

# GREEN LOGISTIC COST MANAGEMENT IN SOUTHERN REGION OF BRAZIL

Engelage, Emanuele<sup>1</sup>  
Borgert, Altair<sup>2</sup>

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## ABSTRACT

This study analyses the practices of green logistic and costs management in an agroindustry in the southern region of Brazil. Interviews with a semi-structured script, follow-up of internal processes and inquiries on websites, in management reports and account plans were conducted, for analyze the company's adherence to the 84 practices identified in the literature and organized into nine components, identify other practices not listed, verify the cost elements linked to these practices and how the company manages these costs. The results indicate that the company uses about 83% of the analyzed practices, with the inclusion of six not mentioned in the literature. For practices not introduced or partially used, potentialities and ways of improvement have been verified. The component with the lowest adherence is green marketing. The loading and unloading, packaging, storage and green production have 100% of the practices used by the company, even if partially. However, for the green transport has an adherence of 95.8% (23 of the 24 analyzed). We identified 70 cost elements, many of which exist regardless of ecological practices, but are affected by them. To manage them, the company performs comparative analysis through an integrated information system that tracks data at analytical levels. Some information is entered into the system in isolation and others can be computed from the following accounting period. Many practices are carried out without the perception that they are socio-environmental actions, but their analysis and monitoring can serve as a basis for strategic decision-making and for the realization of sustainable marketing, including the preparation of the Sustainability Report, which the company intends to disclose in the future. In addition, the results serve as a guide to other companies, even if from different segments, by favoring the understanding of the theme and the existing possibilities and providing indications of how to execute them.

**Keywords:** Agroindustry, Brazil, costs management, Green logistic, sustainability, socio-environmental, southern region

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<sup>1</sup> Bachelor in Accounting (Universidade do Contestado-UnC, Brazil); Specialist in Accounting and Controlling (Universidade Comunitária da Região de Chapecó-UNOCHAPECÓ, Brazil); Master's Degree in Accounting (Universidade Federal de Santa Catarina-UFSC, Brazil); Doctoral Student of the Programa de Pós-Graduação em Contabilidade-PPGC (UFSC, Brazil). Member of the (Research Group) Grupo de Gestão de Custos-GGC, UFSC, Brazil. *Postal address:* Universidade Federal de Santa Catarina, Centro Sócio-Econômico, Departamento de Ciências Contábeis. Campus Universitário-Trindade. Trindade, 88040900. Florianópolis, Santa Catarina, Brazil. Caixa-postal: 476. *ORCID:* <https://orcid.org/0000-0002-9243-5209>. *Phone:* +55 (49) 99923-3629; *e-mail:* manuengelage@hotmail.com

<sup>2</sup> Bachelor in Accounting (Universidade Federal de Santa Catarina-UFSC, Brazil); Master in Administration (UFSC, Brazil); Doctor in Production Engineering (UFSC, Brazil). Full Professor at the Universidade Federal de Santa Catarina-UFSC; Coordinator of the (Research Group) Grupo de Gestão de Custos-GGC, UFSC, Brazil. *Postal address:* Universidade Federal de Santa Catarina, Centro Sócio-Econômico, Departamento de Ciências Contábeis. Campus Universitário-Trindade. Trindade, 88040900. Florianópolis, Santa Catarina, Brazil. Caixa-postal: 476. *ORCID:* <http://orcid.org/0000-0002-0116-8089>. *Phone:* +55 (48) 98404 1503; *e-mail:* altair@borgert.com.br

## RESUMEN

Este estudio analiza la adecuación de las prácticas de logística verde y la gestión de costos en una agroindustria en la región sur de Brasil. Se realizaron entrevistas con base en una guía semiestructurada, así como seguimientos de procesos internos e investigaciones en el sitio Web, a través de informes de gestión y de planes de cuenta, con el fin de analizar la adherencia de la empresa a las 84 prácticas identificadas en la literatura y organizadas en nueve componentes, identificar otras prácticas no enumeradas, verificar los elementos de costo vinculados a estas prácticas y analizar cómo la empresa gestiona estos costos. Los resultados indican que la compañía utiliza aproximadamente el 83% de las prácticas analizadas, con la inclusión de seis no mencionadas en la literatura. Para las prácticas no introducidas o parcialmente utilizadas, se verificaron potencialidades y formas de mejora. El componente con menor adherencia es el marketing verde. En los componentes de carga y descarga, embalaje, almacenamiento y producción verde la empresa emplea 100% de las prácticas de logística verde identificadas, aunque lo hace parcialmente. El transporte verde tiene una adherencia de 95,8% (23 de las 24 analizadas). Fueron identificados 70 elementos del costo, muchos de los cuales existen independientemente de las prácticas ecológicas, si bien se ven afectados por ellas. Para gestionarlos la empresa realiza análisis comparativos, a través de un sistema de información integrado que rastrea los datos a niveles analíticos. Algunas informaciones se ingresan en el sistema de forma aislada y otras se pueden calcular a partir del siguiente período contable. Muchas prácticas se llevan a cabo sin que sean percibidas como acciones socioambientales. No obstante, su análisis y seguimiento pueden servir como base para la toma de decisiones estratégicas, así como para la realización de un marketing sostenible, incluyendo la elaboración del Informe de Sustentabilidad, que la empresa pretende divulgar en el futuro. Además, los resultados sirven de guía para otras empresas, incluso de diferentes segmentos, al favorecer la comprensión del tema y de las posibilidades existentes y proporcionar indicativos de cómo ejecutarlas.

