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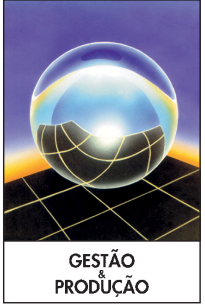

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Relating maturity levels in environmental management by adopting Green Supply Chain Management practices: theoretical convergence and multiple case study

Relacionando níveis de maturidade em gestão ambiental e a adoção de práticas de Green Supply Chain Management: convergência teórica e estudo de múltiplos casos

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Abstract: Although the thematic maturity levels of corporate environmental management and the adoption of Green Supply Chain Management (GSCM) practices are consolidating, they have passed through long ways disconnected, given that both have their genesis circumscribed to corporate sustainability. The aim of this qualitative study was to identify the relationship between GSCM practices and maturity levels of environmental management. Literature systematization was carried out dealing with the maturity levels of environmental management and the typology of GSCM practices to reach the study objective. The study was based on multiple cases studies from five different companies inserted in the production chains with high environmental impact: the sector of pesticides, the sector of batteries, and the sector of lead recycling. It was sought the characterization of a logical standard for the adoption of GSCM practices inherent to each maturity level in environmental management. The main results indicate that: at the reactive maturity level in environmental management, organizations adopt specific GSCM practices related to the imposition of legislation; at the preventive level of maturity, organizations adopt GSCM practices related to the return of investments and the reduction of operational costs; and at the proactive level of maturity, organizations tend to adopt practices related to product innovation and environmental communicational processes and practices, aiming to obtain competitive advantages always based on environmental management.

Keywords: Environmental management maturity; Green supply chain management; Green supply chain management in levels of maturity; Brazil.

Resumo: *Embora as temáticas de níveis de maturidade da gestão ambiental empresarial e a adoção de práticas de GSCM estejam se consolidando, elas percorreram, até o momento, um longo caminho desconectadas, embora ambas tenham sua gênese circunscrita à sustentabilidade empresarial. Buscou-se, por meio de múltiplos casos, a caracterização de um padrão lógico de adoção de práticas de GSCM inerentes a cada nível de maturidade em gestão ambiental. Com base no estudo de cinco casos de empresas inseridas em cadeias produtivas de alto impacto ambiental (setor de suprimentos de defensivos agrícolas, setor de pilhas e baterias e setor de reciclagem de chumbo, buscou-se identificar o relacionamento entre práticas de Green Supply Chain Management (GSCM) e níveis de maturidade em gestão ambiental. Para o alcance do objetivo, foi realizada uma sistematização junto à literatura que versa sobre maturidade de gestão ambiental e tipologia das práticas de GSCM. Os principais resultados apontam que: no primeiro nível de maturidade em gestão ambiental, o reativo, as organizações adotam práticas de GSCM específicas relacionadas à imposição da legislação; no nível preventivo de maturidade em gestão*

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ambiental, as organizações adotam práticas de GSCM relacionadas ao retorno de investimentos e à redução de custos operacionais; e no nível proativo de maturidade em gestão ambiental, as organizações tendem a adotar práticas relacionadas à inovação de produtos e processos e práticas comunicacionais ambientais, visando obter vantagens competitivas baseadas em gestão ambiental. Até o momento, este artigo trata da primeira pesquisa a relacionar níveis de maturidade de gestão ambiental a práticas de GSCM, aplicada a cinco casos com alto impacto ambiental do Brasil.

Palavras-chave: *Maturidade de gestão ambiental; Green supply chain management; Níveis de maturidade em green supply chain managment; Brasil.*

1 Introduction

The adoption of Green Supply Chain Management (GSCM) practices improves the operational and environmental performance of organizations (Zhu et al., 2013). However the practice and theory about GSCM are still at the frontier of knowledge (Jabbour et al., 2013), its conception and implantation are still embryonic, but its benefits tend to generate positive results in the struggle to reduce the anthropic environmental impact.

Great part of the studies carried out mainly focus on companies located in developed countries (Mohanty & Prakash, 2014; Laosirihongthong et al., 2013), with insufficient studies on the subject in countries such as Brazil (Ribeiro & Jabbour, 2012).

There is a lack of studies that involve a greater amount of supply chain links, both downstream and upstream of the focal company (Zhu et al., 2013; Sarkis, 2014; Mitra & Datta, 2014), add to that the importance of maturity levels of environmental management for the development of environmental management (Jabbour, 2015; Ormazabal & Sarriegi, 2012); and, finally, the need for other economic segments to be studied in order to validate the assumption that there is a relationship between GSCM practices and environmental management maturity levels (Jabbour et al., 2014a).

Another important factor is the predominance of quantitative studies, which in part prevents researchers from seeing the whole of the supply chain. However, to better know the GSCM in depth, more qualitative profile studies are needed in order to explore trade-offs, synergies and provide insights. In this way, perhaps truly sustainable companies can be found (Pagell & Shevchenko, 2014).

Thus, this study sought for Brazilian companies belonging to greener supply chains that have restrictive legislation and inputs with a high degree of hazardousness, since Brazil is an integral part of the BRIC (Brazil, Russia, India and China) and presents as the 7th world economy (Jabbour & Jabbour, 2014). These supply chains are: the automotive, the agricultural defensive, and the batteries.

Based on these premises, this qualitative study intended to describe the intensity in the adoption of practices of Green Supply Chain Management (GSCM) in order to identify its relation with the levels of maturity in environmental management, through multiple cases. To date, this article is the first research relating maturity levels of environmental management with GSCM practices; a survey was applied to five different cases insert in Brazilian production chains with high environmental impact.

2 Methodology

It was sought, through multiple cases, the characterization of the practices used as well as the classification of the organizations in maturity levels in GSCM, aiming to analyze which practices are intrinsic at each level, by obtaining a logical standard of adoption of GSCM practices inherent to each GSCM maturity level.

The planning and data collection began in 2013, being carried out through initial telephone contacts and later, through visits in the organizations. The purpose of this procedure is to supply the demand for the case study by collecting documents, visible artifacts and conducting interviews with people who have a key role in the performance of GSCM activities.

The research variables to be used in order to verify the adherence with the multiple case study were obtained through bibliographical research; thus a literature survey on maturity levels in environmental management and GSCM practices was carried out. The research was done using the term environmental management maturity and practices of GSCM, in the portals Web of Science and Scopus. The search filters adopted were the articles that contained in their title the keywords searched and were published in the following media: journals, surveys and reviews.

The research was carried out on 09-12-2014 and as a result composed a database containing 7 articles for the topic maturity level in environmental management and 42 articles for the topic of GSCM practices. The articles were used to structure a framework integrator of maturity levels in GSCM.

Literature was analyzed in depth, so the internal validity of the work was guaranteed, according to the recommendations of Gibbert et al. (2008), in order to have internal validity in the multiple case study, the work must search for varied literature and obtain

results reported from other authors and different theories thus providing its validity.

Due to the complexity and difficulty of obtaining data on environmental practices, the choice of participating companies was chosen per accessibility. E-mails were sent to 14 different organizations informing the research procedures. In view of the response and accessibility, three segments were chosen, due to their high anthropic potential, since they may cause greater or lesser environmental impact, offering a greater or lesser risk to human health and governed by environmental legislation with different levels of restrictions.

