SUSTAINABLE SUPPLY CHAIN MANAGEMENT
AN OPPORTUNITY TO MAKE THE CHAIN MORE COMPETITIVE

Abstract
Firms and suppliers not only comprise the productive and logistical processes, but also cooperate by responding pro-actively to socioenvironmental issues. The literature on Green Supply Chain Management (GSCM) shows that the firms encourage improvements in the environmental performance of suppliers and other supply chain members through adoption of the green procurement, reverse logistic, ecodesign and green manufacturing. Besides this, Sustainable Supply Chain Management include relationships management for the creation of sustainable/socioenvironmental partnerships. Therefore, it is important to understand how socioenvironmental issues are dealt with, especially in the relationships among the members of the supply chain. These article presents the results of a study aimed to analyze socioenvironmental actions between firms and suppliers in the metal-mechanic supply chain. The method used was a descriptive multiple case study that included, mainly interviews with professionals from different areas: Environment and Labor Security, Purchasing, Product Development, Production, Project Management. Two environmental actions excelled the others, one refers to the modification of a painting process in ALFA´s Company, and the other concerns the substitution of the raw materials of a particular product in the BETA´s Company . In these projects there was a reduction in the environmental impact by the substitution of materials, with a reduction in accidents and environmental liability, as well as an improved image before the public authorities, suppliers and clients. A low level of environmental awareness and the difficulties in developing cooperative processes among the links in the chain were identified as limitations to the development of similar actions.

Keywords*:* Green Supply Chain Management; Environmental and Social Management; Competitiveness

Introduction

However public regulation and supervision are still the main company pressure factors for socioenvironmental responsibility, companies are also driven not only to consider the shareholders interests, but also dialogue with stakeholders and answer their demands. Several actors claim to include social and environmental issues in their strategic planning agenda, with the purpose of achieving sustainability on their produtcs and processes. Then, a growth of customers' demands for the substitution of toxic substances and the reduction of products' packages, improvement on the production processes, support of social and environmental projects, among others, can be observed. In addition, companies have noticed that reducing environmental impacts and considering to the demands of society does not imply necessarily at a cost increase. In many opportunities, the implementation of awareness and environmental preservation programs result in reduction of costs. However, this reduction on impacts does not depend only one firm, but on a coordination of the productive chain efforts, because in many cases, the pollutant raw material or the generation of waste occur due to the inputs acquired. In this context, firms and suppliers cooperate on the prevention of pollution, cleaner technologies adoption and product development and stewardship, and afect stakeholders management by responding pro-actively to socioenvironmental issues. The literature on Green Supply Chain Management (GSCM) shows that companies encourage environmental performance improvements in the supply chain members through adoption of the green procurement, reverse logistic, ecodesing and green manufacturing. Besides this, Sustainable Supply Chain Management (SSCM), proposed in this article, include relationship management for the creation of sustainable or socioenvironmental partnerships.

Therefore, it is important to understand how socioenvironmental issues are dealt with, especially on the relationships among members of a supply chain. These article presents a study that aimed at analyzing socioenvironmental actions between firms and suppliers in the metal-mechanic supply chain. For such purpose, the article attempts to describe the environmental actions that involve the dyad customer-supplier and to point out the economic, social and environmental benefits to competitivity gains, and barriers of the customer-supplier partnerships. The method used was a descriptive multiple case study that included as analysis unit the initiatives of two focal companies, ALFA´s Company (manufacturer of road implements) and BETA´s Company (manufacturer of automotive parts) located in the extreme south of Brazil, in the State of Rio Grande do Sul. Two actions excelled the others, one refers to the modification of the painting process, ALFA and DELTA partnership, and the other concerns the substitution of the raw material in a product, BETA and ZETA partnership. The main data was obtained through in-depth interviews with professionals from different areas: Environment and Labor Security, Purchasing, Product Development, Production, Project Management As main results, the initiatives related to SSCM were identified, socioenvironmental management was presented, and the ALFA and BETA Company's were described, emphasizing prodution process, benefits and barriers. The method and results descriptions will be presented after the synthesis carried out about Sustainable Supply Chain Management on the bibliographical review.

Sustainable Supply Chain Management

The Sustainable Supply Chain Management (SSCM) has as origins socioenvironmental management. Literature has presented SSCM as Green Supply Chain Management (GSCM). Therefore, this chapter briefly describes, the main corporate socioenvironmental management approaches, and compare "the traditional" with "the green" supply chain management. So then, define the aim and caractheristics of sustainable supply chain management.

Approaches on Socioenvironmental Management

To Mancini, Hourneaux Jr. and Kruglianskas (2005) a socioenvironmental responsible management (SRM) must consider or exceed ethical, public, legal and commercial expectations in relation to environmental and social issues regarding the goods and services production process, taking into consideration the shareholders (owners, stockholders and investors) and stakeholders (workers and their families, suppliers, distributors, consumers, neighborhood, competitors, government, financial agents, and the society in general) interests. Even though, it´s necessary a business strategic planning change, which should establish the aim and SRM policy in the organization, in other words, include the socioenvironmental variable in the company´s mission, principles, and performances index. (MANCINI; HOURNEAUX JR.; KRUGLIANSKAS, 2005). More than that, the socioenvironmental strategic management (SSM) consists in inserting the "socioenvironmental variable through all the management process of planning, organizing, managing and controlling" the productive activities and their interactions with the market, with the purpose of "achieving their goals and aims the more sustainable way as possible" (NASCIMENTO; LEMOS; MELLO, 2008, p.18). Literature points out four main

organizational socioenvironmental approaches (WALTON; HANDFIELD; MELNYK, 1998, WINN; ANGELL, 2000, BUYSSE; VERBEKE, 2003):

(i) **Reactive –** search for alternatives of cleaning or dispose the residues produced to deal with legal aspects, these are known as ***end-of-pipe*** solutions – remediation technologies and environmental control at the end of the productive process;

(ii) **Receptive** – adoption of **pollution prevention** (P2) technologies through formal planning and environmental performance monitoring to find and eliminate losses through the productive process going beyond the legal aspects;

(iii) **Constructive** – product development and *product stewardship* to minimize the environmental impacts through the whole product life cicle, made upon the product impacts evaluation and the productive processes since the materials selection up to the disposal - *crandle-to-grave* analysis.

(iv) **Proactive** – adoption of a *Total Quality Environmental Management - TQEM*, combining pollution prevention controlling actions and the product development with product management with the **stakeholders management**, dealing with different demands and taking into consideration "all the costs": individual, environmental and of the society.

