Gest. Prod., São Carlos, v. 24, n. 1, p. 78-94, 2017
http://dx.doi.org/10.1590/0104-530X2267-16

Critical success factors for GSCM adoption: case studies in the automotive battery industry

Fatores críticos de sucesso à adoção de GSCM: estudo de casos no setor de baterias automotivas

André Luiz Mauricio[1]
Ana Beatriz Lopes de Sousa Jabbour[1]

Abstract: This study aimed to analyze how the major manufacturers of automotive batteries in Brazil, considered as focal companies in their supply chains, perceive the influence of critical success factors (CSFs) for adoption of green supply chain management (GSCM) practices. A case study was carried out in the three leading manufacturing companies in this sector using data source triangulation: interviews with company managers, coordinators, and supervisors; on site observations of operational activities; and secondary data. The relationship between CSF variables and GSCM practices was investigated. The main results obtained include: "top management commitment" is the most critical success factor for the effective adoption of GSCM practices and that "information management" and "training" (indirectly) are highly critical for adoption of a number of GSCM practices. This study provides deeper insights into this fairly recent topic.

Keywords: Green supply chain management; Critical success factors; Environmental practices; Automotive batteries; Case studies.

Resumo: *A percepção da influência de fatores críticos de sucesso (FCS) à adoção das práticas de green supply chain management (GSCM) é o tema desta pesquisa que tem por objetivo identificar e analisar como as principais empresas fabricantes de baterias automotivas instaladas no Brasil, e consideradas focais em suas cadeias de suprimentos, percebem tais influências. Três das principais empresas de manufatura desse setor foram investigadas por meio da técnica de estudo de casos, com o uso da triangulação de dados: entrevistas com gestores das empresas, observações no próprio lugar das atividades operacionais e obtenção de dados secundários. Esta pesquisa identifica como as variáveis dos FCS se relacionam com as práticas de GSCM. Como principais resultados, tem-se que: O FCS "compromisso da alta direção" é o mais crítico para o sucesso na adoção de práticas de GSCM e que os FCS "gestão da informação" e indiretamente "treinamento" são críticos para a adoção de uma série de práticas de GSCM. A teoria que suporta este tema ainda está em desenvolvimento, portanto a pesquisa contribui com alguns insights que merecem mais aprofundamento.*

Palavras-chave: *Green supply chain management; Fatores críticos de sucesso; Práticas ambientais; Baterias automotivas; Estudo de casos.*

1 Introduction

Critical Success Factors (CSFs) are activities that can ensure successful competitive performance for organizations if their results are satisfactory. Therefore, they should be identified, analyzed, monitored, and effectively dealt with in order to achieve continuous improvement (Rockart, 1979; Boynton & Zmud, 1984; Leidecker & Bruno, 1984; Hu & Hsu, 2010).

Organizations are becoming increasingly interested in managing corporate social responsibility and sustainability as part of their operations management (Walker et al., 2008). Accordingly, environmental management in supply chains (Green Supply Chain Management - GSCM) emerges as a strategic tool since it integrates environmental management principles with supply chain management activities allowing organizations to achieve their profit and market growth objectives and improve ecological efficiency (Muduli et al., 2013). However, there are many factors that still hinder the adoption of GSCM by companies (Testa & Iraldo, 2010). Thus, the identification and assessment of CSFs are of great

[1] Departamento de Engenharia de Produção, Faculdade de Engenharia, Universidade Estadual Paulista – UNESP, Av. Engenheiro Luiz Edmundo Corrijo Coube, 14-01, Vargem Limpa, CEP 17033-360, Bauru, SP, Brazil, e-mail: andresax@ig.com.br; abjabbour@feb.unesp.br

Received May 8, 2015 - Accepted Dec. 31, 2015
Financial support: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), process 304225/2013-4.

importance for the adoption of GSCM practices because if the CSFs are not effectively managed, they can become barriers that can influence and hamper successful implementation of GSCM practices (Muduli et al., 2013; Govindan et al., 2014).

Much of the literature on CSF has focused on the investigation of CSFs for the adoption of ISO 14001 environmental management system (EMS) in organizations in many countries (Quazi, 1999; Hui et al., 2001; Babakri et al., 2003; Zutshi & Sohal, 2004; Sambasivan & Fei, 2008). The main results reported show that if the CSFs are not properly managed, they can become a barrier to organizational success. Some studies have attempted to relate CSF with GSCM, such as those conducted by Hu & Hsu (2010), Kim & Rhee (2012), Ab Talib & Muniandy (2013) and Luthra et al. (2014). However, the aim of these studies was to identify the CSFs for the adoption of GSCM or to identify the CSFs for GSCM practice adoption or evaluate those that can improve organizational performance without addressing their relationship with the different types of GSCM practices.

Based on the results of previous studies on CSFs, environmental management, and GSCM, a research gap can be identified because none of these studies discussed how the CSF variables affect and are related to the GSCM practices. Therefore, considering the aforementioned discussion and facts about GSCM and CSFs, the following question arises: *how do some manufacturers of automotive batteries in Brazil, considered as focal companies in their supply chains, perceive the influence of critical success factors for the adoption of GSCM practices?*

Therefore, this study aims to identify and analyze the influence of CSFs that affect the adoption of GSCM practices in the companies studied. A case study was carried out using data source triangulation (interviews, observations, and document analysis) in the three leading automotive battery assembling in Brazil.

Diabat et al. (2013) emphasize the need for studies on the automotive supply chain. The automotive battery is a segment of the automotive industry and is particularly important since the lead-acid battery has the greatest environmental impact (Matheys et al., 2009). Additionally, there has been a global pressure from stringent environmental regulations affecting automotive battery manufacturers (Brasil, 2008; U.S. Environmental Protection Agency, 2013).

This study aims to contribute to a better understanding of how CSF variables are related and affect GSCM practices in the automotive battery supply chain in Brazil. The objective is to identify CSFs in major companies in this sector to point out the areas that deserve more attention to managers in order to achieve better environmental performance by concentrating efforts on the most critical success factors, leading to a successful GSCM practice implementation.

2 Green Supply Chain Management (GSCM) and Critical Success Factors (CSFs)

Srivastava (2007) highlights that GSCM adds the green component to Supply Chain Management (SCM) to address the influence and relationships between Supply Chain Management and the natural environment. GSCM can reduce the environmental impact of production activities through the change of paradigms and generate profits through the balance between economic and environmental sustainability in organizations (Rao & Holt, 2005; Zhu et al., 2007). GSCM can contribute to sustainability performance enhancement, and thus it is an alternative for companies to rethink their current mode of production (Alves & Nascimento, 2014).

GSCM practices are activities or actions (Golicic & Smith, 2013) that can reduce the environmental impacts of industrial activities without affecting quality, productivity, and operating costs. Some GSCM practices include: internal environmental management, green purchasing, cooperation with customers, eco-design, recovery of investments (Zhu et al., 2008), and reverse logistics (Srivastava, 2007; Sarkis et al., 2011).

These practices are not easy to adopt and implement due to the presence of many internal and/or external barriers. A clear understanding of these barriers will help organizations to prioritize better and manage their resources efficiently and effectively (Walker et al., 2008; Mudgal et al., 2010; Luthra et al., 2011).

