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14.1 Environmental management practices within the supply chain: a case study of textile industry

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Abstract

This study analysed the environmental management practices of a textile supply chain responsible for yarn manufacturing, located in Brazil. Using literature as the start point, a questionnaire was developed and applied with key individuals of the company. The results indicated the implementation of environmental tools, such as an environmental management system and the control of environmental aspects of the company, capable of contributing to the improvement of the company's environmental performance. It was also apparent that the environmental practices in the company studied were required for its suppliers, indicating a continuation of the environmental dimension along the supply chain. The relationship between the company and its partners indicates the existence of collaboration based on the joint development of technical and technological innovations and contribution to the improvement of training of employees.

Keywords:

Environmental management practices, Green supply chain management, Textile industry

1 INTRODUCTION

There is extensive use of water and energy to manufacture products in the textile sector[1]. Typically, there isalso 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 [2].

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 [3], several industries depend on the resource and materials produced by textile sector;thismeans 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.

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 [4]. Therefore, it is important that the members of textile supply chain adopt management tools which focus on the control of environmental impacts, reducing, for instance the waste of resource usage and pollution. For that, Vachon and Klassen [5] indicate the green supply chain as an option.

According to Simpson and Power [6], the environmental impacts related to SC member'sactivitiesmight have negativeeffects in the wholesupplychain, mainly the focal company (FC). The FC connectswithbothsuppliers and customers, and makesdecisions about the final manufacturedproduct[7].Any action of itssuppliersthatmaydirectly or indirectlycontradictthe company'sprinciples causes pressures fromcustomers, non-governmentalorganizations (NGOs), and regulatory bodies. These pressure usuallyclaim for guarantees of the SC memeber'spreviousproposedbehavior[8] [9]. For instance, according to Seuring and Muller [10],somecompaniessuch as Nike, Levi Strauss, Disney, Adidas, Benetton and C&A hadproblems in the pastdue to theirown and theirsuppliers' badenvironmental and social conduct, includingpoorworking conditions and environmental contamination.

Therefore, FC isheldresponsible for the environmental and social impacts thatcaused by theirsuppliers. Additionally,the focal companycanbeencouragedby the pressure exerted by the stakeholderspreviouslymentioned, by internal or externalfactors. Internally, the motivations are characterized by costsreduction and productivityrise. External drivers are in turnrelated to the competitiveadvantagefrom the implementation of environmentaltactics[11].

In thiscontext, the green supplychainemerges as an alternative to manage pressure fromdifferentstakeholders. In accordance with Christopher [12], not onlyfinancial, material, and information management arepivotalelements of SCM,but thereisalso the environmental variable must beincludedthrough the cooperationbetween the SC member and FC [13].

The inclusion of environmental dimensions into the goals shared by the entiresupplychaincanimprove the environmental performance of the all production process, fromrawmaterials to the sale to consumers. Accordingto , a mutualdevelopment of the supplychainmembersisstartedwith the insertion of all the stages belonging to manufacture and commercialization of the product, whichmightenable to analyse of the overall impacts caused by the process and to design solutions to these impacts [8].

In this context, this study analyzed the environmental management practices with focus on the supply chain adopted by a textile industry responsible for yarn manufacturing, located in Brazil.

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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 foursections, in which the first brings the problem and the research objectives. Then the methodology used to collect and analyze data as well as the firm characterization where the case study was conducted, is presented. Finally, there are the results and discussion and the final considerations.

2 METHODOLOGY

2.1 Research Design

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 contained two groups of variables, namely:"Environmental Management Function", "Environmental Practices" and "Interaction with Suppliers" (See, Table 1).

The first two groups aimed to analyze the company's internal situation; the first part evaluated the presence of an environmental management department and the professional responsible for the department. The second part analyzed the maturity level of the organization by checking the possible environmental management tactics adopted, also including the potential motivations and barriers faced by it in the decision process for selection of their particular practices.

The environmental management practices in the supply chain wereanalyzed from the point of view of the interaction of the company with its respective suppliers. Both the criteria used to select the suppliers and the environmental practices required of them by the industry studied were investigated and evaluated. Analysis ofthe data collected led to an evaluation of the level of maturity of the environmental management in the company. Also, it was possible to analyse the requirements adopted, and motivations and barriers considered at the time of its adoption as well as the interaction between company and 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" (26-50% of application to reality of the company); "almost always" (51-75% of application the reality of the company), and "always" (76-100% of application to reality of the company). The answers required were obtained from interviews with the director of operations and environmental manager of the studied company.

2.2 Firm Characterization

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

After the process, the material is transported to another factory in São Paulo (southeast of Brazil),for dyeingand subsequent sale to various branches. The main customers are 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%). Figure1 illustrates the supply chain schematically.