**Palabras clave:** agroindustria, Brasil, gestión de costes, logística ecológica, sostenibilidad, socioambiental, región sur

## RÉSUMÉ

Cette étude analyse l'adéquation entre les pratiques de logistique verte et la gestion des coûts dans une agro-industrie de la région sud du Brésil. Des entretiens ont été menés avec un scénario semi-structuré. De même on a réalisés des suivis des processus internes et des vérifications sur le site web, aussi bien dans les rapports de gestion et dans les plans comptables. Le but étant d'analyser l'adhésion de l'entreprise aux 84 pratiques identifiées dans la littérature de base. Ces pratiques ont été organisées en neuf composantes pour identifier d'autres pratiques non répertoriées, et vérifier les éléments de coût liés à ces pratiques et la manière dont l'entreprise gère ces coûts. Les résultats indiquent que l'entreprise utilise environ 83% des pratiques analysées, avec l'inclusion de six pratiques non mentionnées dans la littérature. Pour les pratiques non introduites ou partiellement utilisées, les potentialités et les formes d'amélioration sont vérifiées. La composante qui suscite le moins d'adhésion est le marketing vert. Les pratiques de chargement et de déchargement, d'emballage, de stockage et de production verte sont utilisées à 100% par l'entreprise, même si elles sont partielles. Le transport vert a un taux d'adhésion de 95,8% (23 des 24 analysés). 70 éléments de coût sont identifiés, dont beaucoup existent indépendamment des pratiques écologiques, mais sont affectés par elles. Pour les gérer, l'entreprise effectue des analyses comparatives au moyen d'un système informatique intégré qui suit les données aux niveaux analytiques. Certaines informations sont introduites dans le système de manière isolée et d'autres peuvent être calculées à partir de la période comptable suivante. De nombreuses pratiques sont réalisées sans que l'on ait l'impression qu'il s'agit d'actions socio-environnementales, toutefois, leur analyse et leur suivi peuvent servir de base à la prise de décisions stratégiques et au marketing durable, notamment dans le cadre de la préparation du rapport sur le développement durable, que l'entreprise entend publier à l'avenir. En outre, les résultats servent de guide aux autres entreprises, même celles qui appartiennent à des segments différents, en favorisant la compréhension du thème et des possibilités existantes et en fournissant des indications sur la manière de les mettre en œuvre.

**Mots-clés :** agro-industrie, Brésil, gestion des coûts, logistique verte, durabilité, socio-environnemental, région sud

## RESUMO

Esse estudo analisa a adequação às práticas de logística verde e o gerenciamento dos custos em uma agroindústria da região sul do Brasil. Foram realizadas entrevistas com roteiro semiestruturado, acompanhamentos dos processos internos e averiguações no site, em relatórios gerenciais e em planos de contas, para analisar a adesão da empresa às 84 práticas identificadas na literatura e organizadas em nove componentes, identificar outras práticas não elencadas, verificar os elementos de custo vinculados a essas práticas e como a empresa gerencia esses custos. Os resultados indicam que a empresa utiliza cerca de 83% das práticas analisadas, com a inclusão de seis não mencionadas na literatura. Para as práticas não introduzidas ou utilizadas parcialmente, verifica-se potencialidades e formas de aperfeiçoamentos. O componente com menor aderência é o marketing verde. A carga e descarga, a embalagem, a armazenagem e a produção verde têm 100% das práticas utilizadas pela empresa, mesmo que parcialmente. Já o transporte verde tem uma aderência de 95,8% (23 das 24 analisadas). Identifica-se 70 elementos de custos, dos quais muitos existem indiferente das práticas ecológicas, porém, são afetados por elas. Para gerenciá-los a empresa realiza análises comparativas por meio de um sistema informacional integrado que rastreia os dados a níveis analíticos. Algumas informações são inseridas no sistema isoladamente e outras podem ser computadas a partir do período contábil seguinte. Muitas práticas são realizadas sem a percepção de que correspondem a ações socioambientais, porém, sua análise e acompanhamento podem servir de base para a tomada de decisão estratégica e para a realização de marketing sustentável, inclusive na elaboração do Relatório de Sustentabilidade, o qual a empresa pretende divulgar futuramente. Além disso, os resultados servem como direcionamento a outras empresas, mesmo que de segmentos distintos, ao favorecer a compreensão do tema e das possibilidades existentes e fornecer indicativos de como executá-las.

**Palavras-chave:** agroindústria, Brasil, gestão de custos, logística verde, sustentabilidade, socioambiental, região sul

## 1. INTRODUCTION

Among the aspects that represent a competitive advantage for organizations, there is the adjustment to environmentally correct practices (Basu, Bai and Palaniappan, 2015). Due to increased environmental impacts from the production chain processes that generate waste and use energy and finite natural resources, there is growing concern about the environmental issues (Basu *et al.*, 2015). This concept, combined with the market requirements, the compliance with environmental legislation and fierce competition have encouraged companies to adopt control policies, preservation and environmental recovery that aim, besides financial gain, improving its image and reputation, as consumers also begin to prioritize products, services and companies with environmentally friendly features (Srisoen, 2013; Seroka-Stolka, 2014).

Logistics is considered a relevant factor in both the economy and the ecological processes, since it represents about 10% of the CO<sub>2</sub> generation of the world, expected to reach between 15% and 30% by 2050 (Bajor, Bořić and Rožić, 2011). This representation is guided in the fact that logistics plays inevitable role throughout the supply chain, especially when

considering the disruption of trade barriers and new forms of transactions resulting from technological developments (Bajor *et al.*, 2011; Basu *et al.*, 2015).

For companies, logistics becomes a value-added source because it involves the planning, implementation and efficient control of the flow and storage of materials, products and information throughout the supply chain (Ballou, 1997; Dey, Laguardia and Srinivasan, 2011). Thus, and considering intensifying expectations of logistics operations, given that there is more and more diversification between local production and consumption, there is considerable representation in business costs. According to Ballou (1997), logistics costs represent from 4% to 30% of total sales, depending on business characteristics and the environment in which it is inserted. In Brazil, according to the Institute of Logistics and Supply Chain-ILOS (2017), the logistics costs account for 12% of the Gross Domestic Product-GDP, while in the business ambit it means about 7.6% of the net revenue, considering transportation, stock and storage costs.

The interaction of social and environmental characteristics with the logistics operations is called green logistics, considered a management

approach that aims to achieve a balance between environmental, social and economic objectives in handling processes, storage and flow of goods and information (Engelage, Borgert and De Souza, 2016). The green logistic aims to inhibit or restrict damage to the environment and society, with the introduction of measures that provide financial returns to the company while worrying about the ability of future generations to meet their own needs (UNO, 1991; Ciliberti, Pontrandolfo and Scozzi, 2008; Seroka-Stolka, 2014).