The level of success of GSCM implementation is greatly influenced by the type and magnitude of barriers. Thus, organizations need to be able to remove the major barriers and identify factors and sub-factors that hinder GSCM implementation and will thus become barriers (Muduli et al., 2013; Govindan et al., 2014). Identifying and assessing the CSF for implementation of GSCM practice is therefore essential.

Critical Success Factors (CSFs) are areas of activities that need to be carefully managed to ensure the attainment of organizational goals (Rockart, 1979). The identification of CSFs provides a means for organizations to assess threats and opportunities in their environment can also provide a set of criteria to evaluate the strengths and weaknesses of the organization (Leidecker & Bruno, 1984). CSFs include issues vital to the current operating

activities of an organization and to its future success (Boynton & Zmud, 1984). This research was based on the CSFs that were established and validated in one of the most important studies on this topic (Wee & Quazi, 2005): information management, total involvement of employees, performance measure, top management commitment, supplier management, training, and green product/process design. These CSFs have been cited several times in other relevant studies

A systematic literature review was conducted, according to Biolchini et al. (2005), in the first two weeks of October 2013. It was based on the research question and aimed to identify relevant scientific studies addressing the relationship between CSF and GSCM practices and CSF variables. The search centered on two sets of keywords and their combinations, which were classified as: "A" - GSCM practices and "B" - CSF in GSCM/EMS, as follows:

A. - "green supply chain management"; "green supply chain management" and "practices", GSCM, GSCM and "practices".

B. - "critical success factors"; "critical success factors" and "green supply chain management"; "critical success factors" and "supply chain management"; "critical success factors" and "gscm"; "critical success factors" and "environmental management"; "success factors" and "green supply chain management"; "success factors" and "supply chain management"; "success factors" and "gscm"; "success factors" and "environmental management"; "critical factors" and "green supply chain management"; "critical factors" and "supply chain management"; "critical factors" and "gscm"; and "critical factors" and "environmental management".

The use of quotation marks in the keywords was necessary so that the system would search for those words within the quotation marks in that exact sequence. Combining keywords with AND means that the first search was performed with the first keyword, and then the search result was filtered using the second keyword.

The search and selection of publications on GSCM and FCS using those keywords was conducted in the following major international databases: ISI Web of Knowledge (Web of Science, 2013) and Scopus (2013). The search for the keywords was carried out using the dropdown menu and choosing: title, abstract and keywords.

According to the search classification used, the following steps and results were obtained:

1) Search and import search results using a compatible Excel file. Results obtained: A-) 1,411 articles; B-) 2,066 articles;
2) Identify duplicates in each search using Excel functions. Results obtained: A-) 719 articles; B-) 1,128 articles;
3) Select the articles that were cited more than once (regardless of the year of publication), the articles published in 2013, 2014, and AIPs - "in Press". The articles that did not meet these criteria were excluded. Results obtained: A-) 429 articles; B-) 776 articles;
4) Analysis of article titles; those that addressed the research topic were selected. Results obtained: A-) 98 articles; B-) 36 articles;
5) Read through the abstract of each article or the entire article (when necessary) to ensure they relate to the research topic. Results obtained: A-) 55 articles; B-) 16 articles, of which 12 were directly related to the topic and 4 were not related to it but included CSF analysis in other areas and were selected for comparison; and
6) Final selection of relevant articles.

The Appendix A includes the CSF variables used in the present study. The next sections present how the literature has considered the relationship between GSCM and CSF.

2.1 Information management (IM)

The CSF "information management" is related to the GSCM practice "internal environmental management". Zutshi & Sohal (2004) suggested that IM and internal and external communications between the organization and its partners were essential to successfully implement an EMS. IM is a CSF for internal environmental management because organizations need to be aware of their own environmental implications and that created by their suppliers, and this is only possible through continuous and up-to-date information (Sarkis, 2012).

The CSF "information management" is also related to the GSCM practice "green purchasing". The effectiveness of an IM system depends on a comprehensive database, i.e., it involves the collection and incorporation of relevant information and evidence, which can be used to verify compliance with environmental standards and requirements; therefore it is also related with the GSCM practice "internal environmental management" (Hu & Hsu, 2010). Suppliers can deliberately create barriers to information sharing due to competitiveness, which can reduce real information availability (Sarkis, 2012).

Organizations should be aware of environmental laws and regulations and gather proper information when developing new products (Hu & Hsu, 2010). This can directly influence the development of green products related to the GSCM practice "eco-design".

2.2 Total involvement of employees (TEE)

The CSF "total involvement of employees" is related to the GSCM practice "internal environmental management" due to the need for cross-functional integration of employee representatives ensuring good synergy, which leads to environmental improvements (Hu & Hsu, 2010). The lack of cross-functional relationships can hinder the inclusion of environmental concerns into the supply chain (Sarkis, 2012).

Organizational barriers, fragmented culture, and resistance to changes can affect EMS performance. Therefore, it is necessary to build an organizational culture that involve all employees, incorporate environmental issues, and motivate and encourage innovation and good decision-making concerning GSCM practices (Harris & Crane, 2002).

Employees with pro-environmental behaviors are committed to environmental sustainability through intrinsic motivation that includes pursuing an activity because it is inherently interesting or pleasurable (Graves et al., 2013). Therefore, pro-environmental behavior influences the adoption of GSCM practices in complex tasks requiring creativity and significant innovation, cognitive flexibility, and problem solving, such as the "eco-design" practice.

2.3 Performance measures (PM)

The CSF "performance measures" affect GSCM practices, especially "internal environmental management", "recovery of investments", "eco-design", and "reverse logistics", due to the need to set goals and indicators that allow:

- monitoring environmental performance during environmental audits to verify environmental compliance with the requirements of ISO14001 and mange decision-making in case of deviations from planned results (Wee & Quazi, 2005; Tummala et al., 2006; Hu & Hsu, 2010);
- measurement of environmental aspects and impacts to manage the risks associated with the development of products throughout their life cycle (Zutshi & Sohal, 2004);
- obtaining funding from the top management by demonstrating the benefits and cost reductions and savings resulting from EMS implementation (Zutshi & Sohal, 2004);
- calibration and maintenance of equipment used in an EMS to monitor activities that can exert considerable impacts on the environment (Sambasivan & Fei, 2008);
- assessment of performance in the recovery of investments from the sale of surplus materials, scrap, and excess capital equipment (Zhu & Sarkis, 2004; Green et al., 2012); and
- measurement of reverse logistics performance in order to reintegrate post-consumer materials and recycled products into manufacturing, adding value and reducing costs, and/or to dispose of them properly (Sarkis, 1998; Srivastava, 2007; Diabat et al., 2013).

2.4 Top management commitment (TMC)

According to Hu & Hsu (2010), the CSF "top management commitment" can make a critical difference to the success of GSCM practices through their understanding, support, and commitment by directly and indirectly affecting all GSCM practices. Zutshi & Sohal (2004) highlight the importance of top management leadership and support to raise awareness regarding environmental issues.

