São Paulo - Brazil - May - 22nd to 24th - 2013
4th INTERNATIONAL WORKSHOP
ADVANCES IN CLEANER PRODUCTION
"INTEGRATING CLEANER PRODUCTION INTO SUSTAINABILITY STRATEGIES"

Green Supply Chain Management: A Study on Criteria Selection and Collaboration with Suppliers

AGUIAR, J. A.[a], PIMENTA, C. D. [a,b*], BALL, P. D.[b]

a. Federal Institute of Education, Science and Technology, Rio Grande do Norte, Brazil

b. Cranfield University, Cranfield, United Kingdon

**Corresponding author, h.c.pimenta@cranfield.ac.uk*

Abstract

The aim of the work presented is to understand the green supply management practices in terms of criteria selection of suppliers and partnership to improve environmental stance of suppliers adopted by a textile industry responsible for yarn manufacturing, located in Rio Grande do Norte (Brazil). Therefore, it was analyzed the company's behavior with the suppliers regarding the adoption of sustainable supply chain management practices. A questionnaire whose analysis criteria were selected from literature was applied with key individuals of the company.Regarding the practice of environmental management in the supply chain, it was found that the company worked with its suppliers through collaborative approach. Direct involvement activities justified this positioning of the company, since it promotes training activities to improve the environmental performance of its partners, and collaborates in the development of the initial suppliers' weaknesses and works with them to develop products. Again, the company uses the environmental variable in a competitive way, including its suppliers in its strategic environmental approach.

Keywords: *Green supply chain management, selection criteria, collaboration, suppliers.*

1. Introduction

Advances in theoretical knowledge about the magnitude of impacts related to products and processes have required a strong commitment of industry to the environment. Thus, it can be seen a significant increase of the adoption of environmental management practices in productive organizations (Gilley et al., 2000; Sarkis et al., 2009).

The textile segment, which is the focus of this study, presents an extensive use of water and energy to manufacture their products (Ren, 2000). Also, it can be seen a huge production of wastewater in the dyeing process, characterized by a high level of chemical substances, such as heavy metals, dyes, detergents and suspended solids (Ciardelli andRanieri, 2001).

Not only the quality of materials supplied but also the commitment of each company membered of the supply chain in terms of a proper environmental adequacy will influence the environmental quality and performance of product in its lifecycle. According to Moore and Ausley (2004), several industries depend on the resource and materials produced by textile sector which means the greater the demand, the greater the consumption of resources for production. Thus, the impacts associated with this

consumption, which is often exacerbated, can be seen in whole supply chain, since the water and energy usage is necessary at all levels of the production process.

Cotton, for example, one of the main raw materials of the textile process, has worldwide impacts due to international distribution of the stages of both production and consumption (Chapagain et al., 2006). Thus, it is important that the members of textile supply chain adopt management tool which focus on the control of environmental impacts, reducing, for instance the waste of resource usage and pollution. For that, Vachon and Klassen (2006) indicate the green supply chain as an option.

In this context, the aim of the work presented is to understand the green supply management practices in terms of criteria selection of suppliers and partnership to improve theirs environmental conduct adopted by a textile industry responsible for yarn manufacturing, located in Rio Grande do Norte (Brazil). Therefore, it was analyzed the company's behavior with the suppliers regarding the adoption of sustainable supply chain management practices.

The research presents initial considerations on a business model for sustainable supply chain management which has been designed in partnership with the EPRSC Centre for Innovative Manufacturing in Industrial Sustainability <http://www.industrialsustainability.org/>.

In order to guide the proposed discussion, this paper is divided into five chapters, in which the first brings the problem and the research objectives. Then it is presented a brief review of literature on green supply chain. The third chapter presents the methodology used to collect and analyze data as well as the firm characterization where the case study was conducted. Subsequently, there are the results and discussion and the final considerations.

2. Green Supply Chain Management

For the purpose of this paper, supply chain (SC)was deffined as a network of companies whose relations lead to the production of goods for sale and the supply chain managemnt (Beamon, 1999) and supply chain management as “the management of upstream and downsrtream with suppliers and customers in order to deliver superior customer value at less cost” (Christopher,2011).

The environmental impacts related to SC member’s activities might have negative effects in the whole supply chain (Simpson and Power, 2005), mainly the focal company (FC). The FC connects with both suppliers and customers, and makes decisions about the final manufactured product (Lambert and Cooper, 2000).