The following materials are supplied to the study company: 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.

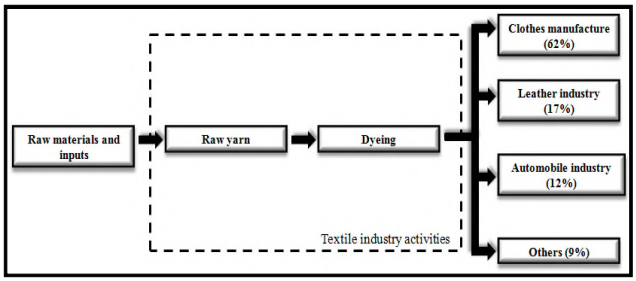

Figure 1: Supply chain –yarn production

The production process for yarn manufacturing is composed of 4 stages (Figure 2). The process begins with the quality control of raw material. The raw material is preparedby washing the cotton and removing undesired wastes (about 18% of the material is discarded after this step). The next step is the manufacture of the yarn through the spinning process. Finally, there is the twist of the yarn to obtain the line.

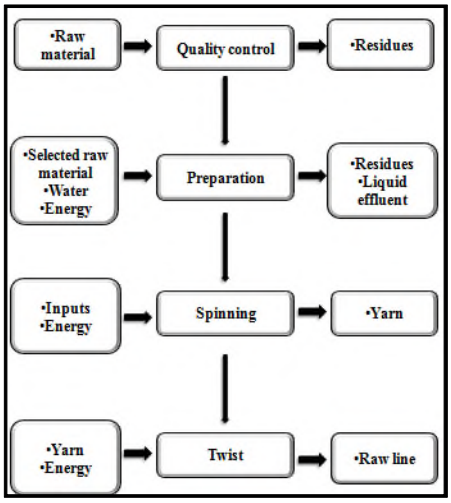

Figure 2: Flowchart– yarn production

3 RESULTS AND DISCUSSION

3.1 Environmental management of the studied company

The industry investigated had a specific department called "integrated management sector" to deal with environmental issues.This sector, which is managed by an engineer,also encompassed occupational health.

Figure 3 illustrates some environmental tactics/strategies adopted by the company studied, in terms of internal control, lifecycle view and quality program.

In terms of internal environmental control, it was claimed that the energy represents a significant impact in the company. In

order to avoid an excessive consumption of electricity to maintain the factory regular functions, the company adopted an energy efficiency plan. This plan included a control and maintenance system to avoid peaks in the electricity used which had as a consequence high costs. Also, the machinery was preventively maintained and programed to work with efficiency around 85%. The plan also encompassed energy use awareness with focus on the proper use of electronic equipment.

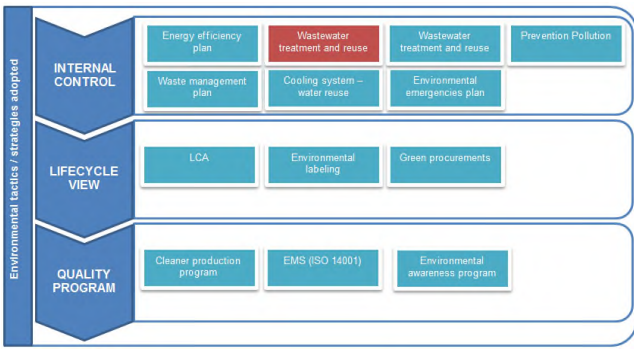

Figure 3: Supply chain – yarn production

In regardto water and wastewater control, it was stated that the water used in the cooling system was reused for gardening. The company had had a wastewater treatment for reuse, however, the system was disabled. Actually, it was requested by government (Public company of water and wastewater treatment) that the wastewater, which had a high level of nutrients due to the presence of natural cotton fibers, was released in the public industrial treatment system. This public system was based on biological treatment and the wastewater could be useful for this system.

In addition, it was reported that a waste management plan was properly implemented by the company studied. The waste plan included the correct transport and disposal of waste, with strategies to better manage the different types of waste and avoiding environmental impacts related to each individual type.

As this is a large company with continuous large-scale production, the risk of pollution and other environmental emergencies are imminent and need to be handled properly to avoid major consequences for the environment and the company's image. Hence, pollution prevention plans and plans for environmental emergencies are recognized by the company, as necessary. Both plans have focused on future fires and possible loss of products, with emphasis on air pollution and soil contamination. To achieve the goals related to the plans, the company has internal rules that stipulate, among other things, banning the burning of any material and flammable waste separation.

Concerning the lifecycle view, it was identified that Lifecycle assessment (LCA), environmental labeling and green procurements were implemented by company. Although, it was said by interviewees that LCA was implemented, they did not comment onwhich product was considered, the results achieved or even present a report.