Transformational leadership is needed on environmental issues to communicate a clear and coherent environmental vision for their subordinates by sharing their values, discussing the importance of sustainability, and taking actions that demonstrate commitment to environmental issues (Graves et al., 2013). Transformational leadership will allow employees to experience self-consistent pro-environmental behavior and they will therefore commit to GSCM practices spontaneously, without coercion or reward.

2.5 Supplier management (SM)

The CSF "supplier management" is related to the GSCM practice "green purchasing" through the following strategies proposed by Hu & Hsu (2010): supplier meeting, self-assessment questionnaire, environmental audit for suppliers, compliance statement, product testing report, establishment of environmental requirements for purchasing items, collaborative research and development with suppliers, and selection and evaluation of suppliers.

The establishment of procedures for supply management and supplier engagement is necessary for the assessment and reduction of environmental

impacts, waste tracking requirement, and requirement for suppliers to implement EMS (Sarkis, 2012).

2.6 Training (T)

According to Zutshi & Sohal (2004), learning and training of all employees is absolutely critical to successful adoption of an EMS. Learning from other organizations' experiences and benchmarking should be considered. Regular training should be provided for skill development and stakeholders' environmental awareness.

Due to the complexity of GSCM practices, organizations face challenges when implementing green initiatives related to these practices. Therefore, the CSF "training" affects directly and indirectly all GSCM practices due to the need for environmental education and training to promote environmental awareness of employees (Hu & Hsu, 2010).

Training is a key factor that can affect employee and managers' attitudes and behaviors. Automotive companies adopt environmental practices during the execution of a training program, but the primary focus of training is eco-design (Sarkis et al., 2010).

2.7 Green product/process design (GPD)

The CSF "green product/process design" affects the GSCM practice "eco-design" because the incorporation of the green issue into new product development (green design) is considered as a systematic method to reduce the environmental impacts of products and processes while stimulating cost reduction and increasing product marketability (Hu & Hsu, 2010).

Existing processes and products should be assessed in order to reduce their environmental impact, and life cycle assessment (LCA also known as Life-Cycle Analysis) should be implemented since it allows the assessment of environmental impacts throughout the chain and the life cycle of product and/or services (Zutshi & Sohal, 2004; Wee & Quazi, 2005).

The CSF "green product/process design" is also directly related to the practice "cooperation with customers" due to the need for cooperation in the development of products, services, and processes that integrate environmental issues (Zhu et al., 2008).

Based on the literature review, Chart 1 summarizes the influences of CSFs on adoption of GSCM practices.

In summary, the CSFs "top management commitment" and "training" theoretically influence all GSCM practices. The CSFs "total involvement of employees" and "green product/process design" are the least influential factors, and "eco-design" is the GSCM practice that feels the greatest impact of CSFs.

3 Methodological aspects

3.1 Research environment

Automotive battery is a segment of an important manufacturing industry, the automotive industry, which is a major industrial and economic force that accounts for 21% of the national industrial GDP and 5% of the total GDP in Brazil (Associação Nacional dos Fabricantes de Veículos Automotores, 2014).

The main focus of these companies is the production of lead-acid batteries for the automotive industry. This segment is of paramount importance due to the great environmental impact of the lead-acid battery (Matheys et al., 2009).

The present study was conducted in three of the 5 five leading automotive battery manufacturers in Brazil (Castro et al., 2013), which are considered as focal companies in their supply chain. Focal companies manage the supply chain, play an important role, and integrate social and environmental issues into their policies and into their business operations, such as the development of products and/or services (Koplin et al., 2007; Seuring & Müller, 2008).

The three companies analyzed were as follows: a large-sized ISO 14001 certified company with EMS; a medium-sized ISO 14001 certified company with EMS; and a medium-sized company with EMS that was implementing certification process. The first one was chosen because large companies tend to focus more attention on environmental issues (González-Benito & González-Benito, 2006). According to Eisenhardt (1989), it is important to analyze companies with different characteristics; these differences can lead to new insights and discussions (Jabbour et al., 2013).

3.2 Research methodology

The case study method was used, a promising qualitative approach in the operations and supply chain management area (Yin, 2009; Csillag et al., 2012). This method has been widely used by researchers aiming to contribute to the acquisition and dissemination of knowledge (Mariotto et al., 2014) since, according to the literature reviewed, this is a consistent research method commonly used for analysis and comparison of data and information (Voss et al., 2002).

Kim & Rhee (2012) recommend the use of qualitative case studies when investigating critical success factors for GSCM adoption; therefore, this was the research method chosen in the present study. The selected companies were denominated Alpha, Bravo, and Charlie to preserve their anonymity. The choice of the number of cases was based on

Chart 1. Critical factors for adoption of GSCM practices, according to the literature.

CRITICAL SUCCESS FACTORS	**GSCM PRATICES**					
	Internal Environmental Management (IEM)	**Green Purchasing (GP)**	**Cooperation with Customers (CC)**	**Eco-design (ED)**	**Recovery of Investments (RI)**	**Reverse Logistics (RL)**
Information management (IM)	Comprehensive information management in the EMS (Zutshi & Sohal, 2004).	Database and barriers to information (Hu & Hsu, 2010; Sarkis, 2012).	------------	Information about environmental laws (Hu & Hsu, 2010).	------------	------------
Total Involvement of Employees (TEE)	Cross-functional integration and cultural change (Harris & Crane, 2002; Hu & Hsu, 2010; Sarkis, 2012).	------------	------------	Pro-environmental behavior (Graves et al, 2013).	------------	------------
Performance Measures (PM)	Goals and performance indicators (Zutshi & Sohal, 2004; Wee & Quazi, 2005; Tummala et al., 2006; Sambasivan & Fei, 2008; Hu & Hsu, 2010).	------------	------------	Measurement of environmental aspects and impacts for risk management (Zutshi & Sohal, 2004).	Performance assessment (Zhu & Sarkis, 2004; Green et al., 2012).	Performance assessment (Sarkis, 1998; Srivastava, 2007; Diabat et al., 2013).
Top Management Commitment (TMC)	Support, commitment, and environmental vision (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013).	Support, commitment, and environmental vision (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013).	Support, commitment, and environmental vision (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013).	Support, commitment, and environmental vision (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013).	Support, commitment, and environmental vision (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013).	Support, commitment, and environmental vision (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013).
Supplier Management (SM)	------------	Strategies to enhance performance (Hu & Hsu, 2010; Sarkis, 2012).	------------	Strategies to enhance performance (Hu & Hsu, 2010; Sarkis, 2012).	------------	------------
Training (T)	Training and awareness (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Sarkis et al., 2010).	Training and awareness (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Sarkis et al., 2010).	Training and awareness (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Sarkis et al., 2010).	Training and awareness (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Sarkis et al., 2010).	Training and awareness (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Sarkis et al., 2010).	Training and awareness (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Sarkis et al., 2010).
Green product/ process design (GPD)	------------	------------	Cooperation for development (Zhu et al., 2008).	Green design and LCA (Zutshi & Sohal, 2004; Wee & Quazi, 2005; Hu & Hsu, 2010).	------------	------------

Legend: *"------------" no evidence in the literature for the relationship between FCS and the respective GSCM practice.*

Source: Authors.

the recommendation by Eisenhardt (1989), who suggests the use of a maximum of 10 cases due to availability of resources, constraints in time, and the challenges of managing large volumes of data. Seuring (2008) points out that there is no clear justification for the choice of the number of cases.