Supply Chain Management versus "Green" Supply Chain Management

Green Supply Chain Management (GSCM) is a mixture of Supply Chain Management (SCM) and Environmental Management (EM) (SRIVASTAVA, 2007). Traditionally, Supply Chain (SC) refers to all activities associated with the transformation and flow of goods and services, including information flows, from the source of the materials to the final users (BOWERSOX; CLOSS, 1996). Supply Chain Management seeks to integrate the company's internal and external activities through a synchronized alignment of the productive activities of all the links of a production chain, attempting to obtain cost reduction, minimization of cycles and the maximization of the value perceived by the final customer (BOWERSOX; CLOSS, 1996, WOOD Jr.; ZUFFO, 1998). Moreover, Green Supply Chain is the redefinition or amplification of the concept of supply chain for the inclusion of the environmental component (BEAMON, 1999, KAINUMA; TAWARA, 2006, SRIVASTAVA, 2007). And it complements the Supply Chain activities through the environmental impacts assessment of all products and processes from the raw material extraction to the waste final disposal. Then GSC considers other stages (see figure 1) in the chain, such as: collection, reuse, remanufacture and reuse, recycling and final disposal of the products and components (BEAMON, 1999). Therefore, Green Supply Chain Management extends the corporate environmental objectives of reducing the use resource and the waste generation of products and services, by carrying out the analysis of the product's life cycle and the management of products and components flow for reuse or recycling (BEAMON, 1999, KAINUMA; TAWARA, 2006, SIMPSON; POWER, 2005, SRIVASTAVA, 2007).

The complexity of productive systems and the need to develop logistic projects motivated by the optimization of the chain of values have led the companies to involve suppliers in their production processes (WOOD Jr.; ZUFFO, 1998). Then the manufacturer, seeking operational excellence, is not pleased if the other links of the chain present uncertainty in carrying out productive activities, causing inefficiency in the chain of value, adding reworks and offscourings

throughout the whole process (WOOD Jr.; ZUFFO, 1998). In the same way, a company's high level of environmental performance can be jeopardized by a low level of the suppliers' environmental management, which results on an increase of interest and importance of the suppliers' environmental performance (SIMPSON; POWER, 2005). Companies that are leaders in environmental posture understand that consumers or other stakeholders do not always differentiate them from their suppliers. This can force them to assume responsibility of the environmental and work practices of their suppliers (LIPPMAN, 2001).

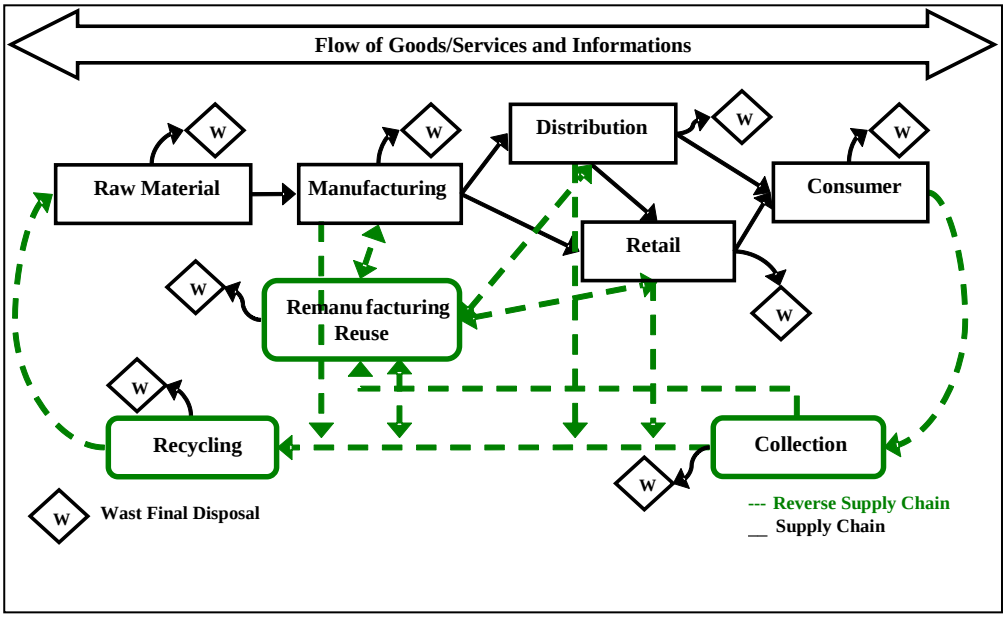

Figure 1 – The Extended Supply Chain
Adaptaded of Beamon, 1999. p.338.

Sustainable supply chain management processes

Lambert, Cooper and Pagh (1997; 1998) have proposed key decision elements for supply chain management: business processes (activities aiming the generation of value for the clients), management components (managerial variables for the integration of the members of the chain) and structure (members of the supply chain). Business process management refers to the relationship and customer service, demand, processing of requests, manufacture flow, purchasing, products development and commercialization, as well as returns (LAMBERT; COOPER; PAGH, 1997). Concerning green supply chain management, Srivastava (2007) defines two main processes: green design and green operations. The first considers issues of the product's environmental health and safety throughout its life cycle. The second refers to green manufacturing and remanufacturing, reverse logistics and waste management process (SRIVASTAVA, 2007). Walton, Handfield and Melnyk (1998) have classified five main activities of environmental management in the supply chain: materials used in the products ecodesign, product design process, improvement of the supplier's production process, supplier evaluation and logistic (reverse and inbound) processes. Acoording to environmental management literature, the traditional supply chain management and the green supply chain, was possible to define five business processes to a Sustainable Supply Chain Management. On this

study were considered as main processes: ecodesign, green manufacturing, reverse logistic, green procurement, sustainable relationships and partnerships.

Ecodesign

Ecodesign seeks to eliminate waste and emissions throughout whole stages of product´s life cycle (cradle to grave) (SENAI, 2003). The research and development processes of products is guided by environmental opportunities and other atributs as efficiency, quality, functionality, ergonomics and aesthetics, beyond considered social and cultural issues of the consumption. The new product concept, a socially and environmentally-friendly one, involve the fabrication of products with replaceable parts or parts that can be fixed, with greater durability, recyclable or with a better use of raw material. Concerning inputs, the use of renewable natural resources, recyclable materials and less toxic products is required, as well as the reuse of material (offscourings and excesses) and the avoidance of critical components. Moreover, the use of packages is reduced or reused (NASCIMENTO; VENZKE, 2007). For Walton, Handfield and Melnyk (1998), the professionals of the design and purchase areas should work together for the environmental improvement of suppliers' products. Another way to professionals interation, in the different tiers of supply chain, is promote the dialogue between designers and experts in materials to influence the procurement specifications of one company. This proposition presumes interaction throughout the design process, in which professionals discuss environmental issues and creation of new products support tools such as Life Cycle Analysis (LCA) and Quality Functions Deployment – QFD) (WALTON; HANDFIELD; MELNYK, 1998).