The focal company has a direct relationship with its customers and needs to build its image and maintain it.Any action of its suppliers that directly or indirectly contradict the company’s principles,might causes pressures from customers, non-governmental organizations (NGOs), and regulatory bodies. These pressures usually claim for guarantees of the SC memeber’s previous proposed behavior (Beamon, 1999; TestanandIraldo, 2010). For instance, some companies such as Nike, Levi Strauss, Disney, Adidas, Benetton and C&A had problems in the pass due to their own and their suppliers’ bad environmental and social conduct, including poor working conditions and environmental contamination (Seuring and Müller, 2008).

Therefore, FC is responsible for the environmental and social impact that caused by their suppliers. The Fig. 01 shows the interaction between the focal company and its stakeholders, in which is necessary mutual commitment of all parties.

The focal company can be additionally encouraged internal or external factors. Internally, the motivations are characterized by costs reduction and productivity rise. External drivers are in turn related to the competitive advantage from the implementation of environmental tactics (Rao and Holt, 2005).

In this context, the green supply chain emerges as an alternative to manage pressure from different stakeholds, including in the Fig. 1. Therefore, not only the financial, material, and information

management are pivotal elements of SCM (Christopher, 2011), but there is also the environmental variable must be included through the cooperation between the SC member and FC (Lee, 2008).

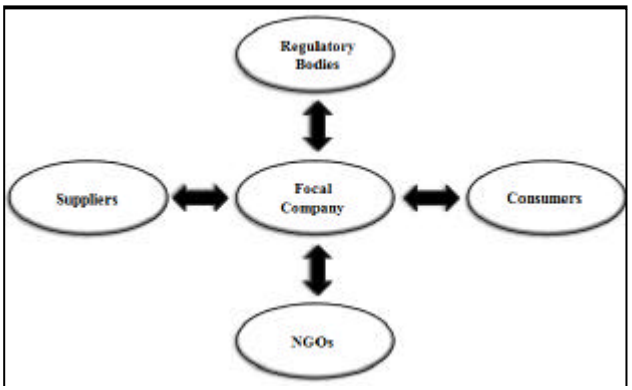

Fig. 1.Relationship between the focal company and its stakeholders.

The inclusion of environmental dimensions into the goals shared by the entire supply chain can improve the environmental performance of the all production process, from raw materials to the sale of products for consumers. As a consequence, a mutual development of the supply chain members is started with the insertion of all the stages belonging to manufacture and commercialization of the product, which might enable to analyse of the overall impacts caused by the process and to design solutions to these impacts (Beamon, 1999).

The initiatives to the adoption of environmental practices are generally started by focal companies. The more specific and strategic are the environmental practices developed by the focal company, greater the level of demand exerted on suppliers (Walton et al., 1998; Jabour andJabour, 2009).

Clearly, the search for lower costs, quality of materials and delivery reliability remain as priorities for the selection of suppliers (Simpson and Power, 2005). In addition, to comply with the environmental law is one of the main topics demanded by FC to its suppliers. However, adjustment to legal and contractual requirements alone do not represent a commitment to environmental dimension (Tam et al., 2006). Thus, when only this condition is evaluated by the company as a criterion for selecting suppliers, the focal company tends to have a low commitment.

The selection criteria selection can be improved by adoption of more strategic requirement such as ISO 14001 (Srivastava, 2007; Seuring and Muller, 2008). In agreement with Jabour and Jabour (2009), the requirement of ISO 14001 as a simplification of the selection process. Not all companies require certification, as occurred in China, where companies such as Bristol-Myers Squibb, IBM and Xerox require their suppliers an environmental management system ISO 14001 only structured, while others such as Ford, GM and Toyota demanded a certificated EMAS by third company from theirs suppliers (Zhu et al., 2007).

Simpson and Power (2005) depict that the FC's relationship with its suppliers can occur in two ways: collaboration or compliance. The collaboration includes direct engagement between the various levels of the supply chain, in which the focal company commits itself to the improvement of its suppliers through employee training and environmental awareness, for example. On the other hand, compliance occurs through power demonstrations of the focal company under its suppliers, without interaction between the parties, basically requesting environmental procurement standard without collaboration neither support, such as environmental law compliance.