According to Gibbert et al. (2008) recommending that four to ten cases should be studied in order to obtain external validity, five companies were chosen as the object of analysis of this study, two of them belonging to the supply chain of agricultural pesticides, one manufacturer of agricultural pesticides and another distributor of agricultural products, two from the supply chain of batteries and batteries, being a manufacturer of automotive batteries, and another a recycler of lead, and one from the automotive supply chain, being the target company manufacturer of vans for trucks.

The procedures performed for data collection in organizations are shown in Chart 1.

The interviews carried out in companies had an average duration of 3 hours, where each company participating in the survey was visited with average duration of 3 hours. In addition, contacts were made by telephone and e-mail with the respective interviewees, to confirm data obtained and to resolve possible doubts about the GSCM practices adopted by the companies.

As recommended by Pagell & Shevchenko (2014), the documentary analysis of the selected chains was carried out through semi structured interviews and direct observations, thus composing a wide range of GSCM practices adopted by companies.

For the verification and analysis of the variables identified in the literature review, the multiple case analysis procedure was used to deeply study the phenomena, ensuring that there is a causal relationship allowing verifying the adherence of the proposed framework.

During the interviews, visible artifacts from organizations were collected, such as photos, plans, layouts, charts and phrases that could represent the studied phenomenon.

For data treatment, the data triangulation technique was used, aiming to answer with precision the proposed research problem. The triangulation of the data followed the processes described in the research protocol is shown is Chart 2.

Based on the research protocol, it is intended to elucidate the research questions posed and to achieve the objectives of this work.

To analyze the data, the procedures already described by Gibbert et al. (2008) were adopted in order to guarantee the internal and external validity of the case study. For the classification of maturity levels the procedures described by Jabbour (2010, 2015) and Jabbour et al. (2014a, b) were adopted.

Chart 1. Dynamics of data collection.

Cases	Segment	Position in the chain	Interviewee	Documents
Case 1 (company A)	Batteries	Lead recycler	Plant director; Quality manager	Documents available on the web; IAP Website; Folders.
Case 2 (company B)	Agricultural defensive	Manufacturer of pesticides	Director of operations; Manager of quality, health and environment	Documents available on the web; Folders; Internal reports.
Case 3 (company C)	Batteries	Manufacturer of automotive batteries	Quality manager; Environmental technician	Documents available on the web; IAP Website; Folders.
Case 4 (company D)	Automotive	Manufacturer of truck vans	Logistics Manager; Work safety and environment technician	Documents available on the web; Folders; Internal reports.
Case 5 (company E)	Agricultural defensive	Distributor of agricultural pesticides	Administrative manager	Documents available on the web; Folders; Reports; Internal documents.

Source: The authors.

Chart 2. Search Protocol.

Search elements	Description
Study questions	How does enterprise environmental maturity relate to the adoption of Green Supply Chain Management (GSCM) practices in light of the evidence of a new integrative framework and a multi-case study?
Analysis unit	To describe and analyze the practices of GSCM and levels of maturity in environmental management in supply chains with high anthropic environmental impact.
Time limits	2014.
Local	Lead recycler (case 1); Industry of agricultural defensives (case 2); Lead acid batteries manufacturer (case 3); Manufacturer of vans for trucks (case 4); and Distributor of pesticides (case 5).
Validity of constructs	Use of multiple sources of data (interviews, direct observations, internal reports and balance sheets).
Internal validity	Comparison between practices found in the literature with the practices performed by the organizations that are the object of study of this research.
External validity	Comparison between the literature and five different case studies.
Key issues in the case studies	What is the main motivating factor for the adoption of GSCM practices? If and how does the company adopt some GSCM practice? If so, which one do you use and how often? How do maturity levels in environmental management relate to GSCM practices?

Source: The authors.

3 Brief conceptual background

3.1 Maturity levels in environmental management

The maintenance of organizational competitiveness, due to the insertion of environmental management practices aimed at mitigating or reducing anthropogenic environmental impacts are a challenge, and the classification of environmental management systems at maturity levels is a road map for the development of competitive environmental management systems (Hunt & Auster, 1990).

The absence of studies on the adoption of GSCM practices in developing countries makes it difficult to compare organizations from developed countries and from developing countries (Mitra & Datta, 2014). The classification of organizations into maturity levels in environmental management increases the possibility of them entering a competitive environment, since it suggests an evolutionary stage of levels (Hunt & Auster, 1990; Ormazabal & Sarriegi, 2012).

In order to achieve the classification of organizations in relation to maturity levels of environmental management, Jabbour (2010, 2015) and Jabbour et al. (2014b) state that there is evidence that firms can be positioned at different levels of environmental management maturity (or in environmental management stages). Thus, the author proposes three levels of environmental management maturity:

- Reactive level: At this level, environmental management only responds to environmental problems generated by the organization itself, such as restrictive environmental legislation, taxation, fines and other penalties, usually imposed by the public sector. Environmental management is seen as an external cost and a legal problem;
- Preventive level: At this level, it is assumed that environmental management costs are lower when pollution generation and environmental problems are prevented. By avoiding environmental damage, companies seek to reduce pollution at source, rather than gain strategic competitive advantages based on environmental performance. Environmental issues are seen as being the responsibility of a few employees within companies or as a less strategic area;
- Proactive level (also known as Strategic Environmental Management Stage): At this level, organizations have environmental management as one of the pillars to gain competitive advantage. Thus, they tend to create lasting competitive advantages of good environmental management. In this last phase, environmental management has the status of an organizational function, mobilizes other areas of the company and incorporates environmental concerns in planning, strategic product development, manufacturing processes and communication.

3.2 Analysis of maturity levels in environmental management and its possible relations with GSCM practices

The literature systematization contains a set of the 31 most cited articles in the portals Web of Science and Scopus, and articles containing the GSCM practices in their title had the following search tools: journals, surveys and reviews and made explicit in their content the practices of GSCM. The research was carried out at 09-12-2014.

In order to delineate a minimum consensus on GSCM practices, we opted to start the analysis with the verification of which article on the GSCM theme is more relevant to the research portals. It was found that the articles with the greatest number of citations were: Green supply chain management: a state of the art literature review (Srivastava, 2007); From a literature review to a framework for sustainable supply chain management (Seuring & Müller, 2008); and, Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises (Zhu & Sarkis, 2004).

Zhu & Sarkis (2004) examined the relations between environmental management practices in the supply chain and the environmental and economic performance; the authors propose a division of GSCM practices into four groups: internal management practices, external practices, ecodesign and return of investment. These denominations are subdivided into practices specific to each group, shown in Chart 3.

In order to compare the GSCM practices proposed by Zhu & Sarkis (2004) with the proposals of articles, the main works found were: Zhu & Sarkis (2006, 2007); Zhu et al. (2007, 2008a, b, 2012a, b, 2013); Ninlawan et al. (2010); Zhu et al., (2013); Lin (2013); Govindan et al. (2013); Jabbour et al. (2013) and Jabbour et al. (2014b). After analyzing the contents of these studies, it was verified that the article published by Zhu & Sarkis (2004) is the only that explain a set of GSCM practices, so this article was used to carry out the comparative analysis (Chart 4).

As a second step, we began the analysis of the authors who, in the first analysis, added or differ, even if succinctly, the practices proposed by Zhu & Sarkis (2004), aiming at the addition of practices.

Thus, it was verified that Azevedo et al. (2011, 2012); Espadinha-Cruz et al. (2011); and Arantes et al. (2014); propose GSCM practices in line with the work of Zhu & Sarkis (2004); but also with the practices of waste minimization, reduction of consumption of hazardous and toxic materials and reverse logistics, which also includes Ninlawan et al. (2010); and Mitra & Datta (2014).