Green Manufacturing

Green Manufacturing has a similar concept of Cleaner Production (CP), since both aim minimization of waste and waste of raw materials, water and energy in the production process (SRIVASTAVA, 2007, NASCIMENTO; LEMOS; MELLO, 2008). However, the Green Manufacturing unlike the CP does not cover the process of product developing, only redesign the production system, adopting clean technologies and highly efficient production techniques. (SRIVASTAVA, 2007). Srivastava (2007) points out five specific operations to the area of green manufacturing: a reduction in the use of resources, waste and products recycling, products and materials remanufacturing, the inventory management and the production planning and scheduling. The remanufacturing corresponds to the recovery and reuse process, which generally involve the operations of repair (inferior quality compared to the new products), refurbish (specific quality) and disassembly (dismantling, demolition or re-processing products) to use the components and materials (SRIVASTAVA, 2007). In turn, the management of inventories and production systems are redesigned to consider finished, semi-finished, remanufactured and returned products besides the inputs (SRIVASTAVA, 2007). The waste management is also improved for the "not" generation or even the reuse and recycling of waste, avoiding the final disposal (SRIVASTAVA, 2007). Regarding to production processes, the environmental projects in partnership (green project partnership) between suppliers and consumers, studied by Vachon and Klassen (2006), aimed at the development and implementation of a new technology to prevent pollution and the cooperation to reduce waste and the use of energy. From this perspective, companies help their suppliers to meet environmental legislation, as well as identify the trail of waste. And through the certification systems of environmental management, monitor the environmental processes of suppliers. (VACHON; KLASSEN, 2006).

Reverse Logistic

Environmental issues can be treated simultaneously with the supply chain management operational process, including solutions of reverse logistics (SHEU; CHOU; HU, 2005). Reverse logistics involves returns and also the activities related to the backwards in the supply chain (STOCK; SPEH; SHEAR, 2005). Traditionally, the returns can result from problems, difficulties or errors in the sale and also due to the minimum stock levels to attend consumers (STOCK; SPEH; SHEAR, 2005). The implementation of programs such as Just-in-Time and Efficient Consumer Response collaborate in the quality control of products and in the inventory management, however the returns are still inevitable (STOCK; SPEH; SHEAR, 2005). Pioneer companies have learned how to make the returns more profitable by designing the supply chain reverse process (CRANDALL, 2006). A better return process helps the company to save more products, which can be reconditioned or remanufactured or still have parts or components resold (STOCK; SPEH; SHEAR, 2005). Thus, the products return to the company's actives as production inputs or products destined to the secondary market (ANDEL, 1997). Besides product reverse logistics, initiatives of return and reuse of packages by clients and suppliers are also common, which reduce not only the material of the packages but also make the production process easier, improving the access to inputs. This commonly results in the adoption of plastic or metal packages, trays or pallets, as well as the use of containers for the delivery of materials. These changes in the logistic processes occur due to the sensibilization and training of employees, mainly in the purchasing areas, related to issues of disposition and obsolescence of inputs, possibly causing a reduction of waste and costs (WALTON; HANDFIELD; MELNYK, 1998).

Green procurement

According to Walton, Handfield and Melnyk (1998), purchase professionals can motivate internal and supplier environmental improvements with the development of a supplier evaluation system, which gives an important weight to environmental criteria. In a first stage, the evaluation criteria are related to complying with the environmental regulations, which is a minimum requisite. However, purchasing companies expect the suppliers to go beyond the legal concordance. Thus, companies seek to communicate that "green products" are a priority for the suppliers to become long-term partners. This occurs due to the need to develop environmental partnerships with the suppliers without the need of regulations and auditing. These authors have carried out a study with managers of five companies of the United States furnishing industry, which made it possible to define ten criteria for the environmental evaluation of suppliers (see figure 2) (WALTON; HANDFIELD; MELNYK, 1998, p.9).

1. Public disclosure of environmental record	6. ISO 14000 certified
2. Second-tier supplier environmentaly-friendly practices (EFP) evaluation	7. Reverse logistic program
3. Hazardous waste management	8. EFP in product packaging
4. Toxic waste pollution management	9. Ozone depleting substances management
5. On EPA 17 Hazardous material list for product labeling	10. Hazardous air emission management

Figure 2 – Top Ten Environmental Supplier Evaluation Criteria
Walton, Handfield e Melnyk (1998, p.9).

The most of the criteria obtained in the study still refer to a reactive environmental response due to the difficulties in associating them to the environmental improvement of the supplier's processes (WALTON, HANDFIELD & MELNYK, 1998). Lippman (2001), in his studies with twenty-five companies, benchmarks or leaders of several sectors concerning strategies and environmental activities in the supply chain, saliented that the corporative consumers have made requests for environmental reasons, thus motivating changes in the environmental performance of suppliers. However, the interviewed suppliers believe that clients still need to integrate environmental criteria, daily in the decision-making purchase processes, attributing enough weight in comparison with other decision parameters such as cost, service, quality, availability and innovation. And also increase buying volume of suppliers that demonstrate leadership on environmental actions. Suppliers still believe that an effective communication and a collaborative approach are necessary in the client-supplier relationship, with the establishment of communication channels and formation of multifunctional teams (marketing, sales, technical departments, among others) seeking the promotion of the information flow (LIPPMAN, 2001).

Managing Relationships and Sustainable Partnerships

Preuss (2005), while addressing the relationship management in the supply chain focused on three main approaches in relation to the challenges of the environment. The first is not to contemplate the environment in relations with suppliers, due to a low environmental impact, of inputs, manufacturing, product and waste. The second stipulates environmental criteria in the companies' purchases, communicating suppliers about environmental requirements beyond the legal requirements, discussed in the previous subsection. The third approach provides cooperation between customer and supplier to develop capacitation beyond environmental issues. (PREUSS, 2005). The choice of different approaches can be linked to the level of relationship between customer and supplier, and the goals that lead to cooperation.

