GREEN SUPPLY CHAIN MANAGEMENT PRACTICES IN THE BIGGEST SOUTH BRAZILIAN COMPANIES

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ABSTRACT

The purpose of this article is to analyze the existing relationship between Green Supply Chain Management practices and the economic and environmental performance in large companies. For this, it was considered a sample composed by the largest companies in southern Brazil. The questionnaire used is composed of 46 questions and was adapted from the studies of Zhu and Sarkis (2004) and Sharma et al. (2017). The management practices of the supply chain and environmental and economic performance were analyzed. The results showed that cooperation strategies have not been widely used by the companies and that in practice internal management differs in relation to the postulates of the environmental policy and the expressed strategic objectives. In relation to the concept of sustainable production, there is a great concern to adhere to ecological practices either internally or with suppliers. Furthermore, the variables involving clients and reverse logistics have not presented enlightening results. The companies studied showed to use more prominently the practices of internal environmental management, sustainable manufacturing and ecodesign. The study also makes it possible to conclude that Green Supply Chain Management Practices had no impact on economic performance.

INTRODUCTION

Traditionally, supply chain management focused mainly on optimizing the acquisition of raw materials from the best suppliers and distributing products efficiently to customers. Extending the traditional supply chain is to allow the consideration of the immediate and future eventual environmental effects of all products and processes (Beamon, 1999). Sustainable supply chain management is a company-wide effort and is more than simply implementing some ecological practices, it is a coherent approach to improving the environmental and organizational performance at all company levels (Zhu et al. 2007) and has motivated companies to work to protect the environment for future generations (Sharma et al., 2017), since the balance of economic and environmental performance has become increasingly important for organizations facing market, regulatory and consumer pressures (Shultz and Holbrook, 1999).

The concept of sustainable supply chain aims to eliminate or minimise waste of resources such as energy and materials, in addition to minimizing negative environmental impacts such as emission of polluting gases and toxic waste, at all stages of the life cycle of a product, from the extraction of raw materials to the use of the product by consumers and their elimination at the end of the life cycle. Among others, the resulting benefits are the following: cost reduction, it facilitates entry into the global market, reduction in energy consumption, substitution of old by new and innovative materials and raw materials, waste reduction, integration of suppliers in the decision-making process, differentiated buying strategies, competitive advantage and improved relationship with regulators (Rao and Holt, 2005; Andrade and Paiva, 2012).

Sustainable supply chain management (SSCM) arises as a new concept of corporate environmental responsibility, but it has been introduced slowly due to factors such as the characteristics of the markets, companies are still focused on internal aspects, lack of stringent laws and low pressure of consumers. However, more effective solid waste policies, pressures from the international market and the search for environmental certification have contributed to the adoption of sustainable management practices in a growing number of companies (Alves and Nascimento, 2014).

Conceptual research within the framework of SSCM has grown in recent years, but research about what is actually being done by organizations is still scarce (Seuring and Muller, 2008). The literature on SSCM practices has gaps in the analysis of existing formal structures, processes adopted by companies and the degree to which they are

implemented (Sehnem and Oliveira, 2016). The awareness that environmental impacts occur at all stages of the life cycle of a product is a determining factor for organizations to act strategically in the planning and execution of more ecological processes, involving customers from product design to final consumer delivery.

When we have important levels of industrialization, the issues related to SSCM become even more critical. In this way, it is important to understand the relationship between the levels of adoption of Green Supply Chain Management practices and the economic and environmental performance in companies.

The discussion of whether the SSCM practices adopted by companies support better economic and environmental performance, has been the subject in several international studies in particular, Zhu and Sarkis (2004), Zhu et al. (2007), Srivastava (2007), Bose and Pal (2012), among others.

SUSTAINABLE SUPPLY CHAIN MANAGEMENT PRACTICES

Ecological supply chains differ from traditional chains, since the management of sustainable supply chains implies the integration of the whole process, including planning, supply, production, consumption and reverse logistics (Rini, 2015). The management of sustainable supply chains includes environmental administration, closed-chain supply and a broad perspective of value generation for the organization and the society (Bose and Pal, 2012). Whereas there are key activities for the implementation of SSCM in organizations and that an important component in the project and analysis of the supply chain is the establishment of appropriate performance measures (Beamon, 1999), there is a set of main activities to be highlighted in particular: ecodesign, internal environmental management, sustainable manufacturing and sustainable logistics.

Ecodesign is a useful tool to improve the environmental performance of companies (Lenvis and Gretsakis, 2001) without creating a negative compensation in terms of cost and functionalities (Green Jr. et al., 2012), being mentioned also as conscious design, considering the process and the life cycle of the product (Srivastava, 2007).