Chien & Shih (2007) describe the environmental management practices of the supply chain and relate them to environmental legislation, stakeholders, environmental performance and financial returns.

The GSCM practices listed by Chien & Shih (2007), which differ from those proposed by Zhu & Sarkis (2004), are:

Chart 3. Description of GSCM practices.

Subgroup	Practices
Internal environmental management	GSCM senior management commitment; GSCM support for mid-level managers; multifunctional cooperation for environmental improvements; management of total environmental quality; compliance with environmental legislation and audit programs; ISO 14001 certification; existence of environmental management systems.
1. External practices of GSCM	Provide design specifications for suppliers, which include environmental requirements for purchased items; cooperation with suppliers to achieve environmental objectives; environmental audit for the management of internal suppliers; ISO14001 supplier's certification; second level of suppliers with environmentally friendly practices; customer cooperation for ecodesign.
2. Ecodesign	Design of products with reduced consumption of material / energy; design of products for reuse, recycling and return of materials and / or components; product design in order to avoid or reduce the use of dangerous substances in products and / or their manufacturing process.
Return of investment	• Return on investment (sale) of excess stocks / materials; sale of scrap and used materials; sale of excess capital equipment.

Source: Zhu & Sarkis (2004).

Chart 4. Synthesis of studies on GSCM practices.

Nº	Classification	Practice	Authors
1	GSCM Practices of external type planning	Providing design specifications for suppliers including environmental requirements on the purchased item; Cooperation with suppliers for environmental objectives; Environmental audit in the management of internal suppliers; Supplier certification ISO14001; Evaluation of the second tier of suppliers in relation to environmentally friendly practices; Customer cooperation for ecodesign; Cooperation with customers for cleaner production; Cooperation with customers to use green packaging; Participation in an Ecoindustrial Park.	Perotti et al. (2012); Zhu & Sarkis (2004, 2006, 2007); Zhu et al. (2007, 2008a, b, 2012a, b, 2013); Liu et al. (2012); Govindan et al. (2013); Jabbour et al. (2013, 2014b); Mitra & Datta (2014); Mohanty & Prakash (2014) and Arantes et al. (2014).
2	GSCM practices for return on investment planning	Return on investment (sale) of excess stocks / materials; Sale of scrap and used materials; Sale of equipment in excess of capital.	Zhu & Sarkis (2004, 2006, 2007); Zhu et al. (2007, 2008a, b, 2012a, b, 2013); Liu et al. (2012); Govindan et al. (2013); Jabbour et al. (2013, 2014b) and Arantes et al. (2014).
3	GSCM practices of internal environmental management type planning	GSCM senior management commitment; GSCM support for mid-level managers; Multifunctional cooperation for environmental improvements.	Zhu & Sarkis (2007, 2006, 2004); Zhu et al. (2007, 2008a, b, 2012a, b, 2013); Liu et al. (2012); Green et al. (2012); Perotti et al. (2012); Chien et al. (2012) Govindan et al. (2013); Jabbour et al. (2013, 2014b) and Arantes et al. (2014).
4	GSCM Practices of green building and construction planning	Attention to building materials (e.g. use of recycled concrete, steel, asphalt and other materials); Construction of thermal insulation; Natural lighting (distribution installations that allow the use of natural light as a source of indoor lighting); Energy-efficient lighting systems; Energy-efficient material handling equipment; Use of alternative sources of energy (for example, solar or photovoltaic panels); Water systems (e.g., plants and landscaping materials that minimize water waste and the use of "gray water" systems).	Perotti et al. (2012).
5	GSCM operational practices of green design product type	Design of products of reduced consumption of material / energy; Design of products for reuse, recycling and return of materials and components; Product design in order to avoid or reduce the use of dangerous substances from products and / or their manufacturing process.	Zhu & Sarkis (2007, 2006, 2004); Zhu et al. (2007, 2008a, b, 2012a, b, 2013); Liu et al. (2012); Chien et al. (2012); Govindan et al. (2013); Jabbour et al. (2013, 2014b); Laosirihongthong et al. (2013) and Arantes et al. (2014).

Source: Based from Zhu et al. (2008a), Azevedo et al. (2011) and González-Benito & González-Benito (2005, 2006).

Chart 4. Continued...

Nº	Classification	Practice	Authors
6	GSCM operational practices of waste reduction and risk minimization processes	Waste reduction; Decreased consumption of hazardous and toxic materials; Establishment of a checklist of substances dangerous to the environment; Profiles of raw materials which do not contain prohibited substances; Approval data for green products; Green manufacturing practices; Manufacture of green products; Green product standards; Use of recyclable materials wherever possible; Reduction of consumption wherever possible; Reuse of materials wherever possible; Total environmental quality management; Compliance with environmental legislation and audit programs; ISO 14001 certification; Existence of Environmental Management Systems.	Azevedo et al. (2011, 2012); Espadinha-Cruz et al. (2011); Chien & Shih (2007); Zhu & Sarkis (2007, 2006, 2004); Zhu et al. (2007, 2008a, b, 2012a, b, 2013); Liu et al. (2012); Green et al. (2012); Perotti et al. (2012); Chien et al. (2012); Govindan et al. (2013); Jabbour et al. (2013, 2014b); Mohanty & Prakash (2014) and Arantes et al. (2014).
7	GSCM operational practices of reverse logistic process	Reverse transport logistics and waste disposal; Strategies of distribution, transportation and execution of the redesign of the components of the logistics system for greater environmental efficiency; Location of environmentally friendly facilities; Use of alternative fuels; Selection of modalities based on “eco-friendly” parameters; Use of cleaner vehicles; Consolidation and effective loading of the entire vehicle load; Routing of systems to minimize travel distances; Vehicle maintenance and disposal.	Azevedo et al. (2011, 2012); Espadinha-Cruz et al. (2011); Perotti et al. (2012); Chien & Shih (2007); Mitra & Datta (2014); Guide & Li (2010); Arantes et al. (2014) and Jabbour et al. (2014b).
8	Communicational GSCM Practices	Regular preparation of environmental reports; Sponsorship of environmental events / collaboration with ecological organizations; Environmental arguments in marketing; Providing regular and voluntary information about environmental management environment for clients and institutions.	González-Benito & González-Benito (2005, 2006).

Source: Based from Zhu et al. (2008a), Azevedo et al. (2011) and González-Benito & González-Benito (2005, 2006).

- Establish a checklist of hazardous substances for the environment;
- Profiles of raw materials that do not contain prohibited substances;
- Approval data for green products;
- Green manufacturing practices;
- Manufacture of green products;
- Green product standards.

Chien et al. (2012), in a survey carried out with the Taiwanese electrical and electronic industry, define the green barriers imposed by the European Union in relation to the global environmental problem and relate them to the adoption of green management practices within the chain, proposing the following management practices:

- Green design;
- Green innovation;

- Green manufacture;
- Green purchases;
- Green logistics;
- Green services.

The study by Chien et al. (2012) highlights the insertion of practices related to green services and green innovation in the set of environmental practices of supply chain management. However, these are contemplated, even indirectly, in the practices of internal environmental management and ecodesign (Zhu & Sarkis, 2004). Already green logistics is present in the works of Azevedo et al. (2011, 2012).