In this context, it is important to highlight the importance of the variable costs, since environmental attitudes require additional investments and expenses, as those related to preventive and monitoring (ecological costs), or those for recovery and penalties on historical facts (environmental costs), which require planning and control for not compromising the continuity of the organization (Casagrande, Corrêa and Uhlmann, 2013). However, these practices may also affect positively on the processes and the image of an organization (Srisoen, 2013; Iakovou, Mallidis, Vlachos and Dekker, 2014; Zhang, Lee, Chan, Choy and Wu, 2015). Therefore, managing the cost elements of green logistics, that is, the portion of costs arising from the socio-environmental adequacy in logistics operations, become a competitive differential by inducing operational efficiency with waste disposal, stimulating different activities, incorporating technologies and resource potential.

In the literature, there are studies about green logistics from the perspective of cost management (Ciliberti *et al.*, 2008; Ping, 2009; Seroka-Stolka, 2014; Tissayakorn and Akagi, 2014). However, many of these studies, especially the empirical studies, focus on single components of green logistic, such as transportation (Lin, Choy, Ho and Ng, 2014; Iakovou *et al.*, 2014) and reverse logistics (Sbihi and Eglese, 2007). It is also seen that much of the literature is developing tools to assist in management of transport routes (Lin *et al.*, 2014; Iakovou *et al.*, 2014; Niwa, 2014), the concept and evolutionary analysis of green logistic and description of the difficulties and potential implementation of its concepts by organizations (Szymankiewicz, 1993; Sbihi and

Eglese, 2007; Ping, 2009; Martinsen and Hüge-Brodin, 2014; Zhang *et al.*, 2015). Thus, despite the relevance of the subject, there is little research that jointly work the cost management variables and green logistic, to cover this entire concept.

This assertion is supported by study of Machado, Reckziegel, Souza and Almeida (2016) that, when analyzing the empirical and theoretical contributions of research on green logistics cost management, identified only six studies, from an initial base of 52 articles, which contained duties inherent to cost management mentioned in their goals. However, it is necessary to expand this vision in order to meet the costs with greater specificity and scope in particular to jointly consider various components of green logistics.

To Engelage, Borgert, Gasparetto, Lunkes and Schnorrenberger (2017), some of the factors contributing to the reduced number of studies that directly address the issue are the difficulty of identifying and gathering comprehensive data, since these are not always clear or available separately; and the lack of clarification as to what are considered green logistic practices. Still, the same authors claim that by these limitations, for in-depth analysis in an organization becomes an alternative in the search for information that portray business reality and provide greater indications on the subject. Therefore, the present study examines, in particular, an agroindustry in Southern Brazil.

It is important to note that Brazil is a country that has the greatest biodiversity in the world, with abundant natural resources: About 12% of surface water available in the planet are in Brazil, and one of the largest fresh water reserves and forest areas (National Water Agency-Brazil, 2018). Thus, the preservation of these resources is important not only to Brazil but to all over the world, the ecological functions and services of its ecosystems, such as the carbon cycle maintenance and, consequently, climate regulation, with mitigation of global warming. This preservation depends on the harmonious integration between the environment and society, and especially between businesses. Therefore, the analysis in an agroindustry is justified by the representation in the Brazilian

economy and the environmental impact that these activities may cause, as they are business that are responsible for processing and benefiting of agricultural products and, therefore, the negative externalities may occur not only in the productive processes, but along the supply chain.

By the importance of the topic and outlines and problems presented, this study analyses the adaptation to green logistics practices and management costs in a factory farm in southern Brazil. Besides the increasing prominence of logistical and environmental axes, this study stands out for its practical relevance in targeting business, government and society. Specifically, the object of analysis now makes it possible to view what is being done, what may be improved and, on that basis, give up contribution to the achievement of sustainable marketing and to strategic decision making. For other companies, even if other segments, the study provides indicative and adaptation possibilities, to provide greater understanding of existing practices of green logistic and give indications of how to perform them and demonstrate ways to manage costs related to them. For the governments and competent authorities, it enables the identification of factors that may be optimized with regard to the norms, laws and granted infrastructure. In addition, for society, discussing this issue strengthens the environmental awareness, with a view to environmentally friendly consumption and aid in collecting the governments and business to reduce the impact of their activities on the environment.

The relevance of this study is highlighted when considering the difficulties in analyzing the practices of green logistics and possible financial and economic impacts, due to the limited disclosure of isolated and consistent data. According to Engelage *et al.* (2017), this factor is motivated mainly by the low inspection and collection of the applicability of ecological practices. In addition, in Brazil, there is no mandatory environmental disclosure, even with some recommendations and guidelines, which characterizes it as a volunteer. Finally, a greater understanding of the subject enables the basis for possible future empirical verification, especially directed to analysis of these impacts.

## 2. GREEN LOGISTIC PRACTICES AND COST MANAGEMENT

The green logistic directs to the efforts to reduce the negative externalities to achieve a sustainable balance between environmental, economic and social objectives (Ballou, 1997; Ping, 2009; Seroka-Stolka, 2014). Therefore, following the precepts of the Triple Bottom Line, which demonstrates the need for companies to consider strategic decisions to maintain economic sustainability through a profitable organization and generating value; social sustainability, stimulating aspects such as education, culture and recreation; and ecological sustainability, keeping alive ecosystems (Vellani and Ribeiro, 2010).

Due to the scope of the term, the green logistic affects the decisions taken in functional areas of business, since the logistics operations are eminently understood in these activities (Wu and Dunn, 1995; Ballou, 1997; Ping, 2009). Engelage *et al.* (2016) identified 112 green logistic practices considered in the literature, of which 85 built by private companies, 24 by government and 3 by consumers. The authors organized a taxonomy involving different areas with environmental directions, which are components of green logistics, as it is seen in Figure Nº 1, which serve as input for the classification of the identified practices. These components are: Green transportation, green loading and unloading; green design; green packaging; green purchasing; green storage; green production; reverse logistic; and green marketing. There is also the inclusion of general field, for green logistics practices classified simultaneously in more than a taxonomy component.

Dey *et al.* (2011), Lai, Wong and Cheng (2012), Dekker, Bloemhof and Mallidis (2012) and Marques and Grande (2015) also list some practices are linked to comprehensive solutions and provide indicative of what could be done for businesses to fit to this concept, such as: Reduction of carbon dioxide emissions; remanufacturing; reuse; recycling; inventory control; ecological purchase; rescue and disposal of scrap; loading consolidation; use of environmental friendly packaging; enhancement and diversification of transport; efficient choice of fuel and equipment; programming routes; among others.