On the other hand, issues related to environment safety and sustainability practices such as the reduction of material and/or energy, reuse, recycling, recovery of material and processes that prevent the use of hazardous materials integrate ecological design (Kafa et al., 2013).

A determining factor in the success of ecodesign is internal cooperation across the organization and external cooperation with partners throughout the supply chain (Lenvis and Gretsakis, 2001).

Internal environmental management is the key to improve business performance (Carter and Carter, 1998). The support of senior managers is necessary and often a key factor for the adoption and successful implementation of most innovations, technologies, programs and activities (Hamel and Prahalad, 1989). Furthermore, to ensure complete environmental excellence, top management must be fully compromised (Rice, 2003). The practice of SSCM must take into consideration all processes and must have strategic direction.

Sustainable manufacturing is defined as production processes that use inputs with relatively low environmental impacts, which are highly efficient and generate little or no waste or pollution. Green manufacturing can lead to lower consumption of raw materials, gains in production efficiency, reduction of environmental expenses and occupational safety and improved corporate image (Ninlawan et. al., 2010).

Generally, the transport component is the most important activity within the logistics systems (Ivascu et al., 2015) and has a significant impact on the environment (Coyle et al., 2010; Cioca et al., 2015). On the other hand, reverse logistics operations are significantly more complex than traditional supply flows (Amini et al, 2005). The reverse logistics focuses on the planning, implementation and control of the flows of materials, inventories, finished products from the point of consumption to the production aiming to recover the value or lead to an adequate return (Lai and Wong, 2012).

As a result of ecological concern, companies seek economic performance, referring to profitability in general and environmental performance that is usually linked to the reduction of energy consumption and waste production. In addition, linking the supply chain performance with the manufacturing sectors, environmental performance must include the reduction of air emissions, waste water and solid waste, as well as the decrease in the consumption of Hazardous materials (Zhu et al., 2005).

RESEARCH METHODOLOGY

The population of this research was composed by the companies of the southern region of Brazil, which participate in the ranking of Revista Amanhã (2017). Three hundread companies were selected, the 100 largest in the states of Paraná, Santa Catarina and Rio Grande do Sul. From these, 35 companies give a response. It was used as a research tool adapted from the questionnaire of Zhu and Sarkis (2004) and Sharma et al. (2017), comprising three blocks. The first focused on the company's profile, comprising: branch of activity, number of employees, and gross revenue in 2016. The second with thirty questions about SSCM practices: (i) ecodesign; (ii) internal environmental management; (iii) sustainable manufacturing; (iv) sustainable logistics; (v) cooperation between suppliers and consumers. The third section with 12 issues subdivided into: (i) environmental performance and (ii) economic performance.

For the analysis of the data it was used descriptive statistics, the analysis of the entropy, the Pearson's

correlation and the canonical correlation was used in order to observe linear relationships.

ANALYSIS AND DISCUSSION OF RESULTS

Ecodesign

Considering the sample of 35 companies investigated, some interesting results were obtained with the application of descriptive statistics and entropy about the information on SSCM practices. These results suggest that companies have a higher degree of agreement in terms of ecodesign particularly, through the use of practices involving the elaboration of projects that foresee the reduction of the use of toxic materials in manufacturing. On the other hand, the development of products in a collaborative way has not been widely used by companies. Zhu and Sarkis (2004) note that ecodesign is a useful and practical technique for improving the environmental performance of manufacturers, addressing product functionality while minimizing the environmental impacts of the life cycle. Thus, it is inferred that the sample companies can improve their planning strategy by entering customers and vendors at that stage, since there is a dependency relationship throughout the chain. Thus, we may expect the development of these relationships.

Internal environmental Management

Companies agree to the use control systems based on environmental laws and regulations and regulatory compliance audits. According to Rivera (2004), the regulatory coercive power exerted by governments pressures the adoption of ecological practices and influences organizations to adopt SSCM initiatives. The findings indicate that the written declaration of Environmental Policy and strategic objectives resulted very relevant in the responses given by respondents, which reaffirms the influence of regulatory pressures on SSCM practices. Regarding the commitment of the board of directors with SSCM, companies agree that there is this commitment, which may not be written, but perceived by the respondents and effectively applied by them. Hamel and Prahalad (1989) claim that the high-level management of a company is ultimately responsible for maximizing shareholder wealth.