3.3 Data collection and analysis

An interview guide was designed for collecting data, according to the recommendations of Synodinos (2003) and based on the concepts in the literature reviewed. It was composed of two parts: characterization of companies and assessment of critical success factors related to the adoption of GSCM practices.

Data were collected through personal interviews conducted mainly with environmental managers, because the knowledge of GSCM practices was required (Green et al., 2012), and with project managers and purchasing managers. The interviews were recorded and transcribed afterwards. Data were also collected through observations in loco of operational activities and by obtaining secondary data. Chart 2 shows the data collection methods used and sources of evidence in the companies studied.

Data analysis included analyzing the interview data, performing a cross-case analysis to identify the relationships between the sources of evidence, and the triangulation of data obtained from the direct observations and secondary data.

Conclusions were drawn based on the convergence of data sources by comparing them with theoretical data, *i.e*., after understanding the phenomena and analyzing the literature, it was possible to consider the evidence to answer the research questions (Cauchick Miguel, 2007).

4 Results and discussion

The companies studied belong to the same industrial segment, and therefore they have similar production processes and supply chains. There are subtle differences in their management style, in the type of equipment used in the processes, and in their ownership structure. The three companies operate in the aftermarket sector and are mainly focused on manufacturers due to the valorization of their products and for being OEMs - Original Equipment Manufacturers. All of them have a well-structured environmental management system managed by qualified professionals with expertise on environmental issues.

Aiming at obtaining high-quality data, the respondents were clearly informed about each CSF proposed by Wee & Quazi (2005) and were asked about to identify the CSFs that affect or had affected the adoption of each GSCM practice in the company.

4.1 Information management (IM)

It was observed that, in all companies, the CSF "information management" is essential for the adoption of the GSCM practice "reverse logistics" because of their several collection points, aiming at an effective transportation and reduction of costs and use of resources. It is also important for the awareness and involvement of distributors, retailers, and collection points. All companies use computer management software to manage information, especially information regarding the laws and industry regulations.

The Alpha company's environmental manager highlighted that that employees have to be aware that environmental indicators need to be constantly monitored. The quality engineer stated that "[...] *information is available for the whole group through information portals*[...]". All processes and/or product information is available to all units located in several countries.

According to the Bravo company's environmental manager, there are no barriers to information sharing between suppliers, customers, and the company. The project manager said that specific information should reach the customers in order to make them aware of the importance of environmental concerns, such as reducing the use of resources, especially packaging and accessories, which are discarded carelessly. For most consumers, product presentation is often more important than product quality. He said that "[...] *this type of view often hinders the manufacturing of products using fewer environmental resources* [...]".

Charlie company had not yet fully established a database system with information about suppliers, products, and customers regarding environmental issues, but they were gathering information to create a database. One of the barriers to information sharing is the lack of knowledge; according to the environmental manager, "[...] *the lack of knowledge in the chain creates barriers to information sharing* [...]".

4.2 Total involvement of employees (TEE)

The CSF "total involvement of employees", according to the data obtained, is related to the GSCM practices "internal environmental management" and "recovery of investments". In the companies studied, cross-functional teams refer to employee participation in the actual implementation of

Chart 2. Sources of evidence and data in the companies studied.

SOURCE OF DATA COLLECTION	SOURCES OF EVIDENCES - COMPANIES		
	ALPHA	BRAVO	CHARLIE
CHARACTERIZATION	• Multinational company. It is 83+ years old and has approximately 1,300 employees. It is the main automotive battery supplier to battery assembly companies; it also operates in the automotive aftermarket sector.	• National capital company. It is 21+ years old and has approximately 545 employees. It operates in the automotive aftermarket, assembly, and export sector.	• National capital company. It is 49+ years old and has approximately 505 employees. It operates in the automotive aftermarket and export sectors and intends to operate in the automotive assembly sector.
INTERVIEW	• Contact made in three steps: two via phone and one visit to the company. The entire process took 6 hours. • Interview with the environmental manager; 22 years with the company • Interview with the quality manager; 6 years with the company. • Interview with the purchasing manager; 7 years with the company. • A questionnaire with open-ended questions was administered. The interviews were recorded and transcribed for further analysis.	• Contact made in six steps: three via phone and three visits to the company. The entire process took approximately 3 and1/2 hours. • Interview with the environmental manager; 19 years with the company (personnel manager/ environmental manager). • Interview with the Project manager - top management representative - 21 with years with the company (mechatronic engineer). • Interview with the purchasing coordinator; 7 years with the company. • A questionnaire with open-ended questions was administered. The interviews were recorded and transcribed for further analysis.	• Contact made in four steps: two via phone and two visits to the company. The entire process took approximately 4 hours. • Interview with the environmental manager; 18 months with the company (environmental engineer). • Interview with the supply coordinator; 14 years with the company (civil engineer). • Interview with the quality control supervisor; 25 years with the company (mathematician). • A questionnaire with open-ended questions was administered. The interviews were recorded and transcribed for further analysis.
DOCUMENT ANALYSIS –SECONDARY DATA	• Company website • Environmental regulations • Business and sustainability report • Integrated Management System Policy • Environmental Policy • Ethics Policy • Guaranteed Recycling Program • Brazilian laws regulating automotive battery manufacturing • Data sheets: Corporation; Building Efficiency, and Power Solutions.	• Company website • Environmental regulations • Material Safety Data Sheet • Technical guidance for environmental issues • System certificates • Renewable energy certificates • Integrated Management System Policy • Awareness campaign poster – Reverse logistics	• Company website • New technical specification information bulletin • EMS goals and objectives' documentation • Environmental policy documentation • Bulletin boards • Letter to customers about principles of environmental protection • Newsletter
OBSERVATION – DIRECT OBSERVATION	• One visit to the company to conduct in-person interviews • One technical visit (equipment evaluated: air filtration systems, dust collection system, and air quality monitoring stations among others).	• Three visits to the company to conduct in-person interviews • One technical visit (equipment evaluated: air filtration systems, dust collection system, air quality monitoring stations, water table monitoring, and soil and vegetation monitoring).	• Two visits to the company to conduct in-person interviews • One technical visit (equipment evaluated: air filtration systems, dust collection system, air quality monitoring stations, and recycling center).

Source: Authors.

improvements and/or suggestions for improvements, which are recognized and followed when feasible without financial reward.

The Bravo company's environmental manager pointed out that the employees have the opportunity to make suggestions and participate in the implementation of practices; the company has a program called "PSST" -

> [...] *the employee gives an idea; the management team analyzes it and verifies its feasibility. If it is feasible, it is put into action; if it works, it is implemented, and at the end of the year the employee receives a monetary reward for the suggestion* [...]".

The Bravo company's purchasing coordinator stated that the total involvement of employees is essential for the recovery of investments since the collection and disposal of scrap and processing residual depends on them.

According to the Charlie company's supply coordinator,

> "[...] *the involvement of employees is necessary because there is no point in investing in new equipment if there is no employee participation and commitment* [...]".