The studies of Vachon & Klassen (2006) and Vachon (2007) contribute to the study of environmental practices of supply chain management, subdividing them into collaborative practices and monitoring practices, from which it can be inferred that, even with a different approach, collaborative practices are considered in the studies of Zhu & Sarkis (2004). This can also be asserted in regarding to the set of monitoring practices.

The general approach proposed by Vachon & Klassen (2006); and Vachon (2007) is broader than that proposed by Zhu & Sarkis (2004), since these last delimit practices related to monitoring and collaboration, involving customers and suppliers.

Liu et al. (2012) indicate that Chinese companies are still in a preliminary phase of adopting GSCM practices, and their environmental management and cooperation with external members of the supply chain are greatly reduced. In this study, the authors delimit four main practices:

- Internally proactive environmental activities;
- Environmentally preferable procurement;
- Environmentally conscious design;
- Vendor inventories and services.

However, these practices do not differ from those proposed by Zhu & Sarkis (2004), but only confirm them as management practices that delimit environmental practices systems of supply chain management.

Green et al. (2012) collaborate with Zhu & Sarkis, (2004) regarding the insertion of the term environmental information system, these practices are contemplated in the study made by Zhu & Sarkis (2004) demonstrating in the practice of internal management the existence of information system.

Perotti et al. (2012) elaborated a compilation of the main practices of GSCM, dividing them into eight groups: green supplies; distribution and transport strategies; storage and green building; reverse logistic; cooperation with consumers; return of investment (ROI); ecodesign and packaging, and internal management. Their research differs from Zhu & Sarkis (2004), in relation to distribution and transport strategies, storage and green construction and reverse logistics. However, they collaborate with the studies of Azevedo et al. (2011, 2012); Espadinha-Cruz et al. (2011) and Chien et al. (2012). However, regarding the cooperation with customers, the item participation is added to an Ecoindustrial Park; in practical internal management, is added the practical use of green information technology (e.g. reduction of the number of servers, use of green, optimization software, number of backup), practices already detailed by Green et al. (2012).

Mitra & Datta (2014) and Laosirihongthong et al. (2013), besides include reverse logistics practices in accordance with the practices from Azevedo et al. (2011, 2012); Espadinha-Cruz et al. (2011); Mitra & Datta (2014) and Chien et al. (2012) also include GSCM external supplier practices, as described by Zhu & Sarkis (2004, 2006, 2007); Zhu et al. (2007, 2008a, b, 2012a, b, 2013) and Lin (2013).

Laosirihongthong et al. (2013) also use the ecodesign practices proposed by Zhu & Sarkis (2004) and add practices derived from obligations imposed by restrictive legislation. These were not included in this systematization, because they meet the motivations for the adoption of GSCM practices, a subject that will be discussed in the section levels of maturity in environmental management.

Mohanty & Prakash (2014) compile the practices of GSCM, dividing them into practices of risk minimization and waste reduction, such as Azevedo et al. (2011, 2012) and Espadinha-Cruz et al. (2011). There are no significant differences with the GSCM practices described here, as they also use the study of Zhu & Sarkis (2004) as basis.

Given the need to group the practices of GSCM into sets, a classification system was used to compile, standardize and group them into sets, based on the premises of Zhu et al. (2008a), Azevedo et al. (2011) and González-Benito & González-Benito (2005, 2006), since these works provide a comprehensive approach regarding the scope of organizational practices.

The set of GSCM practices formulated here follows the classification of juxtaposed environmental management practices: planning practices, operational practices and communicational practices (González-Benito & González-Benito, 2005, 2006).

Given the set of GSCM practices followed by its theoretical justification, it follows the new model for the juxtaposition of GSCM practices in groups. They are presented, linking the classification, the group, the descriptions of the practices and the authors that underlie them, as shown in Chart 4: Synthesis of studies on GSCM practices.

As the GSCM practice groups have distinct practices among themselves, it was necessary to perform the data parameterization by adopting the following mathematical procedures which are described in Equations 1 and 2.:

$$GPGSCM_k = \frac{\sum_i^n PGSCMA_{i,k}}{\sum_i^n PGSCMD_{i,k}} \times 100 \quad (1)$$

where:

k represents the GSCM practices;

n represents the number of elements of each GSCM practice group;

$i = (1, 2, ..., n)$.

$$TPGSCM_k = \frac{\sum_i^m GPGSCM_i}{m}, \text{ onde } m = 8 \quad (2)$$

where:

$i = (1, 2, ..., m)$;

$GPGSCM = GSCM\ Practice\ Range$;

$PGSCMA = GSCM\ Practices\ Adopted$;

$PGSCMD = GSCM\ Practices\ Described$;

$TPGSCM = Total\ GSCM\ Practices$.

Based on the outputs obtained by the calculation using the formula, it is possible to parameterize the relative importance of each set of GSCM practices in relation to the whole, since each set has a different number of practices described in the literature, thus, it's possible to evaluate each group of GSCM practices in relation to the total level of GSCM practices adopt by organizations.

It is also possible to verify which set of GSCM practices is present with greater adoption intensity by the organizations and to position them at the respective levels of maturity of environmental management, allowing the visualization of GSCM practices sets that are intrinsic to each level of maturity of environmental management in organizations.

Based on this information and considering the relationship between GSCM practices and maturity levels in environmental management we can measure environmental performance (Jabbour et al., 2014a) having that the adoption of GSCM practices by organizations improves their economic and environmental performance (Zhu et al., 2008a, 2012b). Since there is evidence that firms can be positioned at different levels of environmental management maturity (Jabbour, 2010, 2015).

It is proposed to relate the intensity of the adoption of GSCM practices, separated here in planning, operational and communicational practices, to the levels of environmental management maturity, thereby obtaining a logical standard for its adoption by the organizations.

However, the union between GSCM practices and maturity levels in environmental management is in line with standardization and business strategies, a fact that demonstrates the similarity of environmental management systems and GSCM, contrasting with the literature tendency to treat them as isolated form (Testa & Iraldo, 2010).

4 Analysis of results in comparison with literature

4.1 Characterization of maturity levels of environmental management

The first case analyzed (company A) is an organization belonging to the supply chain of batteries.

The maintenance of environmental practices is understood as being fundamental for the company's growth in the market. As the quality manager states, "the main motivation for adopting environmental practices is the aggregation of value to the product, supporting the fundamental principles of the company". In this way, the company adopts GSCM practices and communicates its commitment to environmental responsibility. Therefore, the target company belongs to the proactive level, as indicated by Jabbour (2010, 2015) and Jabbour et al. (2014b). According to them an organization belonging to this level of environmental management has strategic connotation, continuously seeking environmental innovations in products and production processes, and is guided by an environmental policy of excellence. In addition, environmental management is considered a source of competitive advantage by top management.

The second case analyzed (company B) refers to an organization belonging to the supply chain of agricultural pesticides.

According to their director of operations "the company visualizes the opportunity of businesses related to the environment". It is clear in several statements from its representatives that the company sees the environmental issue as a business opportunity, including the commercialization of industrial waste as a way to be environmentally responsive and generate financial results. In the interview, the expression "gaining competitive advantage through the adoption of environmental practices" was constant, which denotes the strategic environmental thinking of the company. Therefore, as indicated by Jabbour (2010, 2015) and Jabbour et al. (2014b), this organization also belongs to the proactive level of environmental management, since it has strategic connotation, continually seeking environmental innovations in products and production processes and is guided by an environmental policy of excellence.

The third case analyzed (company C) belongs to the supply chain of batteries.