Sustainable manufacturing

The variable related to the control of expenses and control information system presented a greater agreement of application, suggesting that there is great concern about the amount of expenditure involved in the production process. The variables related to energy efficiency technologies and the impact of sustainable manufacturing in the company's image showed greater variability in relation to the agreement of use by the respondents. This can be an opportunity to make improvements in these companies, as initiatives at the level of SSCM can improve the value of the company's brand, and create a positive impression on the company in the various stakeholders. SSCM can also be seen as an opportunity to develop new lines of business that may become profitable in the future (Bose and Pal, 2012).

Sustainable logistics

The variable related to the packaging for transport has greater agreement among the respondents, suggesting that there is a real concern about planning the packaging to reduce its environmental impact, directly or indirectly. The variables related to the use of alternative transport and reverse logistics systems to collect recycling/reuse products, showed greater variability in the responses, which may be related to the lack of regulation about packaging in some sectors.

Cooperation between suppliers and consumers

There are indications of cooperation with suppliers for the definition of environmental objectives, but the environmental audit for supplier management and the cooperation with suppliers for cleaner production systems deserve deepening, as the answers were disparate. According to Geffen and Rothenberg (2000), the relations with suppliers help in the adoption and development of innovative environmental technologies, since the economies of scale and synergies of the interaction between customers and suppliers and the establishing of research and development agreements lead to improvements in environmental performance.

Environmental Performance

It was possible to see that the reduction in the emission of pollutant gases and the reduction of liquid waste have a greater discrepancy between the respondents. The studies of Frosch (1994) and Geffen and Rothenberg (2000) demonstrated that SSCM practices can improve environmental performance, while the studies of Levy (1995) and Wagner et al. (2001) showed the opposite, that is, the adoption of SSCM practices not contributed to environmental performance.

Economic Performance

The results showed that the variables related to the reduction of the cost of treatment of liquid and/or solid waste and the increase in operational costs showed greater variability among the respondents. Perotti et al. (2012) researched the economic impact of SSCM practices on logistic operators in Italy and identified that in these companies there was a reduction in energy consumption, waste treatment and purchase of materials. On the other hand, there was an increase in investment costs and staff training. It is also observed that the variable with greater homogeneity of responses was the increase in investments in innovation, considering the ecological aspects, reflecting the biggest concern of companies in thinking strategically their ecological chain.

The results indicate that companies have used more emphasis on the practices of internal environmental management, sustainable manufacturing and ecodesign.

The findings are aligned with the research of Khan and Qianli (2017) and the Root et al. (2017). However, the greatest diversity of responses has been achieved in the use of practices involving sustainable logistics and cooperation between suppliers and consumers.

Table 1 - Green supply chain management and performance practices

Dimension	TD Resp.%	PD Resp.%	NR Resp.%	PA Resp.%	TA Resp.%	Average	Entropy	Weight
ECO	2,86	1,43	7,86	44,29	43,57	4,24	0,9976	0,0926
GAINT	1,71	0,00	1,71	23,43	73,14	4,66	0,9992	0,0299
FASUST	4,49	0,82	4,90	32,24	57,55	4,36	0,9978	0,0850
LOGSUST	15,24	4,76	16,19	35,24	28,57	3,57	0,9954	0,1730
CFCACJ	11,07	10,00	16,79	40,00	22,14	3,52	0,9899	0,3813
PA	4,29	1,43	19,29	48,57	26,43	3,91	0,9960	0,1497
PE	3,57	8,57	34,64	39,64	13,57	3,51	0,9977	0,0885
Total Entropy							6,9736	1,0000

Source: Data from the research.

In relation to sustainable logistics, the results are similar to those found by Laosirihongthong et al. (2013), which identified low adoption, not being associated with any measure of performance. Furthermore, Lau and Wang (2009) emphasize that the adoption of reverse logistics in the Chinese electronic industry suffers from lack of required laws, cost of prohibitive investment and low public awareness about environmental protection. Root et al. (2017) also found low association between sustainable logistics and economic performance.

In relation to cooperation between suppliers and consumers, research findings differ from other studies, such as Green Jr. et al. (2012), which have identified that cooperation with customers directly impacts environmental performance and indirectly economic performance. On the other hand, Zhu et al. (2007) did not find positive relationship between cooperation with clients and environmental or economic performance for manufacturers in China.

Table 2 demonstrates Pearson's correlation between the dimensions defined to characetrize green supply chain management practices and performance in this research.