The model of Webster (1992) shows the relationships along a continuum, a clear trend of transactions only to the traditional hierarchy (total verticalisation). These bureaucratic organizational forms, describe more flexible organizational relations: partnerships, alliances and networks. However, these latter will be established only if the companies are willing to have a relationship in the long run, recognizing the interdependence and sharing goals, resources and information (CIGOLINI, COZZI, PERONA, 2004, WEBSTER, 1992). For Morgan and Hunt (1994) the commitment and confidence are key features for an effective cooperation between the partners. Since the trust is the main determinant for which there is mutual commitment between the partners. And trust exists only when the parties are sure of the integrity and dependence of the partner, or the security of the possibility of relying on the other party. Expectations and participation of the partners involve core values: honesty, justice, openness, mutual care and maximum trust (RYAN, 2003). The reliability of the partner is associated with qualities such as: consistency, competence, honesty, sincerity, responsibility, kindness and promptness (MORGAN; HUNT, 1994).

For Ryan (2003) the optimization of strategies for sustainable development (SD) involves the implementation of partnerships between business, governments and the local community. From the models of the four "Ls" of eco-strategy of Ryan (2003), from approaches of sustainable

partnerships of Juniper and Moore (2002), and motivations for partnerships, Madhavan, Shah and Grover (1994) it was possible to identify the following types of partnerships for the SD:

(i) socioenvironmental leadership - get high level of care and measurement of the sustainability goals;
(ii) influence - establish standards and guidelines, encourage attitudes and behaviors of the society and control the evolution of the industry to promote the SD;
(iii) legitimacy - getting recognition and greater prestige among stakeholders through actions to protect and restore environmental and social development of communities.
(iv) learning - providing opportunities for learning about sustainable development for the local community and providing the gradual increase of sustainable practices in business.

Method

The descritive research was based on the strategy of case studies to investigate "how" environmental actions were addressed in the custumer-supplier relationship of the metal-mechanical industry in Rio Grande do Sul. The completion of the case study provides a fair and accurate assessment of the empirical data in order to facilitate the analysis of complex phenomenas (YIN, 2001), that this study relates to the customer-supplier relationship. In addition, this research has adopted the strategy of multiple cases projects, since they result in more convincing, and therefore, more robust evidence as well (YIN, 2001). The cases (units of analysis) relate to environmental initiatives involving members of the supply chain of metal-mechanical industry in Rio Grande do Sul. The method of case study predicts the establishment of three main stages of research, which are: definition and planning, preparation, collection and analysis, analysis and conclusion (YIN, 2001). Thus, it is presented in this chapter the theoretical propositions, the criteria for cases selection, the procedures for collection and data analysis. The theoretical propositions, obtained through literature review, outline not only the research issues, but also the collection plan and data analysis.

Therefore, the theoretical prepositions and the criteria for cases selection used in this research are presented and related in the following table. Based on these criteria, the survey highlighted two projects: the implementation of a new painting centre in the company ALFA and the replacement of raw materials of BETA company. However, it presents some information about other joined initiatives with other members of the supply chain, as well the selection and evaluation criteria of suppliers.

Theoretical Prepositions	**Criteria for Cases Selection** Member Companies of the supply chain:
Members of the supply chain collaborate in socialenvironmental actions	Interact to include socioenvironmental attributes in products and services (Ecodesign); Participate in socioenvironmental improvements in other companies processes (Green Manufacturing); Integrate processes for product return (Reverse Logistic);
Corporations act upon adoption of socialenvironmental practices in other members of the supply chain.	Adopt socioenvironmental criteria for products and production processes of suppliers and distributors (Green Procurement); Manage relationships for the creation of sustainable/socioenvironmental partnerships

Cooperation between members of the supply chain generates economic, social and environmental benefits.	Get environmental, social and economic benefits in cooperation processes with corporate members of the supply chain.
The extent of social and environmental concerns along the supply chain is hampered by limitations in the processes of cooperation between customers and suppliers, and commitment to socioenvironmental issues.	

Procedures for data collection

The data collection was held in different stages: the identification, contact and local visitation, the identification and information collection on the cases to study. Information obtained for the companies' selection and description and their cases originate from primary sources, such as contacts via telephone and e-mail and interviews with professionals from different areas: Environment and Labor Security, Purchasing, Product Development, Production, Project Management. In addition, secondary sources such as Internet and internal documents of the organizations had an important role in this study. Since the definition of the selection criteria, it was used indications of companies by consultants and researchers, which had held up work or research related to the environment. In the survey of possible firms to study, sites on the Internet have been looked up, as well on magazines with great circulation, in particular, and yearbooks on businesses. Initially, six companies were selected: three automobile manufacturers, two producers of parts and a manufacturer of machinery and equipment for painting. After contacting by e-mail and/or telephone these companies selected previously, only two of them had availability and could schedule visits. Because of this, two more companies were contacted, a manufacturer of cabins and parts for trucks and another producer of parts and accessories for cars, but only the first continued participating in the research. So, the visits occurred in three companies: the company ALFA, a road implements producer, the company BETA, a manufacturer of parts of friction and THETA, a manufacturer of cabins for trucks, parts and shielded body. However, only companies ALFA and BETA presented initiatives that met the pre-determined criteria. It is important to stress that these two companies are part of the same group of companies, known in this report as GAMA SA.

In order to obtain information about the structure, profile and activities of the studied companies, were analyzed secondary sources of data: sites, magazines, manuals, folders. The sites of the focal companies, ALFA and BETA, as well the site and the bi-annual social balance of the holding GAMA SA were the main sources of general information. The manual for suppliers of GAMA S.A. and the folders and manuals of the supplier DELTA were important sources of data for the projects under study. However, the depth interview was the main tool for obtaining data of this study. In total, nine interviews were conducted, between the months of July and December 2007. The interviews had a duration of forty-five minutes to an hour and thirty minutes, following given issues previously defined. In the first visits to ALFA and BETA, were conducted interviews with managers in the fields of environment and health & safety; the respondents A and B respectively. The aplication of the first questionnaire in the focal companies provided information about the company, particularly on environmental management. After the selection of cases, these managers indicated other professionals who managed and attended the projects under review. In turn, other two questionnaire, one for corporate customers

and another for suppliers, made possible the project´s description and the relationship between business partners, the review of mutual benefits and the identification of barriers of the project´s implementation under study. Regarding to the project of implementing a painting centre of the company ALFA, besides to the environmental manager, participated in the interviews, the manager of production (interviewed C) and the representative of the supplier company DELTA (interviewed E). For the process of replacement of BETA raw materials, were interviewed the chemical developer (interviewed D), the commercial manager of the company ZETA (interviewed F) and an analyst of suppliers development (interviewed G).

