Accepted refereed manuscript of:

Fiorini PdC & Jabbour CJC (2017) Information systems and sustainable supply chain management towards a more sustainable society: where we are and where we are going, *International Journal of Information Management*, 37 (4), pp. 241-249.

DOI: 10.1016/j.ijinfomgt.2016.12.004

Information systems and sustainable supply chain management towards a more sustainable society: where we are and where we are going

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Highlights

- We systematized the relationship between IS and sustainable supply chain management
- IS is an important support tool for sustainable supply chain management practices
- Further advances in the literature are still needed
- Seven gaps in the literature were identified to suggest future research directions

Abstract

The objectives of this study are to identify and systematize scholarly articles on the use of information system to support sustainable supply chain management and to suggest future research opportunities. Therefore, a structured literature review was conducted. The most relevant studies identified were classified and categorized into seven dimensions: research context, research focus, research method, sector analyzed, information system (IS) beneficiaries, relationship between IS and green supply chain practices, and performance benefits. The main authors and articles on this particular topic were identified. In addition, it was concluded that IS is an important support tool for sustainable supply chain management practices since it brings benefits to the organization, suppliers, and customers. Furthermore, IS positively influences the operational, financial, and environmental performance of the organization. However, further advances in the literature are still needed. The major contribution of this research is related to the recommendations that provide opportunities for future research.

Keywords
Information systems for Sustainable Development; Sustainable supply chain management; Green supply chain management; Sustainable development; Green information systems; Sustainable IT.

Introduction

The integration of environmental aspects into organizations' strategic and operational decisions is a reality that affects not only the organization which makes decisions, but also its customers and suppliers (Sarkis, 2003). A critical issue that demonstrates the growing concern over sustainability issues is the convergence of supply chain and sustainability (Seuring & Müller, 2008; Srivastava, 2007; Zhu & Sarkis, 2004). Seeking to incorporate environmental and sustainable practices into the supply chain, organizations have demanded a great deal of information from their partners. Thus, information systems (IS) have become important tools for the adoption and management of these new practices (Chen, Tai, & Hung, 2012; Dao, Langella, & Carbo, 2011; Green Jr et al., 2012a, 2012b; Hu et al., 2014; Khor et al., 2015; Sarkis, Koo, & Watson, 2013; Shaft, Sharfman, & Swahn, 2001; Wognum et al., 2011). IS hold greater promise for addressing environmental issues in organizations; they can support business initiatives in reducing negative environmental impacts (Jenkin, Webster, & McShane, 2011). Bose and Luo (2011) state it is imperative that organizations understand how to integrate information systems and green initiatives in order to improve business sustainability and identify better practices.

Nevertheless, despite the benefits that information systems can bring to the sustainable supply chain management, this topic has been sporadically discussed in the literature (O'Rourke, 2014; Sarkis, Koo, & Watson, 2013). No studies that sought to systematize the existing knowledge of this topic have been identified so far, which leads to the research question of the present study: which studies address the use of information systems to support sustainable supply chain management?

Therefore, the objectives of this study are to identify and systematize scholarly articles on the use of information system to support sustainable supply chain management and to suggest future research directions. To this end, a structured literature review was conducted. The present study provides useful insights for organization administrators, since it highlights the benefits of using information systems in sustainable supply chain practices, and for researchers, by providing a comprehensive account of what has been published by accredited scholars and by indicating possible gaps in the literature.

The theoretical concepts of sustainable supply chain management and information systems are briefly presented below, followed by the presentation of the methodological approach and the results obtained and, finally, the discussion and conclusion sections.

Conceptual background

Sustainable supply chain management

Managing the sustainability of supply chains is one of four key issues for diffusing corporate sustainability (United Nations, 2013). However, there is no consensus about the definition of green and

sustainable supply chains (Fahimnia, Sarkis, & Davarzani, 2015). A commonly used definition was introduced by Srivastava (2007) as the integration of environmental issues into supply chain management, including product design, raw material selection, manufacturing processes, deliver of end products to consumers, and end-of-life product management. On the other hand, Seuring and Müller (2008) define sustainable supply chain management as the management of material, information, and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development.

Organizations have been incorporating environmental practices into their supply chains driven by regulatory, competitive, and stakeholder pressure (Dauvergne & Lister, 2012; O'Shea, Golden, & Olander, 2013). They have responded to these pressures by demanding from their partners a great deal of information enabling the adoption of sustainable supply chain practices (Perl & Vorbach, 2009).