Table 2 - Pearson correlation between the variables

Var.	ECO	GAINT	FAUST	LGSUST	CFCACJ	PA	PE
ECO	1,00	0,078	0,532***	0,137	0,021	0,357**	0,274
GAINT	0,078	1,00	0,126	0,010	0,225	0,183	0,101
FAUST	0,532***	0,126	1,00	0,261	0,112	0,606***	0,319
LGSUST	0,137	0,010	0,261	1,00	0,321	0,166	0,021
CFCACJ	0,021	0,225	0,112	0,321	1,00	0,236	0,232
PA	0,357**	0,183	0,606***	0,166	0,236	1,00	0,554***
PE	0,274	0,101	0,319	0,021	0,232	0,554***	1,00

*** Significance at the 1% level; ** Significance at the 5% level.
Source: Data from the research.

The results indicate that the greater the eco-design practices, the greater the sustainable logistics practices and this results in greater environmental performance. The result found is aligned with the research for Root et al. (2017). It is concluded that high environmental performance impacts on economic performance and therefore can be considered that high environmental performance makes the organizations reach a better economic performance.

Following the analysis of the descriptive statistic, entropy and Pearson correlation between the sets of variables of green supply chain management practices and environmental and economic performance, the computation of the canonical correlation was performed to test the existence of relationships between the variables that comprise the analyzed groups. The result sobtained by calculating the canonical correlation between the set of variables of the Ecodesign Group (ECO) with the set of variables of the environmental Performance Group (PA) did not present significant P-value at the level of 5% and therefore it is not possible to make inferences about the impact of ecodesign on environmental performance. The same is true for sustainable logistics and cooperation between suppliers and consumers for joint actions. Such findings corroborate the study of King and Lenox (2001) in which no significant link was found between sustainable supply chain management practices and environmental performance. However it differs from the studies of Green Jr. et al. (2012) and Zhu et al. (2007) Where such a relationship was significant.

There was also no significant relationship between the variavbles related to green supply chain management practices and economic performance. Therefore, it was not confirmed that green supply chain management practices that comprise eco-design, internal environmental management, sustainable manufacturing, sustainable logistics and cooperation between suppliers and consumers for joint actions impact on economic performance.

The results presented in Table 3 point out that the correlation between internal environmental management and environmental performance was 74.08%, with a strong association, being the significance level of 0.0771, i.e. less than 10%. In this way, we may conclude that the adoption of practices involving internal environmental management affects the level of environmental performance in companies.

Table 3 - Canonical correlation between internal environmental management variables and environmental performance variables

N.º	Value	Canonical Correlation	Wilks Lambda	Chi-Square	D.F.	P-Value
1	0,54879	0,740804	0,24622	39,2427	28	0,0771*
2	0,28278	0,53177	0,54569	16,9596	18	0,5259
3	0,17233	0,415129	0,76084	7,65322	10	0,6627
4	0,08073	0,284148	0,91926	2,35721	4	0,6704

** Significance at the 10% level.
Source: Data from the research.

This finding demonstrates the importance of internal environmental management, especially the commitment of high level managers and the support of middle-level managers, being necessary for the development of the sustainable management of the supply chain of any company in almost every place in the world (ZHU; Sarkis, 2004).

Table 4 presents the coefficients of the group of variables related to internal environmental management in relation to the environmental performance group of variables.

Table 4 - Coefficients for the canonical variables of internal environmental management and environmental performance

Groups	Var.	Linear Combinations			
		1	2	3	4
Internal Environmental Management	GAINT1	0,437731	0,507332	0,321485	0,422294
	GAINT2	-1,03455	0,653767	-0,549093	0,090497 1
	GAINT3	-0,26392	0,047238 9	0,110277	-0,547184
	GAINT4	0,262294	0,326185	0,035458 4	0,086331 2
	GAINT5	-0,103455	-0,220845	0,834995	-0,686681
	GAINT6	-0,195457	0,110192	-0,799599	-0,659433
	GAINT7	0,91534	0,202544	0,216448	0,139776
Environmental Performance	PA1	0,438973	0,434853	0,701924	-1,02531
	PA2	0,017411 3	-0,110683	-1,51052	0,253955
	PA3	0,698463	0,197872	0,687177	0,641136
	PA4	-0,53477	0,797263	-0,087096 6	0,372262
R1 – Canonical Correlation		**0,7408**	**0,5318**	**0,4151**	**0,2841**

Source: Data from the research.

It is observed that the coefficients that correspond to the first canonical pair present a tendency of greater commitment of the board with the management of sustainable supplies (GAINT1, 0.4377), the certification by ISO 14001 (GAINT7, 0.9153) and the inexistence of a written declaration of Environmental Policy and strategic objectives (GAINT2,-1.0345) are determinants for the greater reduction in emission of pollutant gases (PA1, 0.4389), for the greater reduction of solid waste (PA3, 0.6984) and for the lower reduction of occurrence of environmental accidents (PA4,-0.5347).

Table 5 presents the result of the canonical correlation between the set of variables related to the sustainable Manufacturing Group (FASUST) with the set of variables of the environmental Performance Group (PA).