He also highlighted that the involvement of employees is essential for decision-making.

4.3 Performance measures (PM)

The CSF "performance measures", according to the data obtained, is related to the GSCM practices "internal environmental management", "green purchasing", and "reverse logistics". All companies have reverse logistics performance measurement systems, mainly due to high aggregated value of automotive battery scraps.

Although Alpha and Bravo company's respondents did not mention the CSF "performance measures", it was observed through the direct observations and during secondary data collection that these companies had already established goals, objectives and indicators for most EMS processes. It was also observed that one way to deal with this CSF is through the implementation of a comprehensive and robust EMS performance measurement system, which should undergo periodic analysis.

The Charlie company's environmental manager pointed out that measuring the performance of processes through the assessment of costs and benefits is a condition for obtaining funding from the board of directors, especially with regard to the GSCM practice "internal environmental management". The supply coordinator highlighted the relationship between this success factor and the GSCM practice "green purchasing", which is due to the need to monitor the performance of suppliers using the supplier quality index.

4.4 Top management commitment (TMC)

According to the data obtained, the CSF "top management commitment" is the only factor that is related to and affects the adoption of all GSCM practices.

According to the Alpha company's environmental manager, "[...] *the top management team has to be involved; otherwise, environmental managers won't get anything done* [...]"; the quality engineer demonstrated the top management involvement by the investments made in research centers for the development of new products using advanced processes and technology.

There was direct participation of the board of directors in meetings with shop floor employees in the Bravo Company, aiming at employees' awareness and involvement. The purchasing coordinator made the following comment

> [...] *the director himself said that if he does not get involved and support the cause, the people down there will not believe, so he has to participate, and other directors participate in all meetings too* [...].

The project manager said that when there is commitment from the top management, there is a greater likelihood of successful EMS implementation.

Charlie's company top management motivates the employees for successful ISO 14001 EMS implementation, mainly with the goal of obtaining certification. The supply coordinator emphasized that the commitment of the top management team must be connected with information management because information sharing is fundamental to foster environmental culture in the entire supply chain.

4.5 Supplier management (SM)

The CSF "supplier management", according to the data obtained, is related to the GSCM practices "green purchasing" and "eco-design". Supplier management results from the requirements and compliance with environmental regulations for the supply of items and goods, the evaluation of supply indicators, the involvement in the development of new products and/or processes, and supplier meetings.

It was noted that the Alpha company encourages the involvement of suppliers in the development of new product and process, requires supplier commitment to environmental issues, and holds annual workshops involving all suppliers.

The Bravo company's project manager pointed out that supplier management is essential. The company was undergoing supplier audits, and it was found that some suppliers exhibited resistance to changes. However, there were others who acted more like partners and helped new product development focusing on the reduction of waste and use of resources. The purchasing coordinator stated that "[...] *if the supplier is not managed properly, there is no way to adopt the practice green purchasing* [...]".

4.6 Training (T)

The CSF "training", according to the data obtained, is related to the GSCM practices "internal environmental management", "green purchasing", and "recovery of investments". In the companies studied, the success factor "training" was characterized by the provision of training incorporating environmental issues, by promoting the integration of new employees, and by periodically fostering awareness and review of concepts. In-house or internal training programs are more commonly offered and are often given by the environmental managers. There was no effective evaluation of the training provided in the companies studied, and environmental knowledge was not a requirement for new hires.

According to the Bravo company's project manager, with regard to CSF training, supplier performance and customer experience benchmarking was conducted to pursue the best practices, and some results indicated what should not be done.

4.7 Green product/process design (GPD)

The CSF "green product/process design", according to the data obtained, is related to all GSCM practices, except for "internal environmental management". This critical success factor results mainly from the adherence to regulations of this manufacturing sector. The products are designed to meet technical specifications, and process development is aimed at minimizing environmental impacts and use of resources.

Company Alpha has centers for the development of new products and processes aimed at the investigation and launch of new technologies, which when consolidated, are implemented in other units of the company managing the CSF "GPD" in all its units.

The Bravo company's company purchasing coordinator pointed out that the "recovery of investments" is associated with "green product/process design" because when it is taken into consideration during product development, it is possible to achieve late investment recovery.

Chart 3 shows the relationship between the CSFs and GSCM practices, according to the respondents. The CSFs mentioned by one or more than one respondent was listed in the Chart, regardless of whether there was consensus between them. This Chart also presents the relationship between what was found in the companies studied and what was reported in the literature reviewed (Chart 1).

There are differences in the theoretically systematized relationships between CFS variables and GSCM practices and those that were empirically identified, as shown in Chart 3. These differences between theory and practice are discussed below.

In the companies studied, the CSF "total involvement of employees" results from the involvement of employees in cross-functional teams and their ability to implement their own suggestions, corroborating the findings of Quazi (1999), Hui et al. (2001), Wee & Quazi (2005), Sambasivan & Fei (2008), and Hu & Hsu (2010). There was no evidence for the relationship of this factor with the GSCM practice "eco-design", as shown in Chart 1, based on the literature reviewed. An explanation for this fact is that, according to Graves et al. (2013), the creativity and innovations necessary in the eco-design have to comply with regulations and the requirements of the ordinance No. 301/239/299 - INMETRO (National Institute of Metrology, Quality, and Technology). In this sector, specifically, there is no place for creativity. It was found that there is a relationship between the CSF "total involvement of employees" and the GSCM practice "recovery of investments". This relationship was not evidenced in the literature reviewed. According to the respondents, this fact can be explained by the need for the involvement of employees in the segregation and separation of waste generated to be subsequently sold resulting in recovery of investments.

In the companies studied, the CSF "performance measures" results from the evaluation of the accomplishment of goals and objectives of the EMS indicators, and from cost-benefit analysis of investment projects associated with reverse logistics, confirming literature reports (Sarkis, 1998; Zutshi & Sohal, 2004; Wee & Quazi, 2005; Tummala et al., 2006; Srivastava, 2007; Hu & Hsu, 2010; Diabat et al., 2013). There was no evidence for the relationship between this factor and the GSCM practices "eco-design" and "recovery of investments", as shown in Chart 1, based on the literature reviewed. This is due to the fact that there were no measurement systems to measure environmental aspects and impacts, as highlighted by Zutshi & Sohal (2004), and there were no procedures to evaluate investment recovery performance, as shown in the literature (Zhu & Sarkis, 2004; Green et al.,

Chart 3. Comparison of the relationships between CSFs and GSCM practices: literature x respondents' views.