Information systems and sustainability

Despite the pressure for environmental issues incorporation and the consequent growing demand for information, most companies still know very little about the potential environmental and social impacts of their production networks. Therefore, better data, decision-support tools, and incentives are needed to predict and prevent unsustainable supply chain practices (O'Rourke, 2014). Accordingly, information systems have become essential as accurate and reliable sources of information to support decision making and information flow management.

The role of information systems (IS) in supply chain management has been widely investigated (Auramo, Kauremaa, & Tanskanen, 2005; Barut, Faisst, & Kanet, 2002; Gunasekaran & Ngai, 2004; Kärkkäinen et al., 2007). Gunasekaran and Ngai (2004), for example, argue that it is impossible to achieve an effective supply chain without information technology (IT) since it is the backbone of supply chain management.

Similarly, information systems have been identified as a key factor for achieving environmental sustainability (Bengtsson & Agerfalk, 2011; Elliot, 2011). They facilitate the alignment of information planning and sustainability with organizational practices (Pozzebon et al., 2011). IS can be enablers for sustainable processes, services, and products (Melville, 2010; Seidel, Recker, & Vom Brocke, 2013; Vom Brocke et al., 2013; Watson, Boudreau, & Chen, 2010). For example, the information capabilities of an IS, in terms of its abilities at enhancing communication and knowledge sharing within and across functions, permitted effective compliance with environmental requirements in the study of Butler (2011).

Research methodology

A structured literature review was conducted according to the method initially proposed by Lage Junior and Godinho Filho (2010) and later employed by Jabbour (2013) and Mariano, Sobreiro and Do Nascimento Rebelatto (2015). The steps are summarized in Figure 1. A literature review informs about what has been already published regarding the subject under examination and helps the researchers to justify and support their arguments in providing an original contribution (Pozzebon et al., 2011).

------ PLEASE, INSERT FIGURE 1 ABOUT HERE ------

Firstly, the relevant terms were defined and the initial searches were conducted. The keywords used in the search were: information systems, information system, sustainable supply chain, and green supply chain. Due to the fact that green supply chain management is a result from one of the sustainability dimensions (Fahimnia, Sarkis, & Davarzani, 2015), the term "green supply chain" was also included in the search. The keywords used in combination are shown in Table 1. The search was conducted in the Scopus database using the default search field “title, abstract, keywords”. Initially, 226 articles were identified. This list was narrowed down to 67 titles by selecting journal articles only and eliminating duplicates. It is worth mentioning that the search was conducted in September 2015; therefore, new articles may have been published since then.

------ PLEASE, INSERT TABLE 1 ABOUT HERE ------

In the following step, the 67 articles were narrowed down after reading through their abstracts. The articles which did not address the use of information systems to support supply chain sustainability or environmental practices and those that were unavailable to download were excluded. As a result, the list was narrowed down to 20 articles, but then 2 other articles were added. These articles were identified through unstructured searching using the reference list of the articles selected. The final list was composed of 22 articles. These results are systematized in Table 2.

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After narrowing down the results of articles that addressed information systems and green or sustainable supply chains, a classification system was developed to categorize the articles selected (Step 3). This system was based on seven dimensions, according to the literature analyzed, which were categorized using a combination of numbers and letters (see Table 3).

------ PLEASE, INSERT TABLE 3 ABOUT HERE ------

Classification 1 refers to the context under consideration and was categorized using A-C letter codes. Classification 2 indicates the article focus, which related information systems and: sustainability aspects (A), environmental aspects only (B), supply chain in general (C). When the IS was not the main focus of the study, the article was coded as (D). Classification 3 is related to the research method and was categorized using A-F letter codes. Classification 4 refers to the sector under analysis (A-D). Classification 5 indicates the beneficiaries of the integration of IS into the supply chain: the focal organization (A), suppliers (B), or various stakeholders (C). Classification 6 identifies the green supply chain management practices that are associated with the information systems in the article. These practices were defined by Srivastava (2007), Zhu, Sarkis and Lai (2008), and Sarkis, Zhu and Lai (2011).

Finally, Classification 7 identifies the organization performance, used by Zhu, Sarkis and Lai (2007), and social performance categories that are influenced by information systems.