In the interview conducted, it was verified that, according to the quality manager: "Among the values inherent to the company is the respect for the environment and society". Thus, the organization has as motivating factor the search for competitive advantages along the supply chain, through the adoption of environmental practices. The company seeks to be at the forefront of environmental practices, demonstrating that it is aware of the environmental legislation, seeking to minimize costs with the adoption of environmental practices and, seeking to obtain competitive advantages related to the adoption of GSCM practices. Thus, the company is also classified with the proactive maturity level of environmental management, as indicated by Jabbour (2010, 2015) and Jabbour et al. (2014b).

The fourth case analyzed (company D) is an organization belonging to the automotive supply chain.

The company always cares for the environment, even though in a restricted way, it also values the reduction of energy consumption in its installation, prioritizing natural ventilation and lighting, as well as some programs that advocate the reduction and / or recycling of components. Therefore, the target company belongs to the preventive level, as indicated by Jabbour (2010, 2015) and Jabbour et al. (2014b).

An organization belonging to the preventive level of environmental management envisions that the costs with environmental management are lower when the generation of pollution and environmental problems is prevented. Environmental issues are seen as being the responsibility of a few employees within companies or as a less strategic area.

The fifth and last case analyzed (company E) is an organization belonging to the supply chain of agricultural pesticides.

The company is committed to fulfilling all legal obligations and is a member of an association for the collection of packaging. Company management recommends the conscious use of resources and materials, but its focus is on compliance with legal obligations. Therefore, the target company belongs to the reactive level, as indicated by Jabbour (2010, 2015) and Jabbour et al. (2014b), since organizations belonging this level of environmental management only react to environmental problems generated by the organization itself, such as restrictive environmental legislation, taxation, fines and other penalties, usually imposed by the public sector.

In short, the companies A, B and C were classified in the proactive level, company D was classified in the preventive level and company E was classified in the reactive maturity level of environmental management.

4.2 GSCM practices and maturity levels of environmental management

Remembering that the objective of this study is to outline and explain the relationship between environmental management maturity levels and GSCM practices. The analysis of each set of GSCM practices adopted by companies A, B, C, D and E is shown in Table 1 Wide range of GSCM practices set:

I. GSCM Practices of External Type Planning

In GSCM's practices set of external type planning, the behaviors most adopted by the companies belonging to the proactive level of environmental management are: the provision of environmental specifications for design, including environmental requirements and practice aimed at cooperation with customers for a production cleaner. The adoption of these practices indicates that companies belonging to this maturity level of environmental management adopt practices downstream and upstream of the supply chain, regardless whether or not they are the focal company, since company C is not a focal company.

Companies A and B are part of the same supply chain of batteries, the first is the focal company

Table 1. Wide Range of GSCM Practices Set.

GSCM practices set	Level of GSCM practices adoption				
	Company A	Company B	Company C	Company D	Company E
I	67%	22%	56%	22%	22%
II	67%	67%	100%	100%	--
III	100%	100%	100%	67%	33%
IV	100%	57%	29%	43%	--
V	--	67%	33%	--	--
VI	100%	93%	80%	20%	33%
VII	33%	11%	33%	11%	22%
VIII	100%	100%	75%	--	--
Total	71%	65%	63%	33%	14%

Source: The authors.

and the second is a backbone link. However, even belonging to distinct links, they have the same maturity level in environmental management, the proactive, as they have in common, in addition to the practices described above, the following practices: cooperation with suppliers for environmental objectives; evaluation of environmental practices of internal suppliers and of second tier of suppliers. This fact demonstrates that the maturity level of environmental management has no explicit relation to the focal link of the supply chain.

Noteworthy the fact that no company adopts the ISO 14001 certification, which demonstrates that although GSCM practices related to suppliers are present in companies with higher maturity levels in environmental management, they do not require environmental certification from their suppliers. This finding differs in part from the assertion that there is no relationship between the pressure exerted by the focal company and the adoption of environmental practices (Jabbour et al., 2013).

Company E belongs to the reactive maturity level in environmental management and adopts two practices related to customers, this is due the requirements of the restrictive environmental legislation incident on the segment of agricultural pesticides.

II. GSCM Practices for Return on Investment Planning

Regarding the analysis of the second group, GSCM practices for return on investment type of planning, it is worth noting that company D, belonging to the preventive maturity level in environmental management, adopts all the practices listed in this group, a fact that may be related to the search for cost reduction with the adoption of environmental practices, being these the predominant practices at this level of environmental management. However, the company E, belonging to the reactive maturity level in environmental management, does not adopt any of these practices.

The companies A, B and C belonging to the proactive level of environmental management have in common the adoption of return on investment practices through the sale of surplus stocks and materials, however, even though non-uniformly, companies belonging to this level adopt more than 67% of GSCM practices related to the group.

III. GSCM Practices of Internal Environmental Management Planning

Regarding the analysis of the GSCM practices group of internal environmental management planning, it is worth highlighting the fact that all senior managers of companies surveyed demonstrate a commitment to environmental management and middle level managers provide support for GSCM practices, this happened in companies A, B, C, and D, belonging to the preventive and proactive maturity levels in environmental management. A fact that does not occurred in company E, belonging to the reactive level. On the other hand, multifunctional cooperation only occurred in companies A, B and C belonging to the proactive maturity level in environmental management, indicating that at this level there is multifunctional internal cooperation to obtain environmental improvements.

IV. GSCM Practices of Green Storage and Construction

Concerning the group of GSCM practices of green storage and construction, companies A, B and C belonging to the proactive maturity level of environmental management have in common the adoption of thermal insulation and systems for water reuse. Emphasizing that company D, belonging to the preventative level of environmental management, adopts more green building practices than company C, belonging to the proactive level, and company E, belonging to the reactive level, does not adopt any GSCM practice of this set, indicating that only of higher maturity levels in environmental management lead to the employment of these conduits.

V. GSCM Operational Practices of Green Design Products

Regarding the of GSCM operational practices group of green design product type, company A, belonging to the proactive level, does not adopt any practice of green design, also occurring in companies D and E, belonging to the preventive and reactive levels, respectively. Although company B adopts practices related to the design of products for reuse, recycling and returning materials and producing products in order to avoid or reduce the use of dangerous substances and / or its manufacturing process, we cannot see the predominance of this set of practices in any of the maturity levels in environmental management. This finding contradicts the assertion made by Govindan et al. (2013) that green product design practices are essential for the dissemination of GSCM practices across the supply chain.

VI. GSCM Operational Practices of Waste Reduction and Risk Minimization Processes

The set of GSCM operational practices of waste reduction and risk minimization process stands out among the other groups, because it has the major number of GSCM practices adopted.

The companies A, B and C, belonging to the proactive maturity level in environmental management, have in common the GSCM practices focused on waste reduction; the reduction of consumption of hazardous and toxic materials; establishment of a checklist of substances dangerous to the environment; the reduction of profiles of raw materials containing prohibited substances; the provision of green product type-approval data; the establishment of green product standards; reduction of consumption where possible; re-use of materials wherever possible; management of total environmental quality; compliance with environmental legislation and audit programs; and the existence of environmental management systems.

Worth highlighting the fact that company E, belonging to the reactive maturity level in environmental management, adopts a greater number of GSCM operational practices of waste reduction process and risk minimization than Company D, belonging to the preventive level of maturity in environmental management.