Authors vary in their positions about which one is the best tactic to achieve positive results. Lee (2008), for example, assures that the dominance of the focal company brings positive effects on behavior modification of SC members. Notwithstanding, depending on the maturity level of the suppliers in terms of the environmental management, collaboration can become a competitive strategy with long-term results (Tam et al., 2006; Vachon andKlassen, 2007).

As the focal company's performance will depend on the performance of its partners, it is essential to select good suppliers and require substantial environmental practices from them as well as develop collaboration partnership to improve their environmental conduct. The choice of the practices will depend on the FC's environmental goals, and on the need to adjust to environmental requirements. The FC's commitment to the environmental dimension will also guide its decision making about its individual development and its interaction with suppliers. Thus the focal company can ensure the compliance of its partners, or go beyond through collaboration by working directly with suppliers and bringing long-term benefits by building mutual environmental awareness.

3. Methods

3.1 Research design – questionnaire and data collection

The data collection was carried out through semi-structured questionnaire which was based on the literature review relating to reverse logistics and WEEE. The questionnaire focused on the interaction of the company with its respective suppliers in terms of environmental management practices within the supply chain. Both the criteria used to select the suppliers and the environmental practices required of them by the industry studied were investigated and evaluated.In addition, it was investigated the level of maturity of the environmental requirements, and motivations and barriers considered at the time of its adoption (See Table 1).

Variables	Source
Implementation of EMS and ISO 14001 certified	Testa and Iraldo (2010); Jabour and Jabour (2009)
Environmental authorization from government	Srivastava (2007); Hervani et al.(2005)
Environmental law compliance	
EMS Tools (LCA, cleaner production, plans for environmental control – waste, energy and pollution prevention, training and environmental awareness, internal and external recycling)	Walton et al. (1998); Beamon (1999); Simpson and Power (2005); Seuring and Müller (2008); Vachon and Klassen (2008); Testa and Iraldo(2010)
Cost and quality	Simpson and Power (2005)
Transporting costs	
Preference for experienced companies	

Table 1. Interaction with suppliers

Questions were answered by high management level supported by the sector responsible for environmental issues. The following answer scale was adopted: "no opinion", "never" (0-25% of application to reality of the company), "rarely" (25-50% of application to reality of the company); "almost always" (50-75% of application the reality of the company), and "always" (75-100% of application to reality of the company).

3.2. Description of the studied company

The company studied is located in Rio Grande do Norte State (Northeast of Brazil) and is a multinational company, responsible for the production of around 128 types of yarn The main raw materials used in the process are cotton or polyester fiber. Also, it has 950 employees.

The production occurs with the raw material provided by other companies that belong to the supply chain. After the process, the material is transported to another factory in São Paulo (southeast of Brazil),where occurs the dyeing and subsequent sale to various branches, including mainly clothes manufacture (62%) and leather industry for the manufacture of clothes, leather bags and shoes (17%) and automotive industry for the manufacture of seats and accessories (12%). Fig. 2 illustrates the supply chain schematically.

It is supplied to the company studies the following materials: cotton fiber, polyester fiber; polyester continuous filament, nylon continuous filament; cardboard boxes; wooden pallets, and polyester film for packaging.These products account for about 98% of the inputs used in this case study.

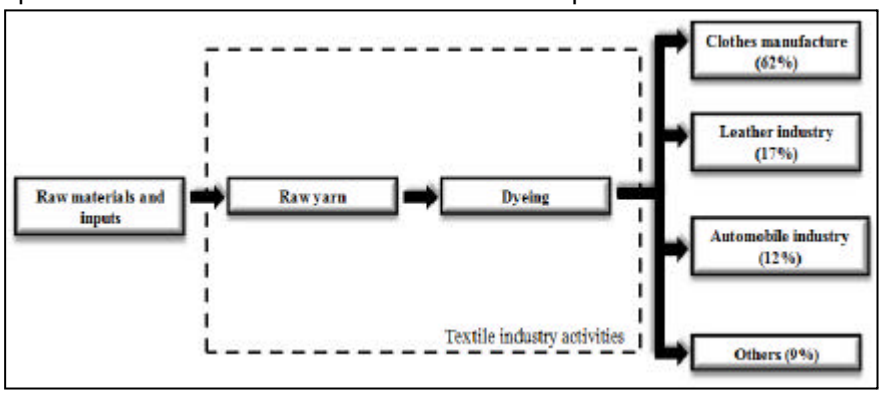

Fig. 2. Supply chain with emphasis on the analyzed textile industry activities

The production process for yarn manufacturing is composed by 4 stages, shown in the flow chart displayed in Fig. 3. The process begins with the quality control of raw material. Then occurs the preparation of the raw material by washing the cotton and removing undesired wastes (about 18% of the material is discarded after this step). The next step is the manufacturing of the yarn through the spinning process. Finally, there is the twist of the yarn to obtain the line.