Table 4 shows the classification of the 22 articles selected considering these dimensions. The next section presents each dimension classified and categorized (Step 4) and also the main gaps and future research opportunities (Step 5).

------ PLEASE, INSERT TABLE 4 ABOUT HERE ------

Results

Bibliometric analysis

Figure 2 shows the number of articles published over the years. It can be seen that the field of study which integrates information systems into green or sustainable supply chains is fairly new and has been investigated in the past 15 years. The first article published was a study conducted by Guide Jr et al. (2000); although information systems are not the main focus of the analysis, it recognizes that the use of IS contributes to the predictability of supply chain activities of a recoverable manufacturing system, and thus it indirectly influences the organization environmental performance. However, between 2003 and 2005 this topic had no major breakthroughs and only one special issue on information systems and environmental aspects were identified (Sarkis, Koo, & Watson, 2013).

------ PLEASE, INSERT FIGURE 2 ABOUT HERE ------

One of the most common forms to evaluate the impact and importance of a scientific publication is by its number of citations. Table 5 shows the 10 most cited articles and their total citation counts in the Scopus database.

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The analysis of the authors' affiliations indicated the number of scientific papers published per country. A map showing the location of publication of these articles was created using the GPS Visualizer gpsvisualizer.com (Figure 3). The size of the circles is proportional to the level of contribution of each continent. It can be seen that North America, particularly the United States, has made the greatest contribution to the literature on information systems and green or sustainable supply chain. The map also shows a high dispersion of publications in Asia.

------ PLEASE, INSERT FIGURE 3 ABOUT HERE ------

Table 6 presents the four authors with the greatest contribution to the number of publications and the number of articles with their first authorship or co-authorship; it shows only four authors because all

others had one publication only. As can be seen, Bhadauria, Green Jr and Meacham were the authors with the highest number of publications, with a total of 3 articles. These authors shared the authorship of these 3 articles, demonstrating strong co-author relationship.

------ PLEASE, INSERT TABLE 6 ABOUT HERE ------

Analysed dimensions

Table 4 shows the category of each article analyzed in the present study. Appendix A presents a brief summary of the contribution of each one of these articles.

National Context

The analysis showed that most of the articles addressed information systems and green or sustainable supply chains in a specific national context, especially in developed countries (45%), as shown in Table 7. Category C was assigned to the articles written without a specific context, such as the conceptual articles, which accounted for 32% of the articles selected. The developing countries had the smallest number of publications. Moreover, none of the articles compared the topic between countries in different contexts. These findings led to first recommendation of the present study:

R1: Conduct further studies in developing countries and compare different contexts in order to understand how they can influence the level of integration between information systems into green or sustainable supply chains.

------ PLEASE, INSERT TABLE 7 ABOUT HERE ------

Research focus

This analysis aimed to investigate the focus of the articles. Most articles were classified as category B, i.e., they related information systems and environmental aspects in the supply chain (Figure 4). However, 9 out of the 22 articles selected (41%) did not focus on information systems or did not relate IS with supply chain sustainable practices, which led to second recommendation:

R2: Verify the direct association between information systems support and sustainable practices in the supply chain, emphasizing the financial and social dimensions.

------ PLEASE, INSERT FIGURE 4 ABOUT HERE ------

Research methods

The analysis shows that most of the articles that address the integration between information systems into green or sustainable supply chains are conceptual studies (41%), followed by qualitative

studies based on case studies (32%). Only 5 articles included surveys as shown in Table 8. None of the articles combined qualitative and quantitative approaches. Therefore, the third recommendation of the present study is:

R3: Adopt a mixed research method approach in further studies on the integration of information systems into green or sustainable supply chains.

------ PLEASE, INSERT TABLE 8 ABOUT HERE ------

Sector analyzed

The results show that 11 out of the 22 articles selected (50%) focused on the manufacturing sector. Category D was assigned to the articles that did not focus on any particular economic sector, which accounted for 27% of the articles. Of the two articles that analyzed the service sector, only the study of Shaft, Sharfman and Swahn (2001) addressed the benefits of information systems to the environmental practices in a transport company (Figure 5). Therefore, the forth recommendation is:

R4: Investigate the use of information systems to support environmental practice in the service sector and the impact on the reduction of CO_2 emissions in transport companies.