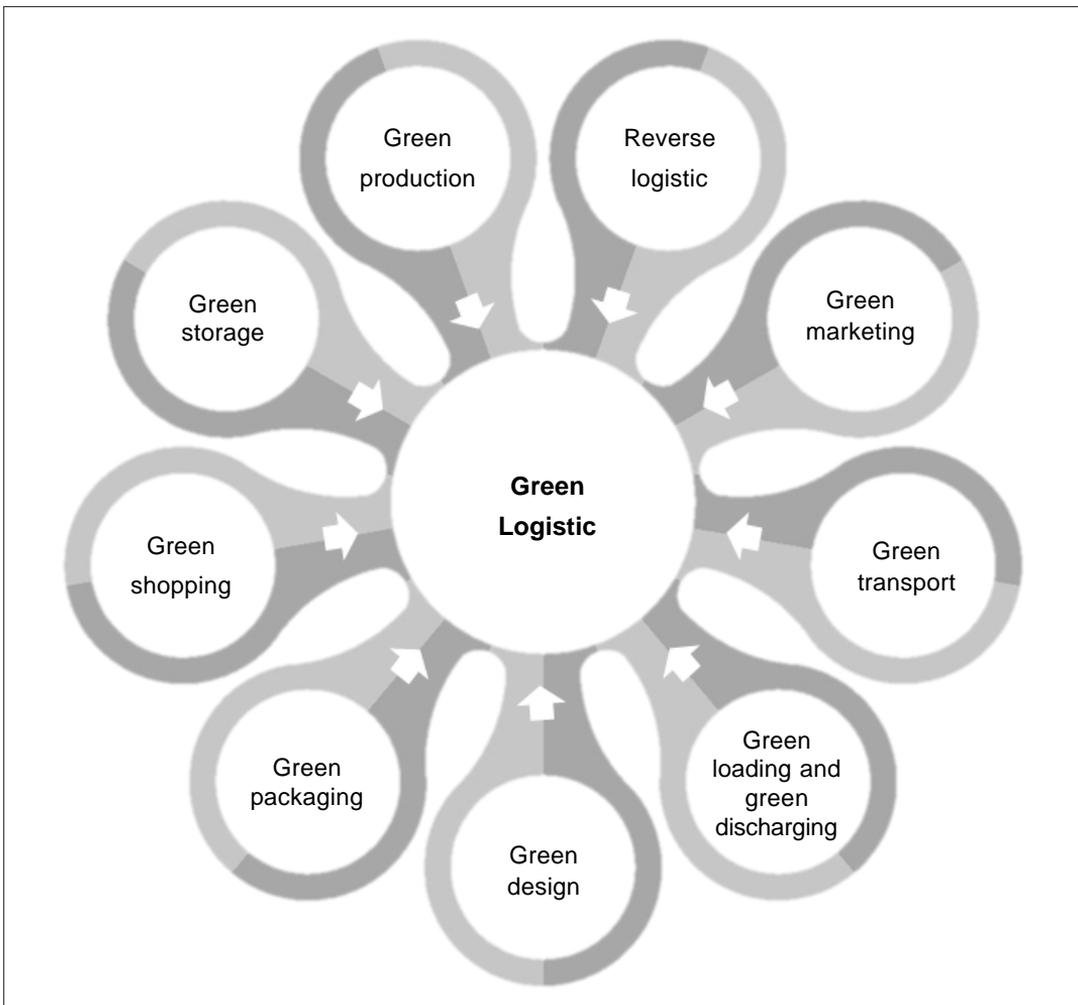


Figure 1. Taxonomy of green logistic components. Source: Adapted from Engelage *et al.* (2016)

As the Institute of Logistics and Supply Chain-ILOS (2011), companies may also act in a consistent manner, aligned with the green logistics, by investing in assets with practices such as: Fleet renewal; mechanical or aerodynamic adjustments in vehicles and equipment to reduce emissions; and prioritizing construction of distribution centers and plants following sustainable guidelines, using solar panels, green roofs and ecological pallets. An, Razzaq, Nawaz, Noman and Khan (2021), also, emphasized the importance of these investments, as a higher quality of infrastructure related to the transport, efficiency in customs clearance and

competence of logistics services significantly mitigate the level of carbon emissions. Besides, the application of resources in renewable energy significantly improves the quality of logistics operations.

However, companies' environmental sensitivity must be supported by environmental legislation (Küçük, Bühs, Weber and Muschiet, 2021). This because, the inclusion of green practices in logistics operations may result in the need for additional investments and expenditures, and add complexity and require greater skills of those involved, with possible changes in culture and behavior (Lin *et al.*, 2014; Iakovou *et al.*, 2014). However, some

authors argue that financial returns to organizations are brought through effective management of these actions, as they may develop the skills of resources, reduce inventory levels and free spaces, improve the utilization of materials, eliminating various types of waste, reduce spoilage and obsolescence costs, expand market share and thus qualify processes and contribute to the generation of higher profits which will offset the increased costs for investments and ecological adaptations (Aronsson and Hüge-Brodin, 2006; Niwa, 2014; Lai *et al.*, 2012). In addition, the dissemination of environmentally sound behavior can bring competitive advantage to the organization and enhance your corporate image (Rodrigue, Slack and Comtois, 2001). For An *et al.* (2021), the quality in green logistics operations can increase the trade volume, because it assists information sharing between supply chain partners, as well as presenting opportunities for socio-environmental growth and development, mitigating social concerns.

Several studies analyze the impacts and consequences of the introduction of green logistic practices in organizational costs. However, most of these studies focuses on specific components of green logistics, especially transport and reverse logistics. Iakovou *et al.* (2014) proposed a management structure of green logistic directed to transport activities, through a case study of a retailer in Greece. The findings reveal that there are higher costs when the company migrates to green solutions, with a focus on reducing CO<sub>2</sub> emissions.

On the other hand, the study of Brădescu (2014) shows financial advantages, in addition to environmental, introducing green practices. The author analyzed the relationship between the practice green and logistic costs, through a case study on the company Mars Incorporated, a global manufacturer of chocolates. The findings show that environmental practices are advantageous to the company, resulting not only in a favorable image, but in increased sales and reduced costs. This is because Mars has significantly improved its operational efficiency and capital. To Brădescu (2014), currently, companies are encouraged to adhere to

environmental standards and therefore to consider and control the costs associated with green logistics. However, the environmental and social costs are still ignored by many companies.