Table 5 - Canonical correlation between sustainable manufacturing variables environmental performance variables

N.º	Value	Canonical Correlation	Wilks Lambda	Chi-Square	D.F.	P-Value
1	0,61297	0,78292	0,201322	44,8798	28	0,0227**
2	0,36135	0,60113	0,52018	18,3002	18	0,4360
3	0,12895	0,3591	0,814508	5,74477	10	0,8362
4	0,06490	0,25477	0,935091	1,87912	4	0,7580

** Significance at the 5% level.
Source: Data from the research.

The results point out a strong correlation in terms of the first linear combination between sustainable manufacturing and environmental performance – which was 78.29%, at the significance level of 0.0227, i.e. less than 5%. In this way, the premise is that the adoption of practices that involve sustainable manufacturing affects the level of environmental performance in companies.

Table 6 exposes the coefficients of the set of variables of the sustainable manufacturing group with respect to the environmental performance group.

Table 6 - Coefficients for the canonical variables of the sustainable manufacturing group and the environmental performance group of variables

Groups	Variables	Linear Combinations			
		1	2	3	4
Sustainable Production	FASUST1	-0,18500	-0,065804	0,516871	-0,24253
	FASUST2	0,16074	-0,003252	-0,21342	-0,59283
	FASUST3	0,03219	0,339714	-0,45590	-0,15013
	FASUST4	0,26612	0,35747	-0,55064	0,239362
	FASUST5	-0,26789	0,36120	0,906295	0,980679
	FASUST6	-0,78630	-0,34148	-0,67061	-0,30931
	FASUST7	-0,29745	0,33344	0,218692	-0,65425
Environmental Performance	PA1	-0,97177	-0,13345	0,938729	-0,28703
	PA2	-0,14682	0,096507	-1,49481	0,305582
	PA3	0,33053	0,754502	0,460921	-0,72062
	PA4	0,12018	0,612012	0,108666	0,816678
R1 – Canonical Correlation		**0,7829**	**0,6011**	**0,3591**	**0,2547**

Source: Data from the research.

The results of the coefficients of the first canonical pair suggest that a reduced use of emission control of pollutant gases (FASUST6,-0.7863) impacts on the lower reduction in emission of pollutant gases (PA1,-0.9717). In this sense, regulatory pressures tend to unleash greater control in the companies, directly impacting on the environmental performance.

CONCLUSIONS AND FURTHER RESEARCH

The objective of the study was to verify the relationship between the adoption of SSCM practices in the economic and environmental performance of the biggest companies in the southern region of Brazil. For this purpose, a descriptive research was conducted by means of a survey and a quantitative approach was developed, in a sample of 35 companies, which includes the largest companies in southern Brazil, classified by the magazine "Revista Amanhã" in the year 2016.

The study used questionnaire adapted from the studies of Zhu and Sarkis (2004) and Sharma et al. (2017), with 46 questions about supply chain management practices (ecodesign, internal environmental management, sustainable manufacturing, sustainable logistics, and cooperation between suppliers and consumers for joint actions) and environmental and economic performance.

Research findings show that companies have used more emphasis on internal environmental management practices, sustainable manufacturing and ecodesign. The greater diversity of responses is related to the use of practices that involve sustainable logistics and cooperation between suppliers and consumers. The results indicate that the greater the practices of ecodesign, the greater the practices of sustainable logistics and that they contribute for a greater environmental performance. In this sense, it is suggested that high environmental performance impacts positively on economic performance.

On the other hand, it was not possible to make inferences about the impact of eco-design, sustainable logistics and cooperation between suppliers and consumers for joint actions in environmental performance. The results of the canonical relationship did not point out a significant relationship between SSCM practices and economic performance. Finally, the results suggest a strong association between internal environmental management and environmental performance, as well as sustainable manufacturing and environmental performance.

Environmental issues affect business worldwide and SSCM is strongly related to organizational environmental issues such as industrial ecosystems, industrial ecology, product lifecycle analysis, extended accountability responsabilities for producers (Zhu et al. 2005). The results of this research corroborate the need for deepening the studies on SSCM, taken into consideration the divergent results about the relationship between SSCM practices and environmental and economic performance.

The results of the study are limited to the sample of companies investigated, because the number of respondents does not correspond to the probabilistic criterion for generalization. Another factor that should be considered is the possible bias traditionally associated to surveying.

For future research, it is recommended to enlarge the sample and develop further analyses for different sectors. In addition, new studies can analyze variables such as: return on investment, competitiveness, brand strategies, seeking to explain the adoption of ecological practices under an economic perspective.

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