------ PLEASE, INSERT FIGURE 5 ABOUT HERE ------

Beneficiaries of the information systems support in supply chains

This analysis determined whether the beneficiaries of the integration of IS into green or sustainable supply chains were: the focal organization (A), suppliers (B), or various stakeholders (C), such as customers. On the case of multiple beneficiaries, more than one category was assigned to the article.

The results indicate that the majority of the articles reported focal organizations as beneficiaries of the IS support (Figure 6). However, a considerable number of articles reported the three categories, A, B, and C, as beneficiaries. Thus, the fifth recommendation is:

R5: Analyze separately and in detail the benefits to suppliers in order to clarify and encourage the integration of sustainable practices into the entire supply chain.

------ PLEASE, INSERT FIGURE 6 ABOUT HERE ------

Relationship with green supply chain management practices

The majority of the articles selected (54%) did not relate information systems with the green supply chain management practices (Figure 7). Among the practices analyzed, 6 articles reported that the information system can support green purchasing practice. As can be seen from Table 4, only 8 articles

related information systems with two or more green supply chain management (GSCM) practices. Therefore, the sixth recommendation is:

R6: Conduct further studies to verify how information systems can support each one of the green supply chain management practices.

------ PLEASE, INSERT FIGURE 7 ABOUT HERE ------

Performance benefits

This analysis determined whether the use of information systems influenced, directly or indirectly, the operational, financial, environmental, and/or social performance of the organization. It was found that most articles acknowledged that information systems positively influence the operational, financial, and environmental performance (Figure 8). In contrast, only 4 articles mentioned impacts on social performance, and only one study, Dao, Langella and Carbo (2011), reported that the four types of performance benefited from IS. Thus, the seventh recommendation is:

R7: Analyze the implications of the use of information systems in sustainable supply chain management for the social performance of the organization.

------ PLEASE, INSERT FIGURE 8 ABOUT HERE ------

Discussions

The results show that most articles were published over the last 5 years, indicating that this field of study is still being developed, as pointed out by O'Rourke (2014) and Sarkis, Koo and Watson (2013).

The articles that addressed the integration of information systems into sustainable supply chain management focused on environmental practices. Therefore, the financial and social dimensions still need more attention. Moreover, despite the fact that most articles are concentrated in the United States, there are several publications in Asia, demonstrating that this field of study has attracted attention from researchers in that continent too (Chen, Tai, & Hung, 2012; Chen et al., 2015; Lai, Hsub, & Chenc, 2012; Liu et al., 2008).

It was found that information system is an important support tool for sustainable supply chain management practices since it brings benefits to the organization, suppliers, and customers (Ayoub et al., 2007; Dao, Langella, & Carbo, 2011; Green Jr et al., 2012a, 2012b; Lai Hsub, & Chenc, 2012; Liu et al., 2008; Shaft, Sharfman, & Swahn, 2001; Wognum et al., 2011). Furthermore, it positively influences the operational, financial, and environmental performance of the organization. On the other hand, the impact of the use of information systems in sustainable supply chain management for social performance is still not clear. It is noteworthy that none of the articles used mixed research method approach and that the

service sector requires further research, especially regarding the reduction of CO_2 emissions in transport companies. Therefore, further advances in the literature are still needed, and they led to the recommendations presented in this study.

A more detailed analysis of the use of information system to support sustainable supply chain management is provided in Appendix A.

Conclusions

The present study aimed to identify and systematize scholarly articles that address the use of information system to support sustainable supply chain management. To this end, a total of 22 articles published in the last fifteen years were analyzed, and based on the analysis of different dimensions, a comprehensive account of what has been published by accredited scholars was provided.

The results from this study can be useful to researchers and organization administrators. From a theoretical point of view, the state of the art on the subject could be mapped and gaps in the literature were identified to suggest future research directions. In addition, the present study provides useful insights for administrators into the use of information system to support sustainable supply chain management.

It is important to mention that only the articles that contained keywords related to information systems and green or sustainable supply chain were evaluated. Therefore, a number of articles on information systems and supply chain that did not address sustainability were not selected for analysis since this topic is well-established in the literature.

To the best of our knowledge, this is the first study to systematize the relationship between information systems and green and sustainable supply chain management. A substantial contribution of the present study is related to the recommendations made. Each one of these recommendations can be considered an opportunity for future studies.