Aronsson and Hüge-Brodin (2006) supports the idea of possible benefits, analyzing the impacts of green practices in logistic activities related to transport in three Swedish multinational companies. The results indicate that the changes were positive relative to the cost and environmental impact, since it had more accurate delivery, changes in modes of transport depending on the storage centralization, greater consolidation of goods, standardization and centralized governance system logistics.

Küçük *et al.* (2021) when analyzing and comparing green logistics practices in textiles industries from Germany and Turkey, quote the importance of considering ecological and financial issues together, in order to extract the maximum benefit from each action. For example, they quote environmental certificates that also bring financial return, by improving the company's image in the market. The recycling, which in addition to reducing and environmental pollution, helps in the disposal of the company's waste and reduces the price of many materials.

By reports of positive and negative impacts on the cost of adherence to green logistics practices, we realize the importance of knowing and manage these values in order to base the decision-making. The importance of the cost of the green logistic issue is also emphasized by Machado *et al.* (2016), whose literary analysis indicates that even in studies that are not directly treated and objectively on the subject, its elements are present and widely discussed.

Furthermore, for Rodrigue *et al.* (2001), the management of green logistic costs should address the maximization of results and not purely to reduce costs, given that there may be increases in costs offset by increases in revenue and thus its measurement, control and planning are needed.

One of the factors favoring the cost management of green logistics is the use of Environmental Management Systems (EMS) as it provides greater control and measurement

of the impact of business activities on the environment and assists in compliance with legal requirements (Tinoco and Kraemer, 2011). But even without the formalization of environmental management systems, businesses can maintain specific controls and measurements of the cost elements of green logistics, through their own accounting information systems.

According to Krajnc, Logozar and Korosec (2012) traditional systems cost accounting do not guarantee the transparency of logistics costs, due to their grouping, considering that usually treated as a component of indirect costs or as selling, general and administrative expenses. The same applies to the green logistic costs, to be more specific. Alternatively, to this statement, Zbib, Rakotobe-Joel and Rigoli (2011) emphasize that businesses and management systems have a wide range of practices to generate the defendants cost information, and current information technologies provide tracking data and generate various information that help control and introduction of ecological practices.

That way, and when considering the various tools and cost management approaches available, ranging from traditional methods already well-established in other areas of study –as the management of logistics costs and supply chain– to integrated models developed from the organizational particularities, it is important to understand how companies measure, book keep and control the green logistic costs.

### 3. METHODOLOGY

In the search for detailed and deepen information that portrays the organizational reality and describes how the topic is incorporated in this context and its effects in terms of cost management, this study aimed at a single company. The determination of the object of study derives from an analysis that begins with the definition of the sector and follows a detailing process, until reaching the company that answers the informational study needs, that has relevance in the market and that accepts the research development proposal. Figure Nº 2 presents a summary of the parameters considered for this definition.

In order to create a structure that enables consistency to the checks and to make a contrast between the literature and the observed reality, the study follows the steps shown in Figure Nº 3.

The first step consists in checking the green logistic practices adopted by the company through a checklist of 85 green logistic practices classified according to the taxonomy organized by Engelage *et al.* (2016). Of these, it is disregarded the practice of adding packaging costs to sales prices, since it is directed to financial strategy, not to environmental suitability. Thus, it remains 84 practices of green logistics for analysis, which are listed in Table Nº 1. Other practices not listed in the literature and that are used by the company were also sought.

The empirical verification based on theoretical findings aims to provide greater strength and assertiveness, by combining knowledge already established and accepted by the scientific community to experience and business practices. This procedure is consistent with the proposed in the study Martinsen and Hüge-Brodin (2014) which also makes a confrontation between the literary findings and data of the companies analyzed.

The second stage identifies the cost elements related to practices analyzed, as the costs of environmental suitability in logistics operations. It is noteworthy that the goal is not to determine monetary values, nor indicate whether earnings or financial losses, but rather to verify the elements (types of costs) suffering variations due to specific practices. With the identification of green logistic costs elements, it is possible to see how they are measured and controlled by the company and used in management approaches (third step).

The findings from the company occur through interviews and on-site checks, in the official website, in management reports and chart of accounts. First, there is a meeting with the head of the planning sector, Programming and Production Control (PPCP) for the presentation of the proposed study and collecting general information. Based on the information provided from this meeting, the analysis in the following areas is established: Quality control; Logistics; Planning,