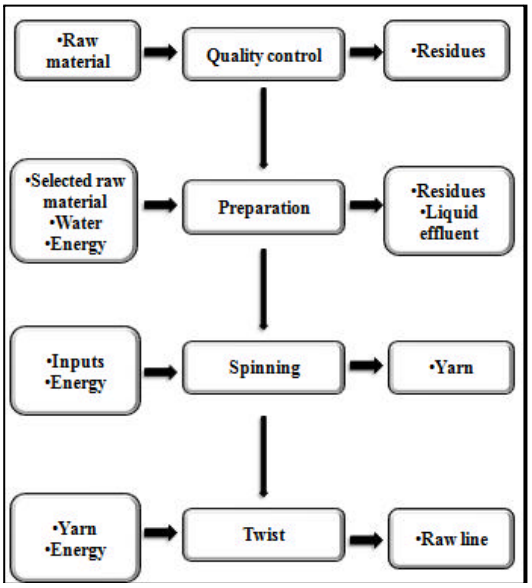

Fig. 3.Flowchart of the production process of the analyzed company

4. Results and discussion

Regarding the environmental selection criteria and partnership for improvements, it can be noted that for almost all evaluation criteria (table 2) the level of maturity was between "almost always" (50-75%) and "always" (75-100%) for the existence of demands made to suppliers in accordance with the environmental practices analyzed by the questionnaire. This result presents a certain level of concern by the company when selecting its suppliers so that they remain within the environmental targets previously established.

Among the criteria examined, it was noted that quality and price of the product is maintained as most important, as discussed by Simpson and Power (2005).

Besides these, some environmental criteria was used by the company studied as behavioral requirements for its suppliers.The company required an environmental management system – ISO 14001(EMS) from its suppliers, but the certification of EMS BY a third company did not apply to all cases. As previously discussed, requiring the ISO 14001 certification from suppliers is a simplification of the selection process (Jabour andJabour, 2009). It is necessary to include other practices that can be targeted to specific environmental problems. Only requiring the ISO 14001 may mean a low level of maturity of the environmental dimension. In the case of the analyzed company, there are other factors required.

Adoption of criteria / demands	Suppliers			
	1	2	3	4
Product quality	A	A	A	A
Product price	A	A	A	A
Transporting costs	A	A	A	A
Preference for experienced companies	AA	A	AA	AA
Compliance with legislation	A	A	A	A
Environmental license	AA	A	A	A
Implemented EMS	A	A	A	A
Implemented and certified EMS (ISO 14001)	AA	A	AA	AA
Cleaner production programs	AA	AA	AA	AA
Waste Management Plan	A	A	A	A
Energy Efficiency Plan	A	A	A	A
Prevention pollution plan	AA	A	A	A
LCA	A	AA	AA	AA
Internal recycling	R	A	A	A
External recycling	AA	A	A	A
Environmental performance assessment	R	AA	AA	AA
Sustainability reports	R	AA	AA	AA
Environmental labeling	AA	AA	AA	AA
Training programs with partners	AA	A	A	A
Environmental awareness activities with partners	AA	A	A	A
Audits of second party	A	A	A	A
Technical/technological collaborations	A	A	A	A
Assistance in environmental emergencies	A	AA	A	A
Assistance in program implementation (ISO, cleaner production)	AA	AA	AA	AA
Rewards for behavior change	AA	AA	AA	AA

* A: always; AA: almost always, R: rarely

**Supplier 01: Cotton lint; Supplier 02: polyester fiber lint, continuous filament polyester and continuous nylon filament; Supplier 03: Cardboard boxes and wooden pallets; Supplier 04: Polyester film for packing line

Table 2. Selection criteria and demands made to suppliers about their environmental practices

The second party audit was annually conducted for all suppliers. This attitude was considered by the organization analyzed as necessary to better understand the functioning of its partners. When audited, suppliers were also investigated on the existence of an "emergency and contingency plan" to manage emergencies and possible environmental impacts.