Plan for analysis and reports of the case study

The preparation for the data analysis includes the definition of classes and variables to be described in the analysis of the research results. For contextualization purpose of the cases, general information and managerial socioenvironmental initiatives of the group GAMA and businesses ALFA and BETA were discussed, highlighting market data, the product lines, financial information, and the environmental profile: the main environmental technologies (pollution control and prevention, product´s life cycle analysis,) and management tools, (Environmental Management System, cleaner production,...) adopted. To underline the relevance of the selected projects, a brief description of environmental initiatives involving other members of the supply chain is presented, identified as the selection criteria of cases for study. Specifically, in relation to the cases, it has been sought to:

(i) Describe the project - emphasizing goals, resources and training involved, and period of preparation and implementation; relationship between partners.
(ii) Analyze benefits - comparing to the "previous/substitute" product or process and emphasizing benefits for each partner and also other members of the supply chain.
(iii) Identify barriers - disadvantages in relation to the previous product or process and difficulties found by the parties involved on the implementation of the projects.

Data analysis was carried out in four steps: summary of the testimonies, interviews' transcription, description of the context and cases' reporting, cross analysis of the information obtained. A summary of the testimonies of interviewees was developed, from the notes taken during interviews. This led to construction of a guide to interviews' transcription and analysis of their data. After the transcription of the data, it was prepared the contextualization and individual reporting of cases, where the information obtained in interviews and secondary sources were interpreted as the theory advocated. Finally, the final analyses with the data crossing from both cases to foster discussion and revision of theories. Finally, the analysis with the data crossing from both cases to foster discussion.

Results

The cases mentioned in this article are based on sustainable supply chain management initiatives of two companies: ALFA, acting in the road equipment sector and BETA in the automotive parts sector. Both firms are part of production and value chain of GAMA S.A. Implements and Participation, which is a holding formed of nine companies that together has more than 7.400 employees and has a profit of R$2.52 billion in 2007, being US$201 million of

those in exportations. The ALFA which originated the other companies and was incorporated to GAMA group only in 2003, holds 36% of the Brazilian market in the haulage/semi-haulage segment and is considered one of the sector's five largest world producers. The BETA is the largest Latin-American producer of friction materials and one of the five largest in the world. It responds for 95% of the supply of heavy sailcloth (for commercial vehicles), 60% light sailcloth and 35% of brake pads to automakers installed in Brazil.

Environmental management systems

The expressiveness of the GAMA company in the market brings constant pressure from stakeholders for the development of an social and environmental policy to guide their companies actions. Then, it´s important to describe for the cases context, beyond the business, the social and environmental management of the companies studied. This analysis provides an understanding of their principles and practices that support the requirements and guidelines to the other members of the supply chain.

Environmental management system in the ALFA company

The ALFA Company possesses a safety, health and environment program according to the ISO norms of Environmental Management and "works exactly like ISO 14000 or OSHAS 18000, in which periodic auditing, action plans, indicators and continuous improvements are carried out" (Interviewee A). The implementation of the environmental management system begun in 2001 and was made effective in 2004, which should be certified as a "decision of the strategic planning […]" (Interviewee A), in 2008.

According to interviewee A, the company "has grown year after year in environmental issues". In 1995, it began with awareness programs on waste selection and safety use of equipments, it also installed an effluent treatment station to attend the industrial complex. In the period from 1997 to 1999, it dedicated to waste destination, building a hazardous waste central and a non-dangerous and non-recyclable waste cell. Due to the concern to not generate waste and improve the production process, the company changed its focus by adopting the cleaner production methodology in 1999. For such reason, it sought the advisory of the Clean Technologies Center (CNTL) and formed a coordinating eco-team and 10 eco-teams in the sectors of painting, boiling and assembly, involving a total of 67 people and 2.860 hours per year of work. After evaluations carried out during the period between 1999 and 2005, the minimization of waste and source emissions was observed with the substitution of materials (gloves, isolation paper…) and improvement of processes (water recirculation, tank polishing, treatment of oil emulsions, alterations in the painting equipments and mats). In this period, the investments in cleaner production equaled a total of R$356.000,00, reducing costs in R$1.367.160,00 per year.

The interviewee A said that the program is one of the company's differential points, because it allows an environmental criteria evaluation since the projects' conception, verifying which "alternatives and impacts they will cause". For the interviewee A, before the program, they "[…] were only putting out the fire and running after to know where the waste came from and what would enter the process", but "today the clean technologies methodology […] is part of the safety, health and environment system". By keeping the eco-teams working, it is possible for them to "observe opportunities […] for better use of raw material, water and energy". The

interviewee A believes that the program has been disseminated throughout the company, affirming that today "people, especially those in the engineering area, already observe this, not only those in the environment area". Therefore, the company continues to seek for new opportunities, developing evaluation indicators and stimulating employee pro-activity by awarding their ideas.

Environmental management system in the BETA company

"BETA has ISO 14001 since 1999", which occurs due to the demands of "[...] clients that are automakers and clients from the European Union" (Interviewee B). Moreover, the environmental management system has demonstrated positive results in waste reduction of the production process, because "in the past, it generated 1000 tons of waste per year, but today […] it generates only 300 tons/year" (Interviewee B).

Interviewee B said that BETA Company's environmental management controls the levels of effluent generation, atmospheric emissions and solid waste, through the effluent treatment station (ETS), exhausters and the waste central. There are few liquid effluents from industrial processes, because the main raw material is powder. There is "a lot of particulated material inside the factory, therefore every point of powder handling has a suction, a vacuum cleaner", and together with the gases "goes to the exhaustion system". This system "[…] has a huge line of exhausters, a gas cleaner and gas burner stove in order to eliminate the emission of pollution […] so that we can accomplish the level emissions" legally determined. In what concerns waste, there is a hazardous waste central for storage before final destination and a cell for waste that can be directed to recycling or coprocessing. In order to obtain a continuous improvement, goals and actions were defined for the environmental management system. These goals include reducing the consumption of drinking water, gas and electric energy, besides minimizing waste in the production processes. The actions correspond to work groups which, in the case of water consumption, have participated since the identification of "[…] leeks, which is a simple thing, to the amplification of the effluents network". Besides that, it also includes awareness programs for the reduction of consumption and studies of new points for the use of treated effluents. For the reduction of energy use, "an internal energy management commission, wich is a multifunctional team" with people from the areas of environment, maintenance, laboratory and factory was created. This team carries out point-to-point analysis in the company in order to identify trifling or waste of the energetic system. For such, the commission counts with other "work fronts" such as those of the 8S (eight senses) program, in which "one of the Ss is to avoid waste". This program has a "checklist in which a monthly auditory is carried out" and awards points to the sectors and if a leek or waste is located removes some points, thus resulting in more consciousness and attempts to solve the problem. At last, regarding waste, the company is concluding an industrial landfill and beginning to send the waste for coprocessing. In spite of the "cost being much more elevated", due to the expenses with transportation (800 km), the company "does not keep an environmental passive" (Interviewee B). And "although changing the destiny of the waste", it is necessary to "continue monitoring the landfill due to the fact that if a problem occurs, they will always be responsible (Interviewee B). On the other hand, coprocessing is carried out by a Cement Company, in which the waste becomes a sub-product, although in a small fraction, when incorporated in the fabrication of cement. With this process, BETA receives a certification of final destination, "affirming that the waste has been destroyed".