Appendix A

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Acknowledgments

This work was partially supported by CAPES, Coordination for the Improvement of Higher Education Personnel, Brazil.

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Figures

Fig. 1 Research steps

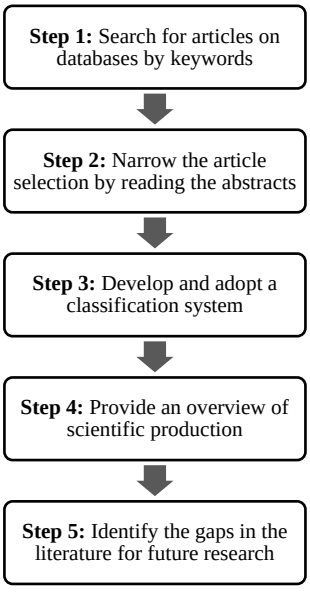


Fig. 2 Publishing trend in this field of study

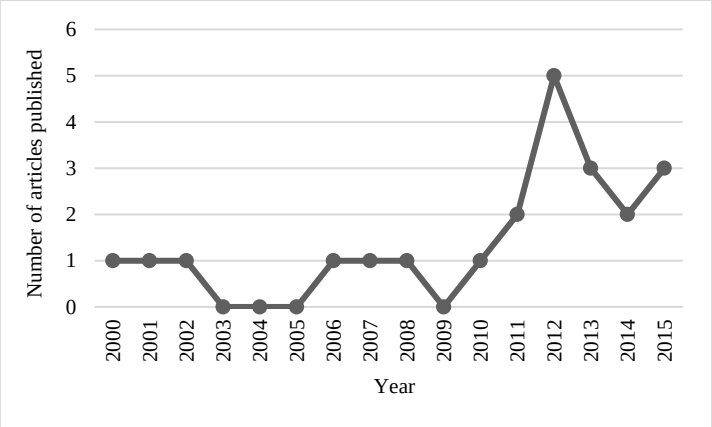


Fig. 3 (Color online) Geographic location of the publications identified

Fig. 4 Frequency distribution of Category 2

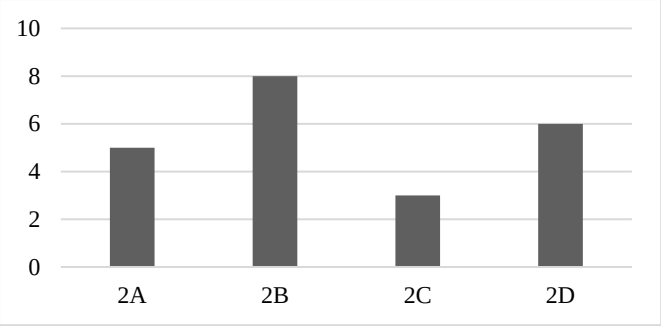


Fig. 5 Frequency distribution of Category 4

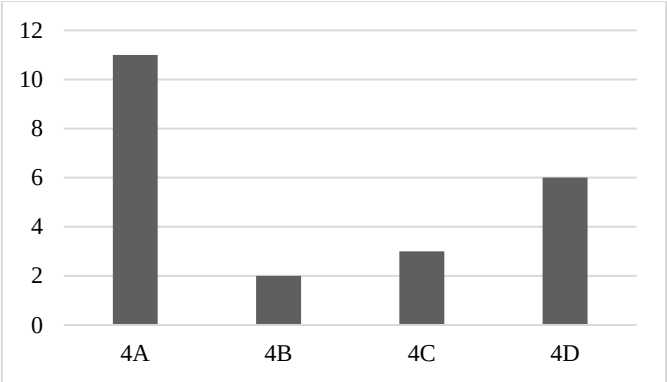


Fig. 6 Frequency distribution of Category 5

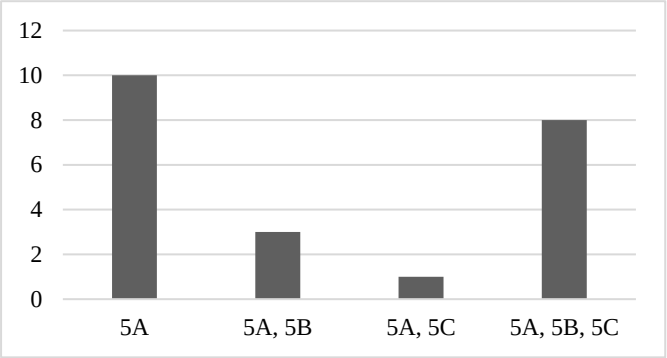


Fig. 7 Frequency distribution of Category 6

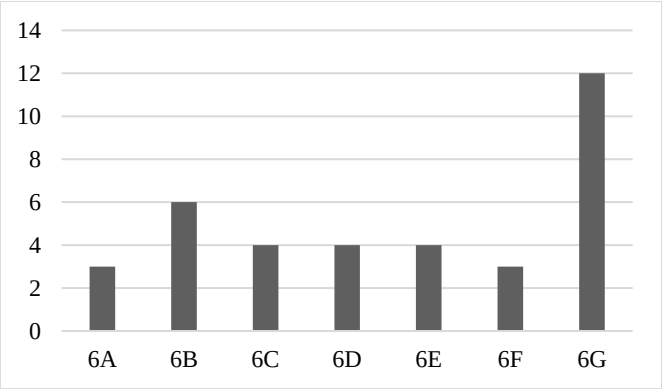
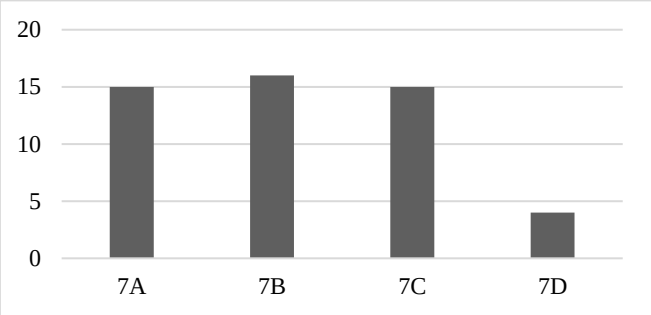


Fig. 8 Frequency distribution of Category 7



Tables

Table 1 Preliminary database search results

Keywords	Search results (No. of articles)	Search results after narrowing down (No. of articles)
"information systems" OR "information system" AND green supply chain	79	20
"information systems" OR "information system" AND sustainable supply chain	147	55 (-8) duplicates
Total	226	67

Table 2 Final number of articles selected

Analysis criteria	Results (No. of articles)
Articles identified in the database search	67
Articles selected after reading through the abstracts	20
Articles selected through unstructured searching	2
Total	22

Table 3 Framework for classifying and coding the articles analyzed

Classification	Meaning	Categories for coding
1	Context	A - Developed country
		B - Developing country
		C - Not applicable
2	Focus	A - Information systems and sustainability aspects in the supply chain
		B - Information systems and environmental aspects in the supply chain
		C - Information systems and supply chain in general
		D - Information systems were not the main focus of the study
3	Research method	A - Quantitative
		B - Qualitative
		C - Conceptual
		D - Review
		E - Survey
		F - Case studies
4	Sector analyzed	A - Manufacturing
		B - Services
		C - Others
		D - Not applicable
5	Beneficiaries of the integration of ISs into the supply chain	A - Focal Organization
		B - Suppliers
		C - Various stakeholders
		A- Internal environmental management
6	Green supply chain management practices	B - Green purchasing
		C - Cooperation with customers
		D - Ecodesign
		E - Investment recovery
		F - Reverse logistics
		G - Not applicable
7	Performance benefits	A - Operational
		B - Financial
		C - Environmental
		D - Social