Furthermore, a life cycle assessment (LCA) was demanded to analyze whether the supplier complies with the requirements related to the product. Due to the high costs associated with this analysis, the requirement was made only to large suppliers. The logistic department is responsible for selecting the companies which will carry the LCA, and the department sets criteria for the choice. The criteria wasbased on the specificity of the raw material that is provided. If the inputs were strategic and difficult to replace, the company must conduct an LCA. The other companies are only audited.

As can be seen in Table 2, the LCA is required mostly to the supplier of cotton. Beamon (1999) and Testa and Iraldo (2010) state the importance of LCA for opportunities of cost reductions and replacing materials with more efficient ones. Nevertheless, it is very difficult to analyze a process essentially agricultural and LCA can become more costly than expected, which does not benefit the supplier.

The company also practiced activities considered by Simpson Power (2005) as belonging to a collaborative relationship with suppliers through actions to support the development of the supplier, including training, technical and technological collaboration, among others explained later on. In a general way, there is sharing of information and the company's commitment to improving the environmental performance of its partners, attitudes assessed by Simpson Power (2005) as important to collaboration to the joint improvement of whole supply chain.

During the second party audit, there was also an investigation of the presence of operational, occupational safety, environmental and occupational health trainings at the supplier's factory. After the analysis of the quality of each type of training, the company would conduct new training those considered as ineffective in the audit. In general, the poor training was related to occupational safety and environmental management.

Environmental awareness through the supply chain was carried out by the invitation of its suppliers(key manager related to sustainability) for taking part in an "internal week of environment". Thus, the focal company can understand the individual vision each of its partners on the importance of awareness related to the environmental dimension and contribute to the improvement of the suppliers' environmental approach where deficiencies were found.

Other collaboration activities conducted by company were environmental emergency assistance and aid in the implementation of activities such as Cleaner Production Programs and ISO 14001. When analyzed the "emergency and contingency plan" during the second party audit, the company checked the main weaknesses and worked closely with the supplier to ensure that all important aspects were well targeted.

The support for implementation of Cleaner Production programs and ISO 14001 certification was conducted by company at its facilities through training. Some manager from supplies was trained on the process of implementation and benefits of these environmental programs.

It is important to note that these two environmental program area requested by the company studies for its supply as a selection criteria as well as the company have a partnership to develop them within some supplies. This relation between requesting and support for development of something that was requested can help suppliers to achieve the standards established by focal company (Seuring and Müller, 2008).

Furthermore, the company also conducted technical and technological collaborations with its partners.One example was the development of new products necessary to the company, where both company and some suppliers share each other laboratorial procedures for improvements of materials and products standards.

Finally, it was found that all of selection criteria were evidenced as practiced in the management routine of the company, being a documented procedures and a contractual clause.

From what has been discussed, it is considered that in addition to communicating with its suppliers, the company presents itself committed to changing the behavior of its partners with respect to environmental dimension. The industry analyzed works with its suppliers through collaboration, according to the previously cited classification of Simpson and Power (2005) hence it can be noted some collaboration with supplies in terms of training and technological sharing.

In general, it can be considered a limiting factor in this research the fact that many information analyzed was not validated or audited to confirm the information given. The access to documents and direct observation of the environment of the company and its suppliers would facilitate the

understanding of the relationship and commitment of the entire supply chain regarding environmental variable.

Another limitation of this research was to look at only one company, with specific data the individual situation of this supply chain of textile production. With the investigation of different situations, one can compare results and better understand what set the different approaches to environmental management, analyzing heterogeneous behaviors of different supply chains for specific relationship between the partner companies and their motivations and barriers to adopt environmental practices.

As the company adopts environmental practices and relates closely with its suppliers, the next step suggested here is to measure the environmental performance of the supply chain to assess the benefits conducted by the addition of the environmental variable. Thus, the company will be able to conduct a study on the quality of its environmental practices and improve them according to its needs, and enable future adoption of other practices that may increase its competitive advantage compared to the other companies regarding the environmental variable.

For other research related to this area, it is suggested to conduct a comparative study between this and other companies in the textile sector with similar positioning in the market to understand the competitive potential of the environmental variable, both nationally and internationally.

6. Final considerations

This paper has introduced initial considerations on a business model for sustainable supply chain management which has been designed in partnership with the EPRSC Centre for Innovative Manufacturing in Industrial Sustainability <http://www.industrialsustainability.org/>. It was focused on some criteria selection of suppliers and partnership to improve environmental conduct of them adopted by a textile industry responsible for yarn manufacturing, located in Rio Grande do Norte (Brazil).