Critical Success Factors	**GSCM practices**					
	Internal Environmental Management (IEM)	**Green Purchasing (GP)**	**Cooperation with Customers (CC)**	**Eco-design (ED)**	**Recovery of Investments (RI)**	**Reverse Logistics (RL)**
Information management (IM)	**Literature**	**✓ Literature**	----------	**✓ Literature**	----------	----------
	----------	**✓ Cases**	**Cases**	**✓ Cases**	**Cases**	**Cases**
Total Involvement of Employees (TEE)	**✓ Literature**	----------	----------	**Literature**	----------	----------
	✓ Cases	----------	----------	----------	**Cases**	----------
Performance Measures (PM)	**✓ Literature**	----------	----------	**Literature**	**Literature**	**✓ Literature**
	✓ Cases	**Cases**	----------	----------	----------	**✓ Cases**
Top Management Commitment (TMC)	**✓ Literature**	**✓ Literature**	**✓ Literature**	**✓ Literature**	**✓ Literature**	**✓ Literature**
	✓ Cases	**✓ Cases**	**✓ Cases**	**✓ Cases**	**✓ Cases**	**✓ Cases**
Supplier Management (SM)	----------	**✓ Literature**	----------	**✓ Literature**	----------	----------
	----------	**✓ Cases**	----------	**✓ Cases**	----------	----------
Training (T)	**✓ Literature**	**✓ Literature**	**Literature**	**Literature**	**✓ Literature**	**Literature**
	✓ Cases	**✓ Cases**	----------	----------	**✓ Cases**	----------
Green product/ process design (GPD)	----------	----------	**✓ Literature**	**✓ Literature**	----------	----------
	----------	**Cases**	**✓ Cases**	**✓ Cases**	**Cases**	**Cases**
Legend:	**Literature**	*Relationship between CSFs and GSCM practices, according to the literature.*				
	Cases	*Relationship between CSFs and GSCM practices, according to the respondents.*				
	----------	*No clear evidence for the relationship between CSFs and the respective GSCM practice in the literature and in the data obtained.*				
	✓	*Similarity in the relationship between CSFs and the respective GSCM practice in the literature and in the data obtained.*				

Source: Authors.

2012). The relationship of this factor with the GSCM practice "green purchasing" was evidenced by the need to monitor supply performance based on the supplier quality index. In the literature reviewed, there is evidence of the relationship of this factor with the GSCM practice "internal environmental management" (Wee & Quazi, 2005; Tummala et al., 2006; Hu & Hsu, 2010).

As can be seen in Chart 3, there is a relationship between the CSF "top management commitment" and all GSCM practices, according to the respondents, confirming and strengthening the impact of this CSF on GSCM practices reported in the literature (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013), as shown in Chart 1.

In the companies studied, the CSF "supplier management" results from the requirements and compliance with environmental regulations for the supply of items and goods, the evaluation of supply indicators, the involvement in the development of new products and/or processes, and supplier meetings. Therefore, it is in agreement with the strategies proposed by Hu & Hsu (2010). Zutshi & Sohal (2004) and Wee & Quazi (2005) emphasize that suppliers' education, training, and environmental awareness are necessary. Accordingly, the companies studied organize and hold workshops and meetings with suppliers. According to the data obtained, the CSF "supplier management", is related to the GSCM practices "green purchasing" and "eco-design", confirming the literature reports (Chart 1).

As for the CSF "green product/process design" in the companies studied, the partner suppliers are involved in product and/or process development, corroborating the findings in the literature reviewed (Zhu et al., 2008; Hu & Hsu, 2010). It was observed that this success factor is related to the GSCM practice "green purchasing" due to the involvement of suppliers in the development of product and/or process, in agreement with the reports of Zhu et al. (2008) and Green et al. (2012). This factor is also related to the GSCM practices "recovery of investments" and

"reverse logistics" since the development of new products and processes aims to achieve sustainable recovery and return on investment through recycle and reuse of materials used in manufacturing, which return to the company through reverse logistics. However, these relationships are not shown in Chart 1.

In the companies studied, the CSF "information management" results from the use of computer management software to manage information regarding standards, laws, regulations, procedures, and the supplier database, corroborating the reports in the literature reviewed (Hu & Hsu, 2010; Routroy & Pradhan, 2013), using newsletters, bulletin boards, and online systems to communicate with the entire supply chain.

According to the data obtained, the CSF "information management" exerts the greatest impact on the following GSCM practices:

- "Green Purchasing" - due to the need for a comprehensive database and compliance with the requirements on the suppliers. Hu & Hsu (2010) emphasize that the effectiveness of an EMS depends on a database containing information about the company and its suppliers;
- "Eco-design" - due to the flow of information between the company and suppliers, to support the development of new products and processes, and also with the customers for the placement of orders, in agreement with Hu & Hsu (2010), who reported the need for information, requirements, and specifications of products and processes to comply with existing legislation;
- "Cooperation with customers" - because customers need to be informed about the handling and specifications of finished products. Sarkis (2012) highlights the need for information sharing in the downstream direction of the supply chain. As can be seen in Chart 1, according to the literature reviewed, there is no relationship between the CSF "information management" and the GSCM practice "cooperation with customers". This is due to the fact that the companies use information management as an approach to training customers;
- "Recovery of Investments" - because the employees need to be informed and made aware of the need for investment recovery from the sale of recyclables and/or equipment no longer used. As can be seen in Chart 1, according to the literature reviewed, there is no relationship between the CSF "information management" and the GSCM practice "recovery of investments". This is due to the fact that the companies use information management as an approach to training internal employees to share or disseminate information;
- "Reverse Logistics" - because customers need to be aware of the requirement to return dead car batteries for recycling. As can be seen in Chart 1, according to the literature reviewed, there is no relationship between the CSF "information management" and the GSCM practice "reverse logistics". This is due to the fact that the companies use information management as an approach to training the downstream companies in the supply chain to share information for reverse logistics operations.

As shown in Chart 1, according to the literature reviewed, there was no evidence for the relationship between the CSF "information management" and the GSCM practice "internal environmental management". This can be explained because there are no barriers to information sharing in the EMS, mainly because of the use of software and tools that facilitate communication.

Based on Chart 3 and the aforementioned discussion, it can be inferred: (a) The CSF "top management commitment" is the most critical success factor for the successful adoption of GSCM practices; empirical findings confirm theoretical analysis; (b) based on empirical evidence, the CSFs that influenced a larger number of GSCM practices are "information management" and "green product/process design", fact that was not reported in the literature reviewed (Chart 1). However, according to the data obtained, "training", is a factor that is not clearly distinguished from the CSF "information management", mainly concerning the GSCM practices "cooperation with customers", "eco-design", "recovery of investments" and "reverse logistics" because trainings are carried out through the information flows in the upstream and downstream directions of the supply chain. On the other hand, the CSF "green product/process design" stood out in the empirical research because the respondents believe that this is critical success factor for the improvement of the practices "recovery of investments" and "reverse logistics"; (c) the CSF "total involvement of employees" is the least likely to influence the adoption of GSCM practices, which corroborates the findings in the literature reviewed; and (d) in the companies studied, "green purchasing"

is the GSCM practice that that feels the greatest impact of FCSs. This finding was not reported in the literature reviewed either.

Therefore, it was found that for successful adoption of GSCM practices in automotive battery companies, managers from this sector should: (a) properly manage the CSF "top management commitment"; (b) effectively evaluate and manage the CFSs "information management" and "training"; and (c) in order to achieve high "green purchasing" performance, all CSFs must be efficiently and properly managed.

Finally, it is important to mention that the topic investigated (relationship between CSF variables and GCSM practices) is a fairly recent topic, and therefore not all empirical findings were consistent with the findings systematized by theory. Therefore, based on the insights provided, the present study leaves avenues for further investigation.