VII. GSCM Operational Practices of Reverse Logistic Process

The set of GSCM operational practices of reverse logistics process type does not present significant adoption by the companies. Although four companies adopt reverse logistics practices of waste disposal, however, there does not seem to be a pattern in adopting these practices. An analysis in line with the results obtained by Laosirihongthong et al. (2013), these authors exposes that reverse logistics practices have low levels of adoption, in a study carried out with 190 companies with ISO 14001 in Thailand. Perhaps the fact occurs having that reverse logistics practices listed in the literature are linked to practices aimed at reducing the anthropic environmental impact of reverse logistics activity.

VIII. Communicational GSCM Practices

The communicational GSCM practices are adopted by companies A, B and C, belonging to the proactive maturity level in environmental management, such as: environmental reporting, event sponsorship, collaboration with environmental organizations and environmental marketing arguments. Meanwhile, the companies D and E belonging to the preventive and reactive levels do not adopt communicative GSCM practices.

With the analysis of the maturity levels in environmental management and the GSCM practices adopted, there is evidence that links the practices of GSCM to the maturity levels of environmental management, since the environmental management of an organization can be classified in maturity levels in environmental management (Hunt & Auster, 1990; Kolk & Mauser, 2002; Ormazabal & Sarriegi, 2012; Jabbour, 2010, 2015; Jabbour et al., 2014b; Teixeira et al., 2012). There is a strong link between the adoption of environmental management practices in companies with a proactive maturity level of environmental management (Ribeiro & Jabbour, 2012).

5 Discussion: synthesis of results and evolution of GSCM practices based on maturity levels of environmental management

It was verified by the analysis that companies surveyed can be classified at different levels of maturity in environmental management, in agreement with the statements of Hunt & Auster ((1990); Kolk & Mauser (2002); Ormazabal & Sarriegi (2012); Jabbour (2010, 2015); Jabbour et al. (2014b); and Teixeira et al. (2012).

It was also identified that the wide range of possible GSCM practices, based on Zhu et al. (2008a); Azevedo et al. (2011); and González-Benito & González-Benito (2005, 2006). This was obtained through literature systematization with the 42 most cited articles in the Web of Science and Scopus portals, which had in their title the term “GSCM practices”. Thus, a wide range of possible GSCM practices were formed, being divided in: (1) GSCM practices of external planning type; (2) GSCM practices of return investment planning type; (3) GSCM practices of internal environmental management planning type; (4) GSCM practices of green storage and construction planning type; (5) GSCM operational practices of the green design products; (6) GSCM practices of waste reduction and risk minimization processes; (7) GSCM practices of reverse logistics process type; and (8) Communicational GSCM practices, in according to the precepts of Zhu et al. (2008a); Azevedo et al. (2011); González-Benito & González-Benito (2005, 2006).

We emphasize the insertion in the literature about the communicational GSCM practices, because due the researches carried out these practices were not considered.

The union of the themes maturity levels in environmental management and the proposed GSCM practices had as a consequence the identification of the positive relations between the maturity level in environmental management of the organizations and the number of GSCM practices adopted by them, being proposed three main maturity levels: Reactive, Preventive and Proactive in GSCM.

The GSCM practices adopted by all the organizations belonging to the proactive level, demonstrates that there are, at least in the companies surveyed, GSCM practices that are common to companies belonging to the same level of maturity management.

Therefore, it is possible to affirm that: companies belonging to the proactive level adopt GSCM practices of cooperation with clients and suppliers for environmental objectives, seeking the return of their investment; by adopting green building and storage practices; seeking to minimize waste and environmental impact; communicating with their markets (supplier and consumer), and all organizational levels of these companies are committed to factors linked to GSCM.

In the preventive level, the predominance lies in the adoption of GSCM practices linked to the search for cost reduction and return of investments, imposed by restrictive legislations.

Already at the reactive level, the practices adopted by the company tend to be those required by the restrictive legislations.

There are indications raised in the cases analysis that the evolution from one maturity level to another in GSCM follows a pattern, which corroborates with the statements of Ormazabal & Sarriegi (2012); and Zhu et al. (2013).

This possible pattern tends to follow the description: at the reactive maturity level organizations are forced to adopt some GSCM practices by imposing restrictive environmental legislation (Jabbour et al., 2014a). These practices become external costs for organizations within the same chain of supply, since practices imposed by restrictive environmental legislation were not customary. This is coupled with the fact that some organizations still do not fully comply with the legislation, thus not having the impact of external cost costs.

As the GSCM practices and constraints imposed by legislation are internalized, thus organizations tend to reduce its external costs and, consequently, their operational costs. Organizations that target strategies with long-term results tend to adopt GSCM practices more easily (Laosirihongthong et al., 2013). The practices of GSCM adopted at that moment are those that directly interfere in the reduction of costs, and (at that moment) the organization is at the preventative maturity level of in environmental management.

As the organization takes ownership of GSCM practices the impact of restrictive environmental legislation is absorbed, then organizations tend to pursue competitive advantages inherent in product or process innovations. At this level, some companies have environmental innovation centers (Jabbour et al., 2014a) and all organizational levels of the company are involved with environmental management, with multifunctional collaboration (Teixeira et al., 2012).

In addition, at this stage there is demand for the communication of environmental results coming from the adoption of GSCM practices. These innovations and the demand for communication with the market lead the organization to gain by adopting GSCM practices, whether for monetary gains, image, or both. At that moment, the organization reaches the proactive maturity level in environmental management.

The union of maturity levels in environmental management and GSCM practices, the findings in literature and also results obtained from cases analyzed bring some practical concerns. Since it was proposed and confirmed that there is a set of practices inherent to each maturity level in GSCM. So managers can use the model presented here in order to raise one maturity level to another, since they can position their company and check which practices that, if adopted, will raise the organization maturity level in GSCM.

Likewise, governments can use the model to encourage industrial sectors to raise the maturity level in GSCM because they may use restrictive environmental legislations or incentive programs to motivate organizations and to achieve higher maturity levels in GSCM.

The finding of the use of communicative GSCM practices by companies with a proactive maturity level in GSCM, until then neglected in the literature, is a point to be highlighted, since it inserts in the context of managerial actions, given the importance of communication of results obtained using GSCM practices.

6 Conclusions

Based on the literature regarding the maturity of environmental management and the main practices of GSCM, a qualitative study was proposed to better understand the pattern of relationship between "adopted practices of GSCM" and "maturity of environmental management" in cases inserted in Brazilian supply chains with high environmental impact.

This integration between the maturity of environmental management and adoption of GSM practices allowed the creation of a logical pattern among these concepts. The main results are:

- At the first level, there are a small number of GSCM practices, and the chain only reacts to environmental problems generated by the organization itself, such as taxation, fines and other penalties generally imposed by restrictive environmental legislations. GSCM

practices are seen as an external cost and a legal problem;

- At the second level as there are a greater number of GSCM practices adopted, it is assumed that GSCM practices costs are lower when pollution generation and environmental problems are reduced or impeded. By avoiding environmental damage, companies seek to reduce pollution at source, rather than gain strategic competitive advantages based on environmental performance. Environmental issues are seen as being the responsibility of a few employees within companies or as a less strategic area;
- At the third level, there are a high number of GSCM practices adopted. Organizations have GSCM practices as one of the pillars to gain competitive advantage and tend to create lasting competitive advantages by adopting GSCM practices. In this last phase, GSCM practices have the status of an organizational function, mobilizing other areas of the company and incorporating environmental concerns into planning, strategic product development, manufacturing processes and communication. These advanced features of GSCM are often present in companies that heavily invest in corporate social responsibility.