Regarding the practice of environmental management in the supply chain, it was found that the company studied works with its suppliers through collaboration, according to the classification of Simpson and Power (2005). Direct involvement activities rate this positioning of the company, since it promotes training activities to improve the environmental performance of its partners, and collaborates in the development of the initial suppliers' weaknesses and works with them to develop products. Again, the company uses the environmental variable in a competitive way, including its suppliers in its strategic environmental approach.

The communication between the different levels of the supply chain was considered as an essential factor to the joint development towards environmental improvement. Besides facilitating the design and development of the final product through discussion on price and quality of inputs, communication was also considered necessary to spread environmental responsibility, making it easier for suppliers to understand the environmental aspects of the stages of the production process and target solutions.

Therefore, to develop a sound partnership with suppliers, not only standards must be required, but also a support must be given by focal company. This support will depend on, for example the number of members in the chain, also the number of tie. It can be seen in this study a short number of suppliers. This fact can explain the control of the company studied in its supply chain, mainly conducted by audits. Thus, it can also be seen the important role that the audit plays in the environmental management of supplies to understand the weakness of its suppliers and how company can support them to improve theirs environmental stance.

7. References

Beamon, B. M., 1999. Designing the green supply chain. Logistics Information Management, V. 12, p. 332 – 342

Chapagain, A.K., Hoekstra, A.Y., Savenije, H.H.G., Gautam, R., 2006. The water footprint of cotton consumptio21'n: An assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries. Ecological Economics.60, 286-203.

Christopher, M., 2011.Logistics and supply chain management: creating value-adding networks. Pearson education.

Ciardelli, C., Ranieri, N., 2001. The treatment and reuse of wastewater in the textile industry by means of ozonation and electroflocculation.Water Research. 35, 2, 567-572.

Gilley, K. M., Worrell, D. L., El-Jelly, A., 2000. Corporate environmental initiatives and anticipated firm performance: the differential effects of process-driven versus product-driven greening initiatives. Journal of Management. 26, 6, 1199-1216.

Hervani, A. A., Helms, M.M.,Sarkis, J., 2005. Performance measurement for green supply chain management.Benchmarking: An International Journal, 12(4), 330-353

Jabour, A.B.L.S., Jabour, C.J.C., 2009. Are supplier selection criteria going green? Case studies of companies in Brazil. Industrial Management & Data Systems. 109, 4, 477-495.

Lambert, D. M., Cooper, M. C., 2000. Issues in supply chain management. Industrial Marketing Management. 29, 65-83.

Lee, S., 2008. Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives. Supply Chain Management: An International Journal. 13, 3, 185-198

Moore, S.B., Ausley, L.W., 2004. Systems thinking and green chemistry in the textile industry: concepts, technlogies and benefits. Journal of Cleaner Production. 12, 585-601.

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.

Ren, X., 2000.Development of environmental performance indicators for textile process and product.Journal of Cleaner Production. 8, 473-481.

Sarkis, J., Gonzales-Torres, P., Adenso-Diaz, B., 2009.Stakeholder pressure and the adoption of environmental practices: the mediating effect of training. Journal of Operations Management.163-176.

Seuring, S., Müller, M., 2008.From a literature review to a conceptual framework for sustainable supply chain management.Journal of Cleaner Production. 16, 1699-1710.

Simpson, D.F., Power,D.J., 2005. Use the supply relationship to develop lean and green suppliers. Supply Chain Management: an International Journal. v10, 1, 60-68.

Srivastava, S K. 2007. Green supply-chain management: a state-of-the-art literature review. International Journal of Management Reviews. 9, 53-80.

Tam, V. W. Y.; et al, 2006. Environmental performance assessment: perceptions of project managers on the relationship between operational and environmental performance indicators. Construction Management and Economics.v.24, p. 287–299.

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.v.18, p. 953-962.

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.

Walton, S. V. et al., 1998. The green supply chain: integrating suppliers into environmental management processes. International Journal of Purchasing and Materials Management. p. 2-11.

Zhu, Q., Sarkis, J., Lai, K., 2007. Green supply chain management: pressures, practices and performance within the Chinese automobile industry. Journal of Cleaner Production. 15, 1041-1052.