5 Final considerations

The present study aimed to identify and analyze the CSFs that impact adoption of GSCM practices in the companies studied. Based on a case study carried out in three of the five leading automotive battery manufacturers in Brazil, it was possible to achieve the objectives stated.

The most significant findings of this study include:

- identification of CSFs "top management commitment", "information management", and "green product/process design" as those that influence the most the adoption of GSCM practices in the industrial sector studied;
- evidence for the relationship between the CSF "top management commitment" and all GSCM practices, corroborating the literature reviewed (Zutshi & Sohal, 2004; Hu & Hsu, 2010; Graves et al., 2013);
- the fact that there is no clear distinction between the CSFs "information management" and "training", according to the characteristics of the industrial segment studied;
- identification and demonstration of how the CSF variables affect and whether they are related with the GSCM practices in the of automotive batteries manufacturers by comparing the literature reports (Chart 1) with the data obtained (Chart 3).

The practical contribution of this study is that, based on the results obtained, it is possible to provide guidelines on how businesses in the automotive battery industry could overcome the shortcomings of CSFs for successful adoption of GSCM practices. Identifying the CSFs for GSCM adoption can help the management team concentrate their attention and efforts on the most critical success factors allowing them to achieve success in a shorter period of time and using fewer resources.

As for the theoretical contribution of this study, based on the case studies, it was found that there may be different types of relationship between CSFs and GSCM practices. This topic is fairly recent; thus, it deserves further study to better understand the benefits and barriers to the adoption of GSCM practices.

Among the limitations of this study, we can mention the fact that the respondents had limited time to participate in interviews and that the interview data were based on individual perceptions of the respondents.

Future research should: increase the sample size; investigate this topic in other industrial sectors; include other supply chain tiers in the analysis of CSFs for the adoption of GSCM practices; measure (statistically), using survey and hypothesis testing, the correlation between CSFs and GSCM practices; and deepen the study of the hypothesis that there is no clear distinction between the CSFs "information management" and "training" in the segment studied.

References

Ab Talib, M. S., & Muniandy, S. (2013). Green supply chain initiatives in malaysia: a conceptual critical success factors framework. *World Applied Sciences Journal*, 26(2), 276-281.

Alves, A. P. F., & Nascimento, L. F. M. H. D. (2014). Green supply chain: a protagonist or a supporting role in Brazil? *Revista de Administração de Empresas*, 54(5), 510-520. http://dx.doi.org/10.1590/S0034-759020140505.

Associação Nacional dos Fabricantes de Veículos Automotores – Anfavea. (2014). *Anuário da Indústria Automobilística Brasileira*. São Paulo.

Babakri, K. A., Bennett, R. A., & Franchetti, M. (2003). Critical factors for implementing ISO 14001 standard in United States industrial companies. *Journal of Cleaner Production*, 11(7), 749-752. http://dx.doi.org/10.1016/S0959-6526(02)00146-4.

Biolchini, J., Mian, P. G., Natali, A. C. C., & Travassos, G. H. (2005). *Systematic review in software engineering*. Belo Horizonte: UFMG.

Boynton, A. C., & Zmud, R. W. (1984). An assessment of critical success factors. *Sloan Management Review*, 25(4), 17-27.

Brasil. Conselho Nacional do Meio Ambiente – CONAMA. (2008, 5 de novembro). *Resolução Conama n° 401, de 4 de novembro de 2008*. Brasília, DF: Diário Oficial da República Federativa do Brasil. Recuperado em 22 de julho de 2013, de http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=589

Castro, B. H. R. D., Barros, D. C., & Veiga, S. G. D. (2013). Baterias automotivas: panorama da indústria no Brasil, as novas tecnologias e como os veículos elétricos podem transformar o mercado global. *BNDES Setorial*, (37), 443-496.

Cauchick Miguel, P. A. (2007). Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução. *Revista Produção*, 17(1), 216-229. http://dx.doi.org/10.1590/S0103-65132007000100015.

Csillag, J. M., Martins, R., & Primo, M. A. M. (2012). Estudos de caso como opção de pesquisa empírica em operações. *RAE-Revista de Administração de Empresas*, 52(4), 380-385. http://dx.doi.org/10.1590/S0034-75902012000400002.

Diabat, A., Khodaverdi, R., & Olfat, L. (2013). An exploration of green supply chain practices and performances in an automotive industry. *International Journal of Advanced Manufacturing Technology*, 68(1-4), 949-961. http://dx.doi.org/10.1007/s00170-013-4955-4.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532-550.

Golicic, S. L., & Smith, C. D. (2013). A Meta-Analysis of Environmentally Sustainable Supply Chain Management Practices and Firm Performance. *The Journal of Supply Chain Management*, 49(2), 78-95. http://dx.doi.org/10.1111/jscm.12006.

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., Kaliyan, M., Kannan, D., & Haq, A. N. (2014). Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. *International Journal of Production Economics*, 147, 555-568. http://dx.doi.org/10.1016/j.ijpe.2013.08.018.

Graves, L. M., Sarkis, J., & Zhu, Q. (2013). How transformational leadership and employee motivation combine to predict employee proenvironmental behaviors in China. *Journal of Environmental Psychology*, 35, 81-91. http://dx.doi.org/10.1016/j.jenvp.2013.05.002.

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

Harris, L. C., & Crane, A. (2002). The greening of organizational culture: Management views on the depth, degree and diffusion of change. *Journal of Organizational Change Management*, 15(3), 214-234. http://dx.doi.org/10.1108/09534810210429273.

Hu, A. H., & Hsu, C. W. (2010). Critical factors for implementing green supply chain management practice: an empirical study of electrical and electronics industries in Taiwan. *Management Research Review*, 33(6), 586-608. http://dx.doi.org/10.1108/01409171011050208.

Hui, I. K., Chan, A. H., & Pun, K. F. (2001). A study of the environmental management system implementation practices. *Journal of Cleaner Production*, 9(3), 269-276. http://dx.doi.org/10.1016/S0959-6526(00)00061-5.

Jabbour, C. J. C., Teixeira, A. A., & Jabbour, A. B. L. D. S. (2013). Environmental training in organizations with ISO 14001 certification: a multiple case study and identification of co-evolution with environmental management. *Production*, 23(1), 80-94. http://dx.doi.org/10.1590/S0103-65132012005000047.

Kim, J., & Rhee, J. (2012). An empirical study on the impact of critical success factors on the balanced scorecard performance in Korean green supply chain management enterprises. *International Journal of Production Research*, 50(9), 2465-2483. http://dx.doi.org/10.1080/00207543.2011.581009.

Koplin, J., Seuring, S., & Mesterharm, M. (2007). Incorporating sustainability into supply management in the automotive industry–the case of the Volkswagen AG. *Journal of Cleaner Production*, 15(11), 1053-1062. http://dx.doi.org/10.1016/j.jclepro.2006.05.024.

Leidecker, J. K., & Bruno, A. V. (1984). Identifying and using critical success factors. *Long Range Planning*, 17(1), 23-32. http://dx.doi.org/10.1016/0024-6301(84)90163-8.