Green supply chain management initiatives

The companies ALFA and BETA showed more than pollution control practices, because they have been worried about pollution prevention, investing in programs to identify opportunities to reduce waste and to make better use of materials, water and energy. These initiatives resulted on environmental, produtivity and cost benefits, and still provided for this companies, prizes and highlights in the environmental liability. In spite of its solid environmental management, the group of companies GAMA does not present a specific program for the extension of the environmental concepts throughout the supply chain. However, the companies studied have demonstrated some initiatives involving the environmental issue and other members of the supply chain, which characterizes an advance in direction of the implementation of a more pro-active environmental response.

According to interviewees A and G, the GAMA company uses a standard supplier selection and evaluation system, in which are based on the "norms of ISOTS which, beyond issues of quality […] evaluate the environmental issue by the ISO14000 […], OSAS, which is being implemented and concerns the safety issue with the supplier and also the SA8000, related with social responsibility" (Interviewee G). The GAMA company's supplying criteria and rules are defined in the supplier manual, which was developed together by professionals of several purchase sectors of companies group. This manual consists of items referring, beyond productive capacity, internal work and supply chain safety (issues, goals, monitoring and evaluation criteria about risk and dangerous), environmental issues (monitoring and law compliance, polices to control and prevent pollution and accidents, employess commitment evaluation, hazardous materials control), and social responsibility (ethics code in stakeholders relationships, policies to avoid discrimination and child and slave labour, to monitoring labour law, remuneration practices) […]. The suppliers needs to attend to 50% of the selection questionnaire to continue in the development stage. If the they do not attend to the requisites, "they must develop an action plan for the adequation to the norm" (Interviewee G). The BETA "do not demand supplier certification, but that he attends to their criteria" (Interviewee G). From there on, he is approved and "receives an access password to the Supplier Portal, […] via Internet and can obtain information regarding the non-conformities and the Supplier Performance General Index classification", besides entering the auditory schedule (Interviewee G).

The environmental criteria are also requested for the distributors through a program called DQP, Distributor Quality Procedure, due to the fact that there is "a concern that they have more or less the same behavior and the same face of the company's procedures" (interviewee A). "This DQP involves criteria of environmental management, being that the distributor must at least follow the legislation", but also other factors, which in the case of the ALFA Company, are defined as important factors: selective collection system and effluent treatment system. However, the criteria are different according to the distributors' standards, because "some are only involved in resale and others with manufacture procedures" (Interviewee A). Besides this, the program may undergo auditory, in which "some people are trained to evaluate the distributors […], to see if they are following the criteria or not" (Interviewee A). But there is no standard procedure or systematic related to clients due to the technical restrictions and costs of the product returns. There are some practices or good environmental behaviors, but these are not systematized. As occurs with the return of the some ALFA Company's frigorific vans, which

possess "[…] polyurethane, which form the isolation plate, a material which the distributor would not have a location to place", but the company has "conditions of destining it adequately" (Interviewee A). However, "it is not a practice, neither the system. And neither does every van have to be returned", in spite of the fact that it already has "organization to return, to be entirely destined […]" (Interviewee A). According to interviewee A, the "focus was to produce and make the product leave", but now the returns are a "demand of strategic planning". The main reason of non-return of the BETA Company is the difficulty in reusing or recycling the products due to outwear and contamination by oils especially from the sailcloth and brake pads after their use. Still regarding the logistic issues, it "has a project of reutilization of pallets and certified wood produced by the supplier of fiberglass, which is reused or recycled also by a consumer in the USA" (Interviewee F).

Regarding changes and projects, the ALFA Company seeks to offer its clients "less weight per product, […] to put a greater load, […] and a better gasket in order to avoid losses, as exemplified by the transportation of grains […] optimizing transportation" (Interviewee A). Some very recent studies have been involving the analysis of the life cycle so that "this methodology can truly be incorporated to the company, and the selection of materials can be made considering the analysis of the life cycle". However, interviewee A informed that this analysis is still in the field of ideas.

Despite of the initiatives presented, that consider social and environmental criteria in the procurement process (suppliers manual) and the distributors relationships, some attempts to return and changes in products and process, companies ALFA and BETA are still distant to implement systematic procedures for green procurement, reverse logistic and ecodesign. Because they have not adopted social and environmental variables in a strategic decision level, the policies and practices only refer to operational decisions level. Meanwhile, two suppliers partnerships, which were pointed out by the environmental managers, showed advance in the improvement of the prodution process and product development. These were considered the main cases focused on this study and will be described next.

Case in green manufacturing – painting center project (e-coat, top-coat)

The ALFA Company made a partnership with the German company DELTA for the construction of a new painting center for automotive parts (chassis) in an area of 15 thousand square meters located in the industrial park of Caxias do Sul. The DELTA Company acts in the capital goods segment and possesses advanced technology in the treatment of surfaces, attending the automotive sector in several countries, automakers in Brazil and also white line manufacturers.

The Project Description

The new painting center for chassis whole will have the automated stream technology, electrophoretic painting (e-coat) based on water and finishing bottom (top-coat) over liquid or powder. The stream system consists on stainless steel stripping and particles retention system, following international standards. The electrophoretic painting system (e-coat) that will be used consists on dipping a piece of metal on a bath of paint diluted in water, through which is going through a continuous electrical current. Thus, painting by migration occurs by migrating particles

of pigments floating on water that will be deposited over the pieces by electrical current flows. The Topcoat system is a final painting using polyester powder, without volatile organic solvents.

According to the project coordinator, from ALFA, "this is a project with high investment, a strategic issue" that attends the company's expectations of "always seeking to innovate […] by developing products and processes" (Interviewee C). In 1994, the company decided to change processes especially in the painting area, beginning a research for the evaluation of the ALFA Company's production needs. Only in 2003, after evaluating "alternatives such as fire galvanization, duplication of the current painting system, […] they were able to point out that the best alternative would be E-coating" (Interviewee C). Due to the need to "evolve with the concept, […] they sought a partner for this project", evaluating "the best technologies all over the world" (Interviewee C).