Table 4 Classification and coding of the studies analyzed

Study	National context	Focus	Method	Sector analyzed	Beneficiaries of the integration of ISs into the supply chain	Green supply chain management practices	Performance benefits
Ayoub et al. (2007)	1A	2A	3B, 3F	4C	5A, 5B, 5C	6G	7B, 7C, 7D
Chen et al. (2015)	1B	2B	3B, 3F	4A	5A	6B, 6D	7A, 7B, 7C
Chen, Tai and Hung (2012)	1B	2B	3B, 3F	4A	5A	6B, 6D	7A, 7B, 7C
Dao, Langella and Carbo (2011)	1C	2A	3C	4D	5A, 5B, 5C	6G	7A, 7B, 7C, 7D
Dedrick (2010)	1C	2B	3C	4D	5A	6G	7A, 7C
Guide Jr et al. (2000)	1A	2D	3C	4A	5A	6E, 6F	7B, 7C
Green Jr et al. (2012a)	1A	2D	3A, 3E	4A	5A, 5B, 5C	6B, 6C, 6D, 6E	7A, 7B, 7C
Green Jr et al. (2012b)	1A	2B	3A, 3E	4A	5A, 5B, 5C	6A, 6B, 6C	7A, 7B, 7C
Hu et al. (2014)	1C	2D	3C	4A	5A	6G	7A, 7D
Khor et al. (2015)	1C	2B	3C	4D	5A, 5B	6B, 6D, 6E, 6F	7B, 7C
Kim and Narasimhan (2002)	1A	2C	3A, 3E	4A	5A	6G	7A, 7B
Lai, Hsub and Chenc (2012)	1B	2D	3B, 3F	4A	5A, 5B, 5C	6G	7A, 7B
Lee e Lam (2012)	1A	2D	3B, 3F	4A	5A	6C, 6E, 6F	7A, 7B
Liu et al. (2008)	1B	2C	3B, 3F	4B	5A, 5B, 5C	6G	7A, 7B
Luna-Reyes et al. (2014)	1C	2A	3C	4D	5A, 5C	6G	7B, 7C
Makiya and Fraisse (2015)	1B	2D	3C	4C	5A	6G	7A
Meacham et al. (2013)	1A	2B	3A, 3E	4A	5A, 5B	6G	7C
Rai, Patnayakuni and Seth (2006)	1A	2C	3A, 3E	4A	5A, 5B	6G	7A, 7B
Sarkis, Koo and Watson (2013)	1C	2B	3C	4D	5A	6B	7C
Shaft, Sharfman and Swahn (2001)	1A	2B	3B, 3F	4B	5A, 5B, 5C	6A	7A, 7B, 7C
Smeitink and Spruit (2013)	1C	2A	3C	4D	5A	6G	7A, 7C
Wognum et al. (2011)	1A	2A	3D	4C	5A, 5B, 5C	6A, 6C	7B, 7C, 7D

Table 5 The 10 most cited articles

Author (year)	Number of citation in the Scopus database
Rai, Patnayakuni and Seth (2006)	539
Guide Jr et al. (2000)	202
Dao, Langella and Carbo (2011)	88
Dedrick (2010)	67
Green Jr et al. (2012a)	57
Ayoub et al. (2007)	56
Wognum et al. (2011)	49
Kim and Narasimhan (2002)	40
Lee and Lam (2012)	24
Green Jr et al. (2012b)	14

Table 6 Authors with the highest number of publications

Author	Number of articles published
Bhadauria, V.S.	3
Green Jr, K.W.	3
Meacham, J.	3
Zelbst, P.J.	2

Table 7 Frequency of articles classified by context

Category	Frequency	Frequency (%)
A - Developed country	10	45 %
B - Developing country	5	23 %
C - Not applicable	7	32 %
Total	22	100 %

Table 8 Frequency of articles classified by research method

Category	Frequency	Frequency (%)
A, E – Quantitative, Survey	5	23 %
B, F – Qualitative, Case Study	7	32 %
C – Conceptual	9	41 %
D – Review	1	4 %
Total	22	100 %

