. (2012)
Internal management	33. Environmental compliance monitoring and auditing 34. Total quality environment management 35. Pollution prevention plans 36. Environmental manager and training for employees 37. Employee incentive programs for environmental suggestions	Olugu et al. (2011); Rao and Holt (2005); Tsoulfas and Pappis (2008); Zhu and Sarkis (2004); Lawson et al. (2006)
Green purchasing	38. Choice of suppliers by considering the environmental criteria 39. Buying environment-friendly raw materials 40. Pressuring supplier(s) to take environmental actions	Carter and Ellram (1998); Carter et al. (2000); Saghiri and Hill (2014); Yang et al. (2013); Kannan et al. (2014)
Green manufacturing	41. Generate minimum waste, and reduce environmental pollution. 42. Re-manufacturing and lean production 43. Cleaner production 44. Improved capacity utilization 45. Lower raw material costs, gain production efficiency, and improve their corporate image 46. Increase amount of goods delivered on time 47. Does not use hazardous or restricted materials during manufacturing and minimize waste during production	Walker et al. (2014); Tseng et al. (2009); De Giovanni (2012); Zhu and Sarkis (2007); Van Hoek (1999); Tseng and Chiu (2012, 2013)
Green packaging	48. Environmentally friendly packaging (Eco-packaging) 49. Returnable packaging, reused packaging, recyclable packaging.	González-Torre et al. (2004); Wu and Dunn (1995); Hsu et al. (2016); Lin et al. (2013); Liu et al. (2013)
Green Logistics	50. Environmentally friendly transportation 51. Environment-friendly distribution 52. Using green fuels such as low sulfur content and alternative fuels such as liquid natural gas. 53. Community/environmental, employee health and safety concerns while transportation.	González-Benito and González-Benito (2006); Murphy and Poist (2000); Enarsson (1998); Salimifard et al. (2012)
Green	54. Care environmental responsibility in	Tseng et al. (2011); Babin and

outsourcing	global outsourcing. 55. Display environmental-friendly culture to all outsourcing stakeholders	Nicholson (2011); Brown (2008)
Green warehousing	56. Decrease inventory levels 57. Investment recovery (IR) (sale) of excess inventories/materials 58. Sale of excess capital equipment	Zhu et al. (2008)

Note: Few scholars highlighted recycle and reuse as another aspect, but it has correlation with green production and reverse logistics. Therefore, the two aspects were rather included in green practices. Additionally, “green transportation” was merged with "green logistics", and “end of life practices” merged with "reverse logistics" for the same reason.

Source: Authors’ own research.

### Conclusions, limitations and suggestions for future research

This study presented a comprehensive list of aspects and practices by reviewing literature from green supply chain management area. Articles published between 1998 and 2016 in top journals were reviewed. Although there are few literature reviews on green supply chain area but a comprehensive list of green practices has not been compiled in the past. A thorough and rigorous review of the influential articles has been done, and hopefully contributes to this field by documenting different aspects and practices of green supply chain.

It is found that there are fifteen aspects by which previous GSCM scholars categorized all green supply chain practices. Initially, only a few aspects such as green purchasing, green packaging, and green manufacturing were found in the literature. As the GSCM discipline is gradually growing, more and more young researchers are coming into this field for further expanding the work in different fashions and in different sub disciplines. Conclusively, it can be said that these fifteen aspects and fifty-eight practices are the results of two decades’ sincere efforts by GSCM scholars. For those who are seeking to do further research in GSCM area, this paper will definitely help them to narrow down their research focus conveniently. Moreover, the data have been collected from the most popular journals and from the most influential authors as well. These ground work will definitely be beneficial and informative for young researchers who have interest in GSCM.

More specifically, researchers who want to do research in evaluating the green supply chain practices (GSCP) in any industry they can use these fifteen aspects and practices. Previous studies did not use all aspects and practices while evaluating GSCP at firms’ level. For example, Kusi-Sarpong et al. (2016) and Rostamzadeh et al. (2015) evaluated GSCP in mining and laptop manufacturing industries respectively using only six aspects. The inclusion of other aspects might have been produced more comprehensive insights. Thus, there is scarcity of literature that used all these fifteen aspects in evaluating

GSCP. Therefore, this study directs researchers to use these aspects in evaluating GSCP to provide a rigorous result in their studies.

This paper has some limitations and, therefore, it suggests for future research. First, this compilation of aspects and practices is the outcome of different industries, and thus may not be applicable for researches focusing on specific industry. Resource based view theory suggests that each firm is different from others. Each industry is different from others in terms of its product, services and operations. Consequently, there are lots of room in this area for future research and exploration. Second, the list provided in this study is not necessarily final. It is a part of ongoing development and filing of researches in GSCM. It is hoped that the compilation keeps proceeding and continues to be a reliable source of information for future researchers. Third, the scope of the list was narrowed down to the top ten journals only. Hence, future study may encompass all the papers and journals in other ranks and fields as well. Fourth, many of the compilation works were made difficult by the definition where green practices were deemed to have similar meaning with sustainability practices. It is strongly suggested that any future research involving these two areas must clearly define their scope of research to ease the categorization. However, careful examination and focused review has been performed to eliminate the redundancy.

There are some limitations in how we gathered and presented the outcomes of the study. As a result, it is recommended that future work is better to enlarge the keywords to embrace sustainable supply chain, transportation, reverse logistics, logistics, shipping, inter-organizational efforts, alliances, partnering; indicating an extensive assortment of keywords could lead to a broader list of aspects and practices. To sum up, the GSCM discipline is growing along with opportunities for improvement on the ground that there exists a small number of dominant literature.

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