The environmental labeling is related to the use of raw materials obtained with ecologically friendly procedures and recycling practiced during the manufacture of its products. Finally, the green procurement will be discussed in the next section.

With regard the quality program, Cleaner production (CP) was implemented to reduced wastes in some processes. According to Pimenta and Gouvinhas [14], CP might prevent continuously the waste and reduce the risk of operations for employees, community, and environment. Also, the company implemented Environmental Management System(EMS); however, it was not certificated by a third-party. It is important to note that to achieve a sustainable supply chain, the first step is for the company to follow the principles guided by ISO 14001 [8]. Moreover, Testa and Iraldo [9] indicate the existence of environmental management system as a first step for implementing a green supply chain. The absence of the proper certification was justified by the excessive bureaucracy found during the obtainment procedure.

In addition, toa quality program implemented by company, training and environmental awareness programmeswereprovided for its employees. Environmental awareness wasfocused on environmental issues related to the company operations in a continuous way. Training in turn focused on operational, occupational safety, "behavioral" and "occupational health". Training and environmental awareness are important to guarantee the effectiveness of the implemented practice. This is also pointed out by Sarkis et al. [15], whose research suggests there is a direct relationship between training effectiveness and the environmental practices adopted by the company, and the organizations analyzed in the research have only the adopted practices when the related training was effective.

Regarding the motivating factors for selection and application of current company environmental tactics, it was found that the most important was to comply with environmental law and the multinational standards. As a multinational firm, it could be seen that the company focused on compliance with regulatory bodies of the international market. This same motivation was observed in multinational companies which worked in China according to Zhu et al. [16]. Also, it was reported as a motivation, achievement of operational efficiency, and pursuit for innovations according to market trends. Schaltegger and Synnestvedt [17] claimed that giving attention to market trends related to environmental opportunities leads to economic opportunities, taking into account costs and benefits.

In addition, the search for operational efficiency is considered as a motivating factor as it indicates optimal use of resources and cost savings in the production process. One of the goals of the company is creating an improvement process aimed at reducing waste to zero, which will increase its efficiency.

Regarding the stakeholders, it was not stated that there was a strong pressure by suppliers or clients to change the company’s behavior. On the other hand, the organization itself demanded a positive environmental stance for suppliers.

Also, it was observed some barriers that hinder the adoption of environmental tactics by the company. The main barrier reported was the absence of government support. The study by Lee [13] for small and medium sized Korean companies concluded that there is significant influence from the government to adopt environmental practices as it facilitates the adoption by governmental investments. Thus, there may be no legal distinction between organizations that only fit to

the regulatory standards and those who seek to go beyond and the use the environmental variable in a strategic way [18].

In general the company studiedhas a proactive stance to the environmental management, considering the classification system proposed by Jabour and Jabour[19]. This model classifiesfirms into three different levels: reactive (companiestackle environmental management as a way to meet the legislation), preventive (companies use it in different areas, but do not take it to a strategic level), and proactive (companies seek competitive advantages from the incorporation of environmental management in a strategic way). From the characteristics outlined by Pimenta [20], this classification is justified by the company's commitment through the adoption of different plans to address solutions to the possible impacts of its activities and the investments in training programs to raise its employee's awareness in specific areas.

3.2 Environmental Management in the Supply Chain

Regarding the environmental selection criteria and partnership for improvements, it can be noted that for almost all evaluation criteria (See Table 2) the level of maturity was between "almost always" (51-75%) and "always" (76-100%) 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.

The company required an environmental management system from its suppliers

An environmental management system (ISO 14001) was required by company studied for its suppliers, but the certification of the system for a third-partydid not apply to all cases. As previously discussed, requiring the ISO 14001 certification from suppliers is a simplification of the selection process [19]. 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 company, other factorsare required.

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

In addition, a life cycle assessment was demanded to assess whether the supplier complies with the requirements related to the product. Due to the costs associated with this analysis, the requirement was made only to large suppliers. The logistic department was responsible for selecting the companies, which would carry the LCA, and the department set criteria for the choice. The criteria were based on the characteristics of the raw material that was 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[8] and Testa and Iraldo[9] state the importance of LCA for opportunities of cost reductions and replacing materials with more efficient ones. Nevertheless, it is very difficult to analyze anagricultural process and LCA can become more costly than expected, which does not benefit the supplier.

The company also practices activities considered by Simpson Power [6] as belonging to a collaborative relationship with suppliers through actions to support the development of suppliers, including training, technical and technological collaboration.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.In a general way, there was sharing of information and the company's commitment to improving the environmental performance of its partners. These attitudes were assessed by Simpson Power [6] as important to collaboration to the joint improvement of whole supply chain.