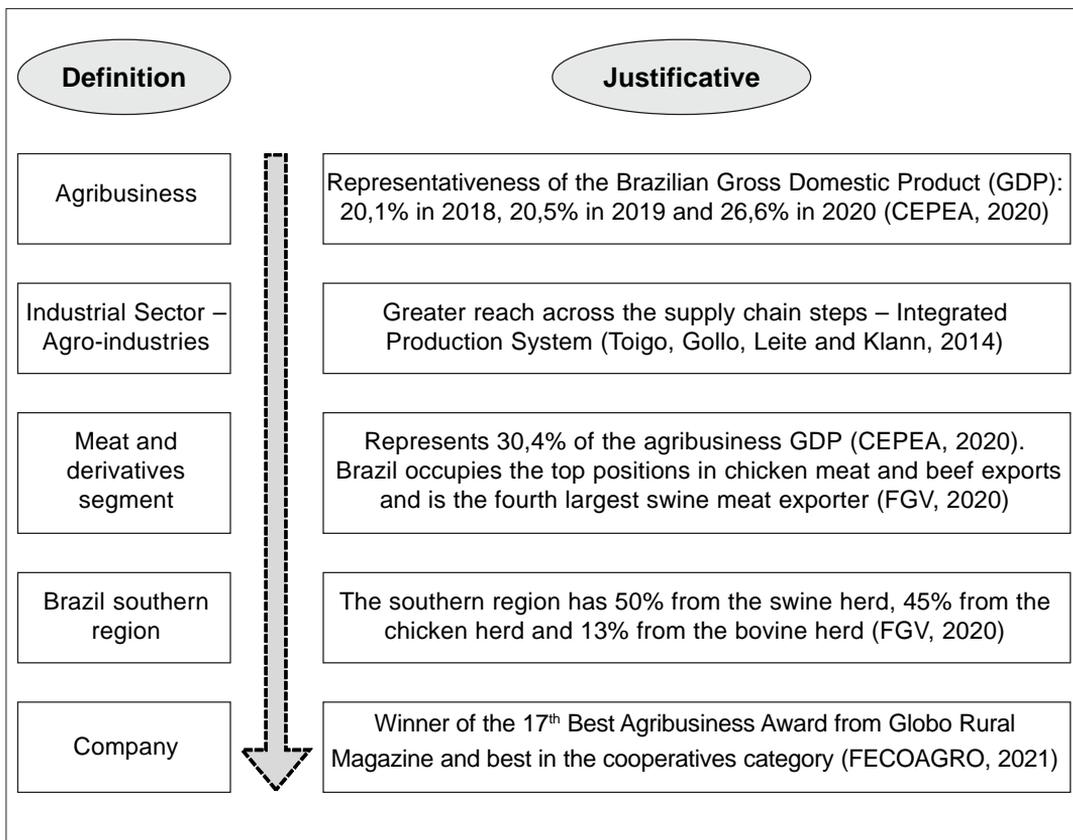


Figure 2. Criteria for definition of the object of analysis. Source: Prepared by the authors

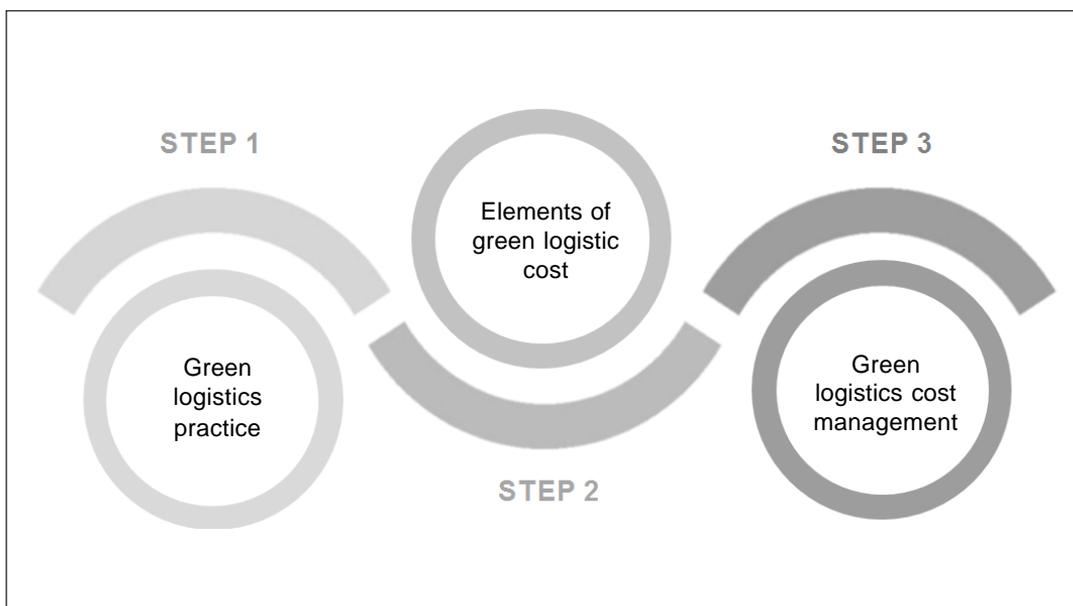


Figure 3. Methodological procedures. Source: Prepared by the authors

Table 1  
Green logistic practices

Green transport	Using intermodal and multimodal transport
	Reduce the use of road transport and boost rail and sea
	Owning transport route management system with scheduling and optimization of deliveries flows
	Prioritize vehicles with clean technology
	Use traffic control system and stagger the short-distance transport to relieve urban congestion at peak times
	Perform delivery
	Give proper destination to vehicle parts and scrap
	Reduce accident rates and the generation of scrap waste
	Manage and maintain the vehicle fleet
	Reduce the vehicle fleet
	Using cleaner fuels
	Using transport equipment with clean technology to ensure product quality (less losses and waste)
	Develop an effective system of transport of dangerous goods
	Give preference to the transport outsourced
	Provide training the driver to know the technologies and ways to prevent waste
	Do not exceed the permitted driving time
	Not carry overloaded vehicles
Loading and unloading green	Introduce digital tachographs
	Create programs to reduce travel time, fuel usage, tire and parts
	Reduce the emission of noise from vehicles
	Create common distribution partnerships
	Track goods sent for delivery
	Stipulate renewal policy vehicles
	Maximize load utilization - avoid underutilization of freight and realize return shipping
	Containerization
	Palletizing
	Standardize the shipping instructions / landing based on fixed rules
Green Design	Maximize the use of resources and avoid waste
	Design product design that promotes recycling and low consumption of materials
	Integrate suppliers in product design and processes to find alternative materials and equipment
Green packaging	Develop products with higher lifetime
	Design the design of packaging to encourage recycling and are biodegradable
	Reduce consumption of packaging
	Using returnable packaging
	Designing secure packaging which reduce the damage to transportation and waste generation
	Using pallets with higher loading capacity, reusable or recyclable
Green shopping	Prefer bulk packaging and negotiating with customers to use
	Reduce emergency shipments
	Evaluate and select suppliers in the process of purchasing and contracting services, when
	Request to suppliers to submit pollutant emissions report
	Prefer goods and products with reduced packaging, reusable and recyclable
Green storage	Create a database for green procurement, with product type specifications, material and other
	Centralizing the purchasing process
	Provision demand according to production schedule and manage inventory at minimum level
	Owning electronic inventory system
	Reduce energy use with deployment of sophisticated lighting systems
	Create practical storage plans that reduce the loss, keep the quality of goods and facilitate
	Elaborate structural compact plant to facilitate internal movement
Streamline distribution centers with prior analysis of the ideal location when considering suppliers	
Managing returned goods inventories	
Give special treatment to hazardous substances	

Source: Adapted from Engelage *et al.* (2016)

Table 1 (continuation)