Client and Supplier Relationship

Choosing the DELTA Company involved not only the choice for the best technology, but also the success of "a rehearsal of the system [...] with the upgrade of painting equipments" of the brake producing company of the GAMA group (Interviewee C). This renewal resulted in a painting center built and managed by DELTA, which attends other companies of the group. According to the DELTA Company's representative, other projects of the ALFA Company such as the paint supply center and the modernization of painting and washing booths also counted for the definition of the partnership. Therefore, in 2005, the companies signed a letter of intention for the project and in 2006 they sealed the deal. The project was developed together, in which they defined "from the entries and exits, equipments, disposition and layout" (Interviewee C). According to interviewee C, "[…] ALFA makes the investment and DELTA deals with the project development. DELTA has entire technical responsibility and every approval is of both the ALFA and DELTA companies". The painting center is already in the phase of civil construction, to be managed and contracted by DELTA, which will also handle with the acquisition and installation of national and imported equipments, being that the internal movement is of the ALFA Company's responsibility. DELTA has the following responsibilities: the recruitment of employees and suppliers, following the ALFA Company's criteria, and the beginning of the operations of the new plant, of which the continuity is still in negotiation.

The Project Benefits

The interviewees stressed some advantages of the new system like: durability, efficiency and less environmental impact. For interviewee D, the benefits are especially quality and cost and also durability due to the excellent resistance against corrosion. In terms of quality, the interviewee A pointed out the salt-spray test and humid booth that E-Coat system ensures, respectively, 240h and 150h, while the E-Coat plus the Topcoat ensures 750h and 200h. Interviewees A, C and D saliented the high productivity and automation of the E-Coat, besides a high degree of material transferency due the electrical properties of the deposited layer of ink. This allows painting in areas of difficult access and the uniformity of the thickness of ink, that carries out a low loss of ink, which is next to zero, incurring in economic benefits and environmental. Interviewee D assured also that GAMA will obtain more benefits in costs if DELTA continues the operation of the already installed painting center and takes over the new center. In security matters and environment, interviewee A informed that the painting by electro deposition uses a system based on water, free of heavy metals, given the requirements of

environmental legislation. Interviewee A still believes that these are the most advanced system of waste water treatment, reducing the danger of fire and facilitating the waste water treatment, since the inks are based on water. “The plant also has its own waste water treatment system” (Interviewees A and D).

The Project Barriers

On the other hand, the system presents some disadvantages, such as high initial investment and the fact that the use of E-Coat only permits one color to paint and the Topcoat needs to set it up for different colors. The three interviewees spoke of the complexity of the project, due to the fact that it involves various areas, professionals and companies that already in the phase of definition have demonstrated some resistance to change the painting system. Moreover, interviewee D sees the difficulty in “understanding the clients’ expectations in relation to what he bought, what he expects […] and if he is not answered, to make the alignment […] so that the plant can really attend what he needs”. He also affirms that the size of the new plant and the respective need of workforce will lead to a great effort in training, since the difficulty in finding “capacitated personnel with the knowledge of automation” had been confirmed in a previous project. In terms of painting process, the use of e-coat allows only a single color of paint and top-Coat needs to set up for different colors.

Case in ecodesign – substitution of the asbestos fiber for fiberglass

The great pressure from foreign market, especially the European automotive industry, the company BETA led to a process of replacement of raw material: the asbestos fiber. Thus, for a total replacement of the fiber of asbestos throughout the production process, the BETA developed a partership with the ZETA, the fiberglass , a new solution.

The Production Process Description

The fiber glass, before the asbestos fiber, and phenolic resin (composite agglutinant) are the main component of the BETA’s friction products. They are a result of a “dry mixture of resins, fibers, mineral products, lubricants, abrasives” (Interviewee E). This mixture undergoes a process of conformation (hot pressing for fusion, fluidification and resin covering the whole composition); polymerization, turning into a curved tile; and new pressing and thermal stabilization by baking in order to avoid swelling, dilatations and growth. After this process, the tile is cut, polished, punctured and worn out (use restrictive system), generating waste that together with the waste of the production process are recycled.

Client and Supplier Relationship

The BETA Company “began developing materials without asbestos [...] in 1983 and 1984 with the asbestos elimination programs” (Interviewee E), which was completely eliminated from the production in 2002. In this period, the formulations with asbestos were gradually being substituted. However, in the end of the 1990s, a “great pressure […] from the export clients for a guarantee that there would be no contamination of the asbestos-free formulas with asbestos began” (Interviewee E). For interviewee E, it was “more of a political issue” and he believes that some asbestos fibers do not alter the performance of the product and that the factory’s safety

processes do not result in health problems for the employees[i]. Nonetheless, the external pressures regarding the risks of contamination of not only the employees but also the community and product maintenance professionals made the BETA Company decide, in 2002, that "it would no longer produce materials with asbestos" (Interviewee E). Since it could lead to work law suits, as occurred with the ZETA Company, according to interviewee G's testimony, which requested an agreement with the USA due to the innumerous lawsuits from employees and the community.

The BETA had already worked with fiberglass for 20 years, but to make the change economically viable, it needed to develop, together with the supplier, the ZETA Company, a special type of fiber. Consequently, the BETA Company expended investments and development efforts to test and approve the new input, involving development chemists, application engineers and quality and purchase managers. Due to the high cost of the fiberglass, in the new formulation a smaller quantity of fiber was used in comparison to the asbestos fiber, cheaper complementary raw materials were sought and the process was altered seeking gains in productivity. The release of the product in the market and consequent increase of demand for fiberglass led the ZETA Company to invest in the acquisition of new production equipments. Both parts believe that they maintain a good relationship today, accepting the pressures related to cost on one side and sale increase on the other. However, due to the caution with confidentiality, especially regarding the formulas, they have sealed a deal of exclusivity for 2 years.

The Project Benefits

The process of elimination of the fiber of asbestos products and processes not only ensured the continuity of the relationship with the European automakers, but also gave to BETA the advantage of being the pioneer company in the national market to provide brake lining without asbestos (Interviewee F). The fiber of asbestos substitution also helped the company to avoid to labor problems, especially with abestosis disease. The recycling materials process generate today a reutilization at least 95% of the production waste. In spite of the 40 or more different formulations, most of the BETA Company's demand corresponds to 3 or 4 formulas, making the recycling process of the waste produced easier. With these actions, the company stopped "putting, in 3 years, 22 thousand tons of this powder in the landfill, and […] consuming […] natural minerals" (Interviewee E), besides gaining "price competitivity" (Interviewee E) due to input changes and gains in scale. This phase of waste reuse provided to BETA winner the FINEP award and sell more than 70 million products from 2004 to 2006. They also reached a greater durability of the product and therefore an "acceptable cost-benefit for the user", which, in different markets, control more and more the duration time of the product and the offered price, as well as the time and expenses with vehicle maintenance.