During the second-party audit, the presence of operational, occupational safety, environmental and occupational health training at the supplier's factorywere investigated. 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 bythe trainingduring the annual internal week of environmental awareness with key manager related to sustainability. Thus, the focal company could understand the individual vision of its partners on the importance of the environmental dimension. Also, the environmental management level of its suppliers could be improved when deficiencies were found.

Other collaboration activities conducted by the company were environmental emergency assistance and aid in the implementation of activities such as Cleaner Production Programmes and EMS. During the second-party audit, the main weakness was identified in order to closelywork with the supplier to ensure that all important environmental aspects and impacts were well controlled.

The support for implementation of CPprogrammes and EMS (ISO 14001) was conducted by the company at its facilities through training. Managers from supplies were trained on the process of implementation and benefits of these environmental programmes.

Therefore,it can be note that not only the company requested some selection criteria for its suppliers but also helped to implement what was requested, in this case two environmental programmes (CP and EMS). According to Seuring and Muller [10], this relationship between requesting and support is essential to help suppliers to achieve the standards established by focal company.

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 in materials and products standards.

Thus, it was found that all of the selection criteria were evidenced as practiced in the management routine of the

company, being a documented procedure and a contractual clause.

From what has been discussed, it is considered that in addition to communicating with its suppliers, the company showed commitment to changing the environmental behavior of its partners. The company worked with its suppliers according to the previously cited classification of Simpson and Power [6] hence it can be noted some collaboration with suppliers in terms of training and technological sharing.

In general, it can be considered a limiting factor in this research the fact that much of the 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 the focus on only one company, and the specific individual situation of this supply chain of textile production.

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.

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

4 CONCLUSION

This paper focused on some selection criteria of suppliers and partnership intended to improve their environmental conduct 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 [6]. Direct involvement activities confirm 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 suppliers' initial 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 seen here as an essential factor for 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 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 tiers. There are a small number of suppliers in this study. This fact can explain the level of investment made andthe control of the focal company studied in its supply chain, mainly conducted by audits.

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Table 1: Variables adopted in the questionnaire

Group of variables	Variables	Source
Environmental management sector	EM sector Existence	[15] [21]
	Professional responsible	
Environmental tactics	Implementation of EMS - 14001	[8] [9]
	*Internal control (*energy efficiency plan, waste management plan, wastewater treatment and reuse, environmental emergency plan, prevention pollution.); *Lifecycle view (*LCA, Environmental labeling and green procurement); *Quality (*EMS – ISO 14001, Cleaner production and training and environmental awareness)	[15] [22]
	Barriers to adoption of practices (Absence of requirements by law, government support, suppliers' pressure, customers' pressure, operational benefits and Low level of market trends focused on environmental management)	[13] [18]
	Motivations to adoption of practices (Compliancewithlegislation, Adequacy to the multinational standards ,Existence of government support, Suppliers' and custumers' pressure, Operationalcostreduction, Operationalefficiency and Innovations to meet market trends)	[16] [17] [23] [24]
Interaction with suppliers	Implementation of EMS - 14001	[9] [19]
	Environmental authorization from government	[25] [26]
	Environmental law compliance	
	EMS Tools (LCA, cleaner production, environmental control plan – waste, energy usage and pollution prevention, training and environmental awareness, internal and external recycling, second audit)	[5] [6] [8] [9] [10] [27]
	Cost and quality	[6]

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

Adoption of criteria/demands	Suppliers			
	Cotton lint	polyester fiber lint *	Cardboard boxes and wooden pallets	Polyester film for packing line
Product quality	A	A	A	A
Product price	A	A	A	A
Transportingcosts	A	A	A	A
Preference for experiencedcompanies	AA	A	AA	AA
Compliancewithlegislation	A	A	A	A
Environmentallicense	AA	A	A	A
Implemented EMS	A	A	A	A
EMS (ISO 14001)	AA	A	AA	AA
Cleaner production programs	AA	AA	AA	AA
Waste Management Plan	A	A	A	A
EnergyEfficiency Plan	A	A	A	A
Prevention pollution plan	AA	A	A	A
LCA	A	AA	AA	AA
Internalrecycling	R	A	A	A
Externalrecycling	AA	A	A	A
Environmental performance assessment	R	AA	AA	AA
Sustainability reports	R	AA	AA	AA
Environmentallabeling	AA	AA	AA	AA
Training programs withpartners	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, CP)	AA	AA	AA	AA
Rewards for behavior change	AA	AA	AA	AA

Legend: A: always; AA: almost always, R: rarely / * continuous filament polyester and continuous nylon filament

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