Luthra, S., Garg, D., & Haleem, A. (2014). Critical success factors of green supply chain management for achieving sustainability in Indian automobile industry. *Production Planning and Control*, 26(5), 339-362.

Luthra, S., Kumar, V., Kumar, S., & Haleem, A. (2011). Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique: An Indian perspective. *Journal of Industrial Engineering and Management*, 4(2), 231-257. http://dx.doi.org/10.3926/jiem.2011.v4n2.p231-257.

Mariotto, F. L., Zanni, P. P., & Moraes, G. H. S. M. D. (2014). What is the use of a single-case study in management research? *Revista de Administração de Empresas*, 54(4), 358-369. http://dx.doi.org/10.1590/S0034-759020140402.

Matheys, J., Timmermans, J. M., Van Mierlo, J., Meyer, S., & Van den Bossche, P. (2009). Comparison of the environmental impact of five electric vehicle battery technologies using LCA. *International Journal of*

Sustainable Manufacturing, 1(3), 318-329. http://dx.doi.org/10.1504/IJSM.2009.023977.

Mudgal, R. K., Shankar, R., Talib, P., & Raj, T. (2010). Modelling the barriers of green supply chain practices: an Indian perspective. *International Journal of Logistics Systems and Management*, 7(1), 81-107. http://dx.doi.org/10.1504/IJLSM.2010.033891.

Muduli, K., Govindan, K., Barve, A., & Geng, Y. (2013). Barriers to green supply chain management in Indian mining industries: a graph theoretic approach. *Journal of Cleaner Production*, 47, 335-344. http://dx.doi.org/10.1016/j.jclepro.2012.10.030.

Quazi, H. A. (1999). Implementation of an environmental management system: the experience of companies operating in Singapore. *Industrial Management & Data Systems*, 99(7), 302-311. http://dx.doi.org/10.1108/02635579910262526.

Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management*, 25(9), 898-916. http://dx.doi.org/10.1108/01443570510613956.

Rockart, J. F. (1979). Chief executives define their own data needs. *Harvard Business Review*, 57(2), 81-93. PMid:10297607.

Routroy, S., & Pradhan, S. K. (2013). Evaluating the critical success factors of supplier development: a case study. *Benchmarking: An International Journal*, 20(3), 322-341. http://dx.doi.org/10.1108/14635771311318117.

Sambasivan, M., & Fei, N. Y. (2008). Evaluation of critical success factors of implementation of ISO 14001 using analytic hierarchy process (AHP): a case study from Malaysia. *Journal of Cleaner Production*, 16(13), 1424-1433. http://dx.doi.org/10.1016/j.jclepro.2007.08.003.

Sarkis, J. (1998). Evaluating environmentally conscious business practices. *European Journal of Operational Research*, 107(1), 159-174. http://dx.doi.org/10.1016/S0377-2217(97)00160-4.

Sarkis, J. (2012). A boundaries and flows perspective of green supply chain management. *Supply Chain Management: An International Journal*, 17(2), 202-216. http://dx.doi.org/10.1108/13598541211212924.

Sarkis, J., Gonzalez-Torre, P., & Adenso-Diaz, B. (2010). Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. *Journal of Operations Management*, 28(2), 163-176. http://dx.doi.org/10.1016/j.jom.2009.10.001.

Sarkis, J., Zhu, Q., & Lai, K. H. (2011). An organizational theoretic review of green supply chain management literature. *International Journal of Production Economics*, 130(1), 1-15. http://dx.doi.org/10.1016/j.ijpe.2010.11.010.

Scopus. (2013). Recuperado em 29 de agosto de 2013, de http://www.scopus.com

Seuring, S. A. (2008). Assessing the rigor of case study research in supply chain management. *Supply Chain Management: An International Journal*, 13(2), 128-137. http://dx.doi.org/10.1108/13598540810860967.

Seuring, S., & Müller, M. (2008). From a literature review to a conceptual 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.

Synodinos, N. E. (2003). The "art" of questionnaire construction: some important considerations for manufacturing studies. *Integrated Manufacturing Systems*, 14(3), 221-237. http://dx.doi.org/10.1108/09576060310463172.

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), 953-962. http://dx.doi.org/10.1016/j.jclepro.2010.03.005.

Tummala, V. M. R., Phillips, C. L., & Johnson, M. (2006). Assessing supply chain management success factors: a case study. *Supply Chain Management: An International Journal*, 11(2), 179-192. http://dx.doi.org/10.1108/13598540610652573.

U.S. Environmental Protection Agency – EPA. (2013). *Batteries*. Recuperado em 29 de agosto de 2013, de http://www.epa.gov/wastes/hazard/wastetypes/universal/batteries.htm

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management*, 22(2), 195-219. http://dx.doi.org/10.1108/01443570210414329.

Walker, H., Di Sisto, L., & McBain, D. (2008). Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. *Journal of Purchasing and Supply Management*, 14(1), 69-85. http://dx.doi.org/10.1016/j.pursup.2008.01.007.

Web of Science. (2013). Recuperado em 29 de agosto de 2013, de http://apps.webofknowledge.com

Wee, Y. S., & Quazi, H. A. (2005). Development and validation of critical factors of environmental management. *Industrial Management & Data Systems*, 105(1), 96-114. http://dx.doi.org/10.1108/02635570510575216.

Yin, R. K. (2009). *Case study research: design and methods*. EUA: Sage Publications.

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., & Lai, K. H. (2007). Green supply chain management: pressures, practices and performance within the Chinese automobile industry. *Journal of Cleaner Production*, 15(11), 1041-1052. http://dx.doi.org/10.1016/j.jclepro.2006.05.021.

Zhu, Q., Sarkis, J., & Lai, K. H. (2008). 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.

Zutshi, A., & Sohal, A. S. (2004). Adoption and maintenance of environmental management systems: critical success factors. *Management of Environmental Quality*, 15(4), 399-419. http://dx.doi.org/10.1108/14777830410540144.

Appendix A. Relationship between CSF variables and the literature reviewed.

CSF VARIABLES		AUTHORS								
No.	**Brief Description**	**Quazi (1999)**	**Hui et al. (2001)**	**Babakri et al. (2003)**	**Zutshi & Sohal (2004)**	**Wee & Quazi (2005)**	**Tummala et al. (2006)**	**Sambasivan & Fei (2008)**	**Hu & Hsu (2010)**	**∑ Total Relationship between the Variables.**
1	Supplier	X			X	X	X		X	**5**
2	Communication and Information	X		X	X	X	X	X	X	**7**
3	Material Flow and Recycling						X		X	**2**
4	Involvement of Employees	X		X	X	X	X	X	X	**7**
5	Indicators and Measurements			X	X	X	X	X	X	**6**
6	Top Management Support	X		X	X	X		X	X	**6**
7	Training			X	X	X		X		**4**
8	Design				X	X		X	X	**4**
9	Life Cycle Analysis				X				X	**2**
10	Laws and Regulations				X			X		**2**
11	System Integration				X					**1**
12	Industrial Ecology				X					**1**
13	Certifications	X		X						**2**
14	Uncertainty and Assistance			X				X		**2**
15	Answers and Pressure							X		**1**

Source: Authors.