The Project Barriers

The change needs has led to BETA a new challenge, not only to meet the market demands for lower social and environmental impact of products, but also the prodution process efficiency in cost. According to the interviewee E, the issues of costs generated great difficulty for the BETA to replace the fiber of asbestos, that said: "the asbestos which was a much cheaper

[i] Asbestos can cause asbestosis – disease which consists in injuries of the pulmonary tissue caused by an acid produced by the organism in an attempt to dissolve the fibers, possibly leading to lung failure. (http://pt.wikipedia.org/wiki/Asbesto - our translation)

fiber" needed to be replaced for a "fiberglass which was much more expensive". Then BETA Company's invested in research and development to search a new material that minimizate this cost. And also it attended the quality requisites, the new fiber "could not be too long […]" (Interviewee E) due to the difficulties of processing and especially conformation. According to the ZETA representative, "the formulation of the brake lining […] uses different types of powders […] with resin" and that "asbestos is all reticulated, […] very soft […] and the powder agglutinates" easily, differently from the "fiberglass, which is completely leveled […], resulting in difficulties of adherence and conformation. Thus, the ZETA Company's research efforts sought to "provide several products […] in which the variables […] are the numbers of cables per fuse, the length of the fiber and the diameter of monofilament, because the main effect of the fiberglass in the lining is mechanical resistance […]" and also friction, due to the necessity of breakage efficiency of the product. However, the market still produced products with asbestos at lower prices, which led the BETA Company to develop a new project: the reuse of waste (originated from the process). This reuse "is not total," due to the "use of abrasive grains in the compound [...] cause damage in the application of the brake drum against" (Interviewed E).

Conclusion

This study examined the initiatives of the GAMA S.A. group and found that these organizations include environmental requirements on their relationships with suppliers and others members of the supply chain. In turn, customers, international tiers, also pressure companies to improve environmental performance. The cases of the companies ALFA and BETA demonstrated the cooperation of suppliers in process and product modifications, which involve environmental benefits, as well as increased productivity and reduced costs. Nonetheless, these action are not systematic and there isn´t a proposal from structured Green Supply Chain Management (GSCM), thus the environmental assets have been only consequences, not a goal of these initiatives.

The advance of environmental management of GAMA´s group firms, evolving from simple controls to prevent pollution, through environmental management systems and cleaner production programmes, motivated the search for competitiveness through environmentaly-friendly solutions, wich include the suppliers participation. Allied the trajectory of evironmental responsibility, efforts to the development of suppliers are essential factors to the realization Green Supply Chain Management. The example of the GAMA group, that has a structured system of selection and evaluation of suppliers and a pro-environmental culture led to inclusion of environmental criteria in the relationship with suppliers, in case of ALFA, also extended this criteria to distributors. The cases of ALFA and BETA companies reinforced foreign market trend. Meanwhile, the first company search the environmental practices benchmarking, in reponse to more gains in image than by the demands of customers, wich are final consumers. While, the second suffers direct pressure of customers, for the adoption of environmental practices, the example of ISO 14001 certification and of the raw material substituition (asbestos).

The suplliers technologies and products were essential to changes in ALFA and BETA, processes and goods modifications which include environmental benefits. In the first case, the

effort of research and technical responsability is the supplier DELTA, to provide a new painting system that provide greater durabilty to the product, to include new procedures for the surfaces pre-treatment. And minimize the environmental impact, to reduce the use of critical materials (paints and solvents), to use paint based on water and include a treatment effluents system. In the second, there are the contribution of the BETA´s research and development center, seeking the specifications of fiberglass to replace the asbestos fiber and also the supplier ZETA, offering different specification of the requested materials. The efforts of BETA company, not only allowed the substituition of raw material, given the international standards of safety, health and environment, but also the waste recycling, to create a new formulation for its products, causing other environmental benefits beyond.

In addition to the environmental benefits, such example of cooperation between customers and suppliers generated earnings of mutual competitiveness. The painting center project will provide ALFA gains in productivity and costs through automation process and waste reduction, also in quality with a world reference surface finish and a greater durability of the products. While DELTA provides for the continuity of the relationship and the opportunity for new business, the example of the possibility of operation of the both painting centers of the GAMA´s group. The case of the replacement of asbestos fiber for fiberglass, result BETA to continue provide the foreign market and to be innovative in the internal market, being the first to offer the basis brake pads of fiberglass in the country. And the continuity in the product development allows the company to be price competitive, because waste recycling reduced production costs. The ZETA company obtained continuity and increase of fiberglass supply.

Both cases involved efforts of cooperation, customer and supplier financial investments, integration between professionals, sharing information... The close relationship between partners was motivated by the complexity processes and technical difficulties, as companies sought the required skills for the completion of projects in cooperation with suppliers. However, this relationshp was limited by the opportunism risk, leading the companies to perform contracts to ensure the implementation, exclusivity and secret of projects considered strategic by companies.

However, even before the barriers of relationships with suppliers, the initiatives of GSCM have been limited by legal aspects, national context – the example of environmental criteria of GAMA group – and international context– of the requirements of external customers and cars assembly installed in the country. The actions submitted by GAMA group, especially, in the cases of ALFA and BETA, have been prioritized economic gains, reducing costs, increasing productivity, minimizing waste, more than the environmental gains. The companies' professionals consider the use of methods such as product life cycle analisys, providing others changes in products to decrease environmental impact, and the reuse and management of returns, but theses advances in GSCM have been limited by financial investments required for such changes. This organizational behavior restricts the businesses competitiveness to economic gains in the short term, not considerating the benefits of legitimacy to cooperate in the improvement of whole supply chain, and the advances in respect os clean technologies.

Dispite of activities to protect the environment aggregate value through financial benefits and image gains, the managers interviewed had difficulty to link the suppliers management to environmental management. And the professionals involved in the environmental area had difficulty to identify projects with environmental benefits and others members of the supply chain participation. Thus, research in GSCM area, especilly in Brazil, should consider a gap in

knowledge about these new concepts, the rarity these actions and difficulties to obtain information about businesses (access restrition and disclosure constraints), because have been involved strategic issues.

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