Green production	Reduce consumption of hazardous materials
	Have clean production technology
	Control the quality of manufactured products
Reverse logistic	Collecting and recycling waste and used goods internally separate recyclables
	Plan cleaning processes of recycled materials (reduction of pollutants)
	Create proper disposal policies and tire recycling
	Using recycled materials in the production process and take advantage of waste
Marketing green	Disclose pollutant emission rates
	Disclose the practice green logistics
	Have environmental certification
General	Establish collaborative partnerships for longer periods
	Have commitment of top management
	Receiving feedback from stakeholders
	Have clarification about the concepts of green logistics
	Provide training and work in partnership for the adequacy of suppliers and customers
	Develop a visual representation of the supply chain to identify opportunities for improvement
	Develop metrics and environmental indicators and monitor them
	Evaluate employees on environmental criteria
	Follow occupational safety standards for logistics operations
	Conduct environmental audits
	Establish specific plans for sustainable actions with goals, temporal delimitation and internal
	Investing in the development of green technologies
	Have a department responsible for environmental issues
	Comply with the environmental regulations and norms
	Prevent environmental accidents
	Decrease the printed documentation that comes with the product
	Using information technology
Reduce consumption and recycle office supplies	
Provide staff training	
Reduce the consumption of materials in logistics operations	
Use environmental performance control tools	
Acting in embodiment e-commerce	

Source: Adapted from Engelage *et al.* (2016)

Programming and Production Control (PPCP); Planning, Programming and Control Agriculture (PABX); Controllershship; Information Technology (IT); and Field service. Figure N°4 shows the organization chart, which shows the sector level analytically.

In quality control sectors, information technology and field technical assistance interviews with industry officials were carried out. While in the PPCP, PABX, logistics and controlling, in addition to interviews with officials, monitoring the activities of all involved in the processes were carried out.

As for the characterization of the interviews, these were divided into two main points. First part is a previously defined structure based on literature findings, in order to guide and lead the identification of green logistic practices actually used by the company (Step 1). After that, there are inquiries about the particulars of the

processes in order to identify new green logistic practices not mentioned in the literature, the cost elements related to these practices and evidence about possibilities for managing these costs (Steps 2 and 3). Therefore, there is a predefined structure and respondents have greater autonomy to discuss the subject. These questions do not occur directly in order to not to induce the respondent.

The monitoring of sectors presents a detailed knowledge of the procedures, process mapping and verification of information passed during interviews. This monitoring is done through site visits, where there is the routines and functions of all those involved. In PPCP sector, PABX and controlling, there is division only between tasks, so for a given period, the employees accompanied one by one in order to understand how they develop their functions. By knowing their routines, it is

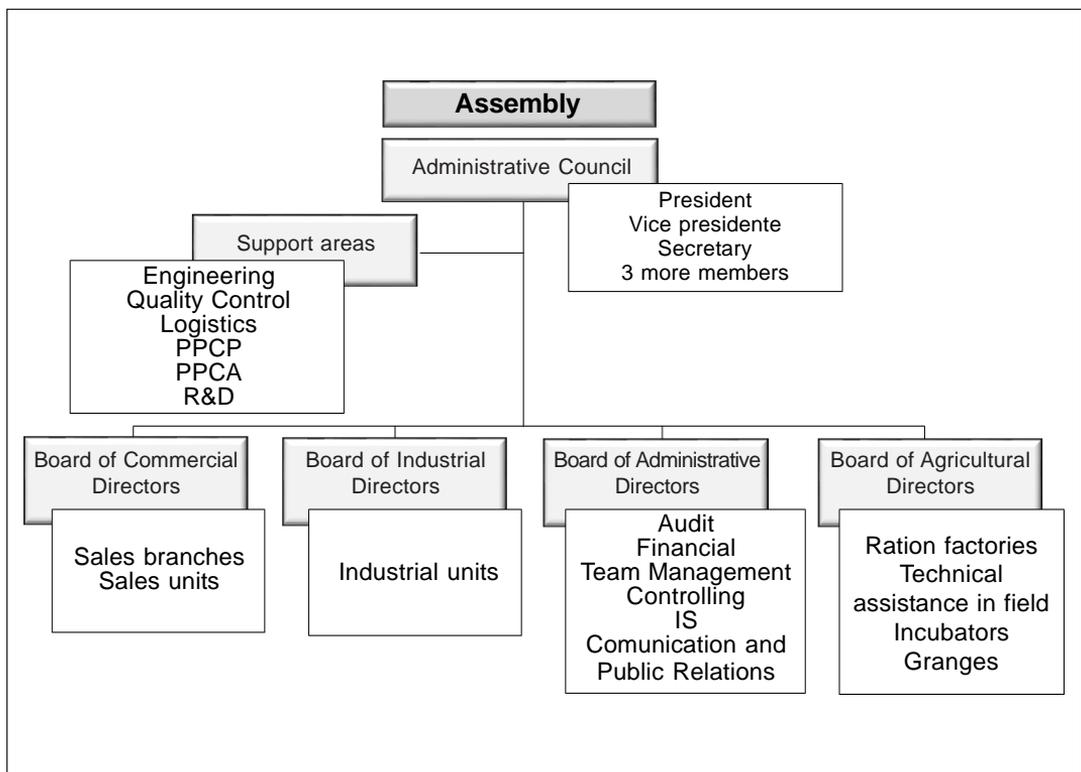


Figure 4. Organization chart. Source: Prepared by the authors

also analyzed the inclusion and integration of data in information systems.

In contrast, the logistics industry is divided into sub-sectors, with respect to what the company called logistics costs tree (Figure N° 5). There is a responsible for the areas of agricultural logistics (operations between farms, hatcheries and refrigerator) and primary logistics (fridge to distribution centers), one responsible for the secondary logistics (distribution centers to the customer) and another responsible for the export logistics, which also takes care of administrative costs and with pallets. Thus, the interviews and follow-ups occur beside these professionals by the same perspectives described above, but without expanding the checks to other employees.

For the last step (Step 3), it was carried out a new interview with the responsible for the controllership area, since this holds general information and consolidated costs and management reports.

It is noteworthy that during all the stages checks were carried out on the official website, in managerial and chart of accounts reports, in order to seek further information and give veracity to the transferred information. There are also time intervals between each procedure so that the researcher can gather and analyze the data.