Table A.1 Systematization of the contributions of the articles analyzed

Study	Research contribution summary
Ayoub et al. (2007)	Proposed an information system for the biomass supply chain that facilitates decision making and its evaluation according to their own interests, might they be environmental, economic, social, or other type of decisions.
Chen et al. (2015)	Introduced an information system for green products that integrates design, supplier management, green production, and product recycling. Thus, this IS helps improve efficiency, reduces management costs, and ensures environment protection.
Chen, Tai and Hung (2012)	Proposed the development of an IS to select green supply chain members. The selection is made according to environmental laws and regulations imposed by industries. The information system helps organizations make decisions quickly, supports the implementation of the ecodesign practice, and contributes to cost-benefit analysis and efficiency improvements.
Dao, Langella and Carbo (2011)	Stated that the IS/IT resources can optimize energy consumption, reduce environmental costs, and enable rapid communication between companies, their stakeholders, and supply chain partners. Furthermore, it suggested that the alignment of IS/IT with human resources and the supply chain leads to the development of sustainability capability.
Dedrick (2010)	Affirmed that the IT/ISs have a great potential to increase carbon production since they are used to reduce energy consumption, for example, in supply chain and/or transport systems.
Guide Jr et al. (2000)	Stated that the use of ISs along with new production planning and control techniques facilitates the prediction of the supply chain activity management of a recoverable manufacturing system minimizing environmental impact.
Green Jr et al. (2012a)	Concluded that ISs should incorporate environmental efforts because of the internal environmental management. In addition, green ISs are essential for the implementation of GSCM practices - green purchasing, cooperation with clients, ecodesign and, investment recovery. Therefore, they influence the environmental, financial, and operational performance.
Green Jr et al. (2012b)	Concluded that the internal environmental management directly impacts the ISs, resulting in changes to incorporate environmental issues. The ISs directly influence the environmental cooperation with suppliers and clients. They have the ability to share information about environmental efforts and results and to determine the environmental demands of consumers.
Hu et al. (2014)	Developed a closed-loop supply chain system to improve the sustainability of fashion products. In this system, the IS/ITs are important to promote sustainability in the fashion supply chain. They integrate various stakeholders, contribute to a rapid-response supply chain, and can be used to assess the carbon footprint of each fashion product, contributing to social responsibility.
Khor et al. (2015)	Suggested that the IT/ISs enable the green supply chain management activities to achieve sustainability goals. The supply chain members can make informed and sustainable decisions based on the use of ISs.
Kim and Narasimhan (2002)	Investigated a set of desirable strategies to use ISs in supply chain integration. Firstly, it refers to their use in value creation, followed by logistics operations, and finally in infrastructure support enabling companies to seek cost reduction and differentiation, achieving competitive advantage.
Lai, Hsub and Chenc (2012)	Reported that the use of IT/IS in the green supply chain management enables the integration of processes due to information availability, transparency, and partnerships. It improves new product development speed, increases customer loyalty, and reduces complaints about environmental problems. As a consequence, the green product sales increase, while the time required for material acquisition and for information processing and retrieval reduces.
Lee and Lam (2012)	Concluded that the ISs and technology applied to reverse logistics have a direct and positive impact on service quality and financial performance. Information systems provide updated data to monitor inventory, enabling better visibility into material status. Finally, it reported that few organizations use ISs to support reverse logistics.
Liu et al. (2008)	Found that the use of ISs improved information exchange between supply chain parties. There were improvements in the performance of logistics functions, for example, the average inventory, the average delivery time, and the total supply costs were reduced. The organization, the customers, and the suppliers benefited from the improvements. The adoption of IS led to cost reduction, revenue generation, and customer satisfaction.
Luna-Reyes et al. (2014)	Proposed the use of the IS to provide as much information as possible to consumers so that they know when, where, and by whom the products were manufactured. Therefore, ISs can be used to promote product and supply chain transparency and to encourage the consumption of more sustainable products.
Makiya and Fraisse (2015)	Suggested that a geographic IS can be used to monitor the sustainable practices of the beef supply chain. In addition, ISs can synthesize a wide variety of data becoming essential

	for planning and decision-making.
Meacham et al. (2013)	Argued that the ability to exchange information with supply chain partners using ISs, improves environmental performance. The monitoring of environmental sustainability initiatives and the results of supply chain partners enable collaborative decisions, leading to better environmental performance.
Rai, Patnayakuni and Seth (2006)	Found that the IT/IS can develop the ability to promote supply chain integration, enabling the distinction between the physical and information flows and the exchange of information between supply chain partners. This leads to improvements in operational and financial performance.
Sarkis, Koo and Watson (2013)	Stated that green IS/ITs are important for the management of supply chain environmental information flows. The development of technologies can help the monitoring and acquisition of environmental performance data in purchasing activities and supplier management.
Shaft, Sharfman and Swahn (2001)	Found that the use of ISs resulted in an improved environmental performance for the organization and its suppliers, which enabled to attract new business. The study concluded that one of the key elements for successful integration of suppliers into environmental practices of the company is the extensive use of ISs to support environmental management.
Smeitink and Spruit (2013)	Suggested that ISs and technologies can help make the organization more environmentally-friendly. For example, they contribute to the assessment of supplier environmental responsibility and to track environmental information.
Wognum et al. (2011)	Found that the use of IT/ISs should be intensified to facilitate the low-cost exchange of information between chain actors and increase cooperation between them. Such information exchange bridges the knowledge gap between consumers and producers, increasing sustainability due to improved transparency.