This logic allows the creation of an apparent pattern between the adoption of GSCM practices and the maturity level in environmental management, since in the reactive level organizations adopt GSCM practices related to the imposition of legislations; in the preventive level organizations adopt GSCM practices related to the return of investments and the reduction of operational costs; and in the proactive maturity level of in environmental management, organizations tend to adopt practices that advocate the innovation of products and processes and communication, in order to obtain competitive advantages.

In summary, it can be said that, due this study was carried out in Brazil (developing country) and having analyzed five distinct cases, where at least two companies belonging to the same supply chain. This work supplies, respectively, the shortcomings of studies in developing countries as previously raised by by Jabbour et al. (2013, 2014a, c), Mohanty & Prakash (2014); Laosirihongthong et al. (2013); and Ribeiro & Jabbour (2012), and also studies focused on different links of the target company, as raised by Zhu et al. (2013), Sarkis (2014) and Mitra & Datta (2014).

Therefore contributing as an extension to the state of the art of GSCM literature, since it provides empirical evidence with high anthropic environmental impact, and also provides an indicative of GSCM practices that are intrinsic to each maturity level in environmental management. In other words, it links the evolution of environmental management with a typical pattern of GSCM practice adoption, which may be useful for environmental managers interested in continuously improving the maturity level of environmental management.

However, some research limitations are worth mentioning, and these are related to the inherent shortcomings of the method chosen, since the proposed maturity levels in GSCM need a quantitative study to be consolidated, but could not be disregarded in this study, because they became evident. This fact, coupled with the small number of cases surveyed, exposes its lack, inherent to the chosen research method, and postulated as a gap to be filled by future quantitative studies, in order to increase the validity of its results and verify its adherence in other industrial segments and links in the supply chain, having that organizations focuses on the provision of distribution services and adopts a reduced number of GSCM practices described.

In this sense, the wide range of GSCM practices described here may not adequately evaluate GSCM practices adopted by service providers, or because it is a sector and / or link in the supply chain with a lower degree of environmental impact, leaving, therefore, the organizations belonging to the distribution link impaired in comparison with other industrial segments.

So this is a limitation of this work, however to minimize the lack of research on distinct links of the supply chain target company, according to Zhu et al. (2013); Sarkis (2014); and Mitra & Datta (2014); this procedure became necessary, postulating as a gap to be verified in other researches, for better understanding the relation of maturity levels in environmental management and the adoption of GSCM practices in companies that have as their final activity the provision of services.

Finally, the maturity levels in GSCM listed here make an important contribution qualitative contribution, although they lack quantitative confirmation, for future studies focused to validate other economic sectors and companies with different sizes.

References

Arantes, A. F., Jabbour, A. B. L. S., & Jabbour, C. J. C. (2014). Adoção de práticas de Supply Chain Management: mecanismos de indução e a importância das empresas

focais. *Production*, 24(4), 725-734. http://dx.doi.org/10.1590/S0103-65132014005000007.

Azevedo, S. G., Carvalho, H., & Cruz-Machado, V. (2011). The influence of green practices on supply chain performance: A case study approach. *Transportation Research Part E, Logistics and Transportation Review*, 47(6), 850-871. http://dx.doi.org/10.1016/j.tre.2011.05.017.

Azevedo, S. G., Carvalho, H., Duarte, S., & Cruz-Machado, V. (2012). Influence of green and lean upstream supply chain management practices on business sustainability. *Transactions on Engineering Management*, 59(4), 753-765. http://dx.doi.org/10.1109/TEM.2012.2189108.

Chien, M.-K., & Shih, L. H. (2007). An empirical study of the implementation of Green Supply Chain Management practices in the electrical and electronic industry and their relation to organizational performances. *International Journal of Environmental Science and Technology*, 4, 383-394.

Chien, M.-K., Chang, T.-M., & Kuo, W.-C. (2012). Applying grounded theory to study Green Supply Chain Management practices in Taiwan's industry. In *Proceedings of the International Technology Management Conference* (pp. 25-27). Dallas: IEEE. http://dx.doi.org/10.1109/ITMC.2012.6306381.

Espadinha-Cruz, P., Grilo, A., Puga-Leal, R., & Cruz-Machado, V. (2011). A model for evaluating lean, agile, resilient and green practices interoperability in supply chains. In *Proceedings of the 2011 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)* (pp. 1209-1213). Singapore: IEEE.

Gibbert, M., Ruigrok, W., & Wicki, B. (2008). Research notes and commentaries what passes as a rigorous case study? *Strategic Management Journal*, 29(13), 1465-1474. http://dx.doi.org/10.1002/smj.722.

González-Benito, J., & González-Benito, Ó. (2005). Environmental proactivity and business performance: an empirical analysis. *Omega*, 33(1), 1-15. http://dx.doi.org/10.1016/j.omega.2004.03.002.

González-Benito, J., & González-Benito, Ó. (2006). A review of determinant factors of environmental proactivity. *Business Strategy and the Environment*, 15(2), 87-102. http://dx.doi.org/10.1002/bse.450.

Govindan, K., Kannan, D., Mathiyazhagan, K., Jabbour, A. B. L. S., & Jabbour, C. J. C. (2013). Analysing Green Supply Chain Management practices in Brazil's electrical/electronics industry using interpretive structural modeling. *The International Journal of Environmental Studies*, 70(4), 477-493. http://dx.doi.org/10.1080/00207233.2013.798494.

Green, K. H., Jr., Zelbst, P. J., Meacham, J., & Bhadauria, V. S. (2012). Green Supply Chain Management practices: impact on performance. *Supply Chain Management*, 17(3), 290-305. http://dx.doi.org/10.1108/13598541211227126.

Guide, V. D. R., Jr., & Li, J. (2010). The potential for market cannibalization of new product sales by remanufactured products. *Decision Sciences Journal*, 41(3), 547-572. http://dx.doi.org/10.1111/j.1540-5915.2010.00280.x.

Hunt, C., & Auster, E. (1990). Proative environmental management: avoiding the toxic trap. *MIT Sloan School of Management*, 31, 7-18.

Jabbour, A. B., Jabbour, C. J. C., Govindan, K., Kannan, D., Salgado, M. H., & Zanon, C. J. (2013). Factors affecting the adoption of Green Supply Chain Management practices in Brazil: empirical evidence. *The International Journal of Environmental Studies*, 70(2), 302-315. http://dx.doi.org/10.1080/00207233.2013.774774.

Jabbour, A. B., Jabbour, C., Govindan, K., Kannan, D., & Arantes, A. F. (2014a). Mixed methodology to analyze the relationship between maturity of environmental management and the adoption of Green Supply Chain Management. *Resources, Conservation and Recycling*. http://dx.doi.org/10.1016/j.resconrec.2014.02.004.

Jabbour, A. B. L., Jabbour, C. J. C., Sarkis, J. S., & Govindan, K. (2014c). Brazil's new national policy on solid waste: challenges and opportunities. *Clean Technologies and Environmental Policy*, 16(1), 7-9. http://dx.doi.org/10.1007/s10098-013-0600-z.

Jabbour, A. B., Jabbour, C. J. C., Latan, H., Teixeira, A. A., & Oliveira, J. H. C. (2014b). Quality management, environmental management maturity, green supply chain practices and green performance of Brazilian companies with ISO 14001 certification: Direct and indirect effects. *Transportation Research Part E, Logistics and Transportation Review*, 67, 39-51. http://dx.doi.org/10.1016/j.tre.2014.03.005.