#### 4. ANALYSIS OF THE PRACTICES OF GREEN LOGISTICS

Overall, the 84 green logistic practices analyze daim, directly or indirectly, to reduce

negative impacts on the environment through the following macro-objectives: (i) reduce air, water, soil, noise pollution, among others; (ii) inhibiting the deterioration and contamination of the environment; (iii) optimize the use of time; (iv) reduce the risk of environmental accidents; (v) avoid inefficient use of finite and infinite natural resources; (vi) prevent excessive generation of waste; (vii) avoid waste, loss, damage and obsolescence; (viii) take and recycle waste; (ix) to provide adequate tailings disposal; (x) reduce wear and road vehicles and scrap generation; and, (xi) generating well-being, safety and better working conditions.

The company in question operates in the manufacture and sale of pork meat and poultry, dairy products, processed products and supplements for animal feed. Some peculiarities of its operations are in accordance with the green logistic practices mentioned in Table N° 1 and enable the achievement of macro-objectives. Still others may be improved or introduced by the company. Some features are:

- It uses basically the road, but there is also shipping for export of refrigerated goods and cabotage to transfer between the ports of the north and northeast regions of Brazil through the coastline;
- Freights are 100% outsourced and part of the remuneration of carriers is variable (25%) and depends on the fulfilment of the basic requirements such as conditions and fleet usage time, use of biodegradable fuels, the need for preventive maintenance, training and guidance of drivers;

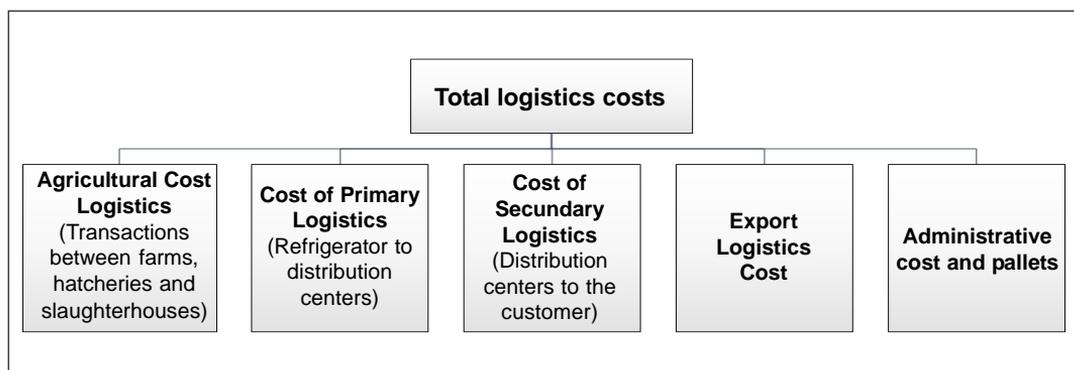


Figure 5. Logistic cost tree. Source: Prepared by the authors

- There is a routing system, which includes the collection points and delivery and control variables that automatically traces the route optimizing rotated km and the travel time. Among the control variables are cited: Unmedicated ration to be delivered earlier than medicated, vehicle loading capacity, the need for full time vehicles for the distribution of poultry and pork cuts between branches, risk points, legislation particular as limits of time, among others;
- There is urban traffic control only where there is specific legislation, such as São Paulo and Rio de Janeiro;
- It has integrated systems ranging from the control of agricultural operations (SIGA), automation (Move Weigh System-MWS) to management procedures;
- Uses ammonia for industrial cooling processes, but has prevention and control procedures in the storage and handling of the substance, and transportation is liability vendor;
- It has 100% of the screened fleet, in addition to tracking the production chain of poultry, pork and milk, the origin of shipment and final destination, which also allows inventory control, maintaining adequate levels to meet production demand;
- Containerization used for products transported by coastal and maritime transport; pelletization in all industrial products; and distribution in bulk to feed, transfer pork cuts and chickens between branches, and some end products;
- There are training programs targeted to service the external public, which standardizes sales issues and loading / unloading of goods, the 5S Program and the project Recycling is Life<sup>3</sup>;
- Employees receive profit sharing for compliance with targets linked to internal programs, in particular for recycling;
- The recyclable materials are sold to a specialized company and there is no control over its processes, as well as the disposal of tires is the responsibility solely of the carrier;
- Part of the revenues from the sale of recyclable materials is reversed for employee well-being in the workplace;
- Research and development of industries and engineering design products and processes to optimize the use of resources and time and quality assurance;
- All product packaging is recyclable, except for polystyrene trays. The milk boxes are also recyclable, but require additional procedures to separate the materials;
- Pallets, plastic containers, animal cages, egg trays and cartons are recyclable and/or reusable;
- There is no charge to vendors present sustainability report, but these are accredited and evaluated under other criteria, and the company offers the Code of Conduct for suppliers, about the minimum conditions to be respected, as well as charges the basic requirements of adequacy of producers, cooperatives and affiliated carriers;
- Uses solar lighting in own farms, but in the industry for the environment of the insulation to keep temperatures down. In these, the energy sources used are: Biomass, biogas and hydroelectric;
- The structural industries plant is designed based on the slaughtering and processing flows;
- Some units still use old machinery, less automated, particularly some feed mills;
- There is an organization and metrics sector, which are designed, improved, audited and controlled internal rules and procedures and a team of technicians in occupational safety establishing rules, provides guidance and makes periodic checks;
- There is no explanation in the company on the concept of green logistics, as many relate exclusively with reverse logistics;
- Has a Sustainability Committee formed by employees from other areas of the company, responsible for developing actions to evolve in economic, social and environmental issues;
- Not invest to design or develop green technologies, acquires only when economically and operationally feasible; and
- Do not make sales in the e-commerce modality.

<sup>3</sup> The 'Recycling is Life' program is proposed to reduce the consumption and the use of waste, in order to increase operational efficiency and give proper disposal waste and tailings.

Based on the above characteristics and breakdowns observed during the study, Table N° 2 shows the adherence Company percentages for each component of the taxonomy in order to determine the adherence in relation to the literature.

To the components and green loading and green discharging, green packaging, green production and green storage, it is possible to consider that the business uses, even partially, 100% of the listed practice. The lower grip component is the green marketing. The company has awards in the environmental and information related to the topic published on its official website, but the practices analyzed relate only to disclosure of