Jabbour, C. J. C. (2010). Non-linear pathways of corporate environmental management: a survey of ISO14001-certified companies in Brazil. *Journal of Cleaner Production*, 18(12), 1222-1225. http://dx.doi.org/10.1016/j.jclepro.2010.03.012.

Jabbour, C. J. C. (2015). Environmental training and environmental management maturity of Brazilian companies with ISO14001: empirical evidence. *Journal of Cleaner Production*, 96, 331-338. http://dx.doi.org/10.1016/j.jclepro.2013.10.039.

Jabbour, C. J. C., & Jabbour, A. B. (2014). Latin America: research opportunities on management for sustainable development. *Latin American Journal of Management for Sus-tainable Development*, 1(1), 1-6. http://dx.doi.org/10.1504/LAJMSD.2014.059780.

Kolk, A., & Mauser, A. (2002). The Evolution of environmental management: from stage models to performance avaluation. *Business Strategy and the Environment*, 11(1), 14-31. http://dx.doi.org/10.1002/bse.316.

Laosirihongthong, T., Adebanjo, D., & Choon Tan, K. (2013). Green Supply Chain Management practices

and performance. *Industrial Management & Data Systems*, 113(8), 1088-1109. http://dx.doi.org/10.1108/IMDS-04-2013-0164.

Lin, R. J. (2013). Using fuzzy DEMATEL to evaluate the Green Supply Chain Management practices. *Journal of Cleaner Production*, 40, 32-39. http://dx.doi.org/10.1016/j.jclepro.2011.06.010.

Liu, X., Yang, J., Qu, S., Wang, L., Shishime, T., & Bao, C. (2012). Sustainable production: practices and determinant factors of Green Supply Chain Management of Chinese companies. *Business Strategy and the Environment*, 21(1), 1-16. http://dx.doi.org/10.1002/bse.705.

Mitra, S., & Datta, P. P. (2014). Adoption of Green Supply Chain Management practices and their impact on performance: an exploratory study of Indian manufacturing firms. *International Journal of Production Research*, 52(7), 2085-2107. http://dx.doi.org/10.1080/00207543.2013.849014.

Mohanty, R. P., & Prakash, A. (2014). Green Supply Chain Management practices in India: an empirical study. *Planning & Control*, 25(16), 1322-1337. http://dx.doi.org/10.1080/09537287.2013.832822.

Ninlawan, C., Seksan, P., Tossapol, K., & Pilada, W. (2010). The implementation of Green Supply Chain Management practices in electronics industry. In *Proceedings of the International Multiconference of Engineers and Computer Scientists*. Hong Kong: IMECS.

Ormazabal, M., & Sarriegi, J. M. (2012). Environmental management: understanding its evolution through maturity states. *Environmental Quality Management*, 22(1), 31-42. http://dx.doi.org/10.1002/tqem.21315.

Pagell, M., & Shevchenko, A. (2014). Why research in sustainable supply chain management should have no future. *The Journal of Supply Chain Management*, 50(1), 44-55. http://dx.doi.org/10.1111/jscm.12037.

Perotti, S., Zorzini, M., Cagno, E., & Micheli, G. J. L. (2012). Green supply chain practices and company performance: the case of 3PLs in Italy. *International Journal of Physical Distribution & Logistics Management*, 42(7), 640-672. http://dx.doi.org/10.1108/09600031211258138.

Ribeiro, S., & Jabbour, C. J. C. (2012). Environmental management in ethanol and sugarcane plants in Brazil. *International Journal of Sustainable Development and World Ecology*, 19(1), 54-66. http://dx.doi.org/10.1080/13504509.2011.590542.

Sarkis, J. (2014). Sustainable operations management: recent trends and future directions. *International Journal of Operations & Production Management*, 34(5).

Seuring, S., & Müller, M. (2008). From a literature review to a concept framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699-1710. http://dx.doi.org/10.1016/j.jclepro.2008.04.020.

Srivastava, S. K. (2007). Green supply-chain management: a state-of the- art literature review. *International Journal of Management Reviews*, 9(1), 53-80. http://dx.doi.org/10.1111/j.1468-2370.2007.00202.x.

Teixeira, A. A., Jabbour, C. J. C., & Jabbour, A. B. L. S. (2012). Relationship between green management and environmental training in companies located in Brazil: a theoretical framework and case studies. *International Journal of Production Economics*, 140(1), 318-329. http://dx.doi.org/10.1016/j.ijpe.2012.01.009.

Testa, F., & Iraldo, F. (2010). Shadows and lights of GSCM (Green Supply Chain Management): determinants and effects of these practices based on a multi-national study. *Journal of Cleaner Production*, 18(10-11), 953-962. http://dx.doi.org/10.1016/j.jclepro.2010.03.005.

Vachon, S. (2007). Green supply chain practices and the selection of environmental technologies. *International Journal of Production Research*, 45(18-19), 4357-4379. http://dx.doi.org/10.1080/00207540701440303.

Vachon, S., & Klassen, R. D. (2006). Extending green practices across the supply chain: the impact of upstream and downstream integration. *International Journal of Operations & Production Management*, 26(7), 795-821. http://dx.doi.org/10.1108/01443570610672248.

Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of Green Supply Chain Management practices in Chinese manufacturing enterprises. *Journal of Operations Management*, 22(3), 265-289. http://dx.doi.org/10.1016/j.jom.2004.01.005.

Zhu, Q., & Sarkis, J. (2006). An inter-sectoral comparison of Green Supply Chain Management in China: drivers and practices. *Journal of Cleaner Production*, 14(5), 472-486. http://dx.doi.org/10.1016/j.jclepro.2005.01.003.

Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research*, 45(18-19), 4333-4355. http://dx.doi.org/10.1080/00207540701440345.

Zhu, Q., Sarkis, J., & Lai, K.-H. (2007). Green Supply Chain Management: pressures, practices and performance within the Chinese automobile industry. *Journal of Cleaner Production*, 15(11-12), 1041-1052. http://dx.doi.org/10.1016/j.jclepro.2006.05.021.

Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K.-H. (2008a). Firm-level correlates of emergent Green Supply Chain Management practices in the Chinese context. *Omega*, 36(4), 577-591. http://dx.doi.org/10.1016/j.omega.2006.11.009.

Zhu, Q., Sarkis, J., & Lai, K.-H. (2008b). Confirmation of a measurement model for Green Supply Chain Management practices implementation. *International Journal of Production Economics*, 111(2), 261-273. http://dx.doi.org/10.1016/j.ijpe.2006.11.029.

Zhu, Q., Tian, Y., & Sarkis, J. (2012a). Diffusion of selected Green Supply Chain Management practices: an assessment of Chinese enterprises. *Production Planning & Control: The Management of Operations*, 23(10-11), 837-850. http://dx.doi.org/10.1080/09537287.2011.642188.

Zhu, Q., Sarkis, J., & Lai, K.-H. (2012b). Examining the effects of Green Supply Chain Management practices and their mediations on performance improvements. *International Journal of Production Research*, 50(5), 1377-1394. http://dx.doi.org/10.1080/00207543.2011.571937.

Zhu, Q., Sarkis, J., & Lai, K.-H. (2013). Institutional-based antecedent sand performance outcome sof internal and external Green Supply Chain Management practices. *Journal of Purchasing and Supply Management*, 19(2), 106-117. http://dx.doi.org/10.1016/j.pursup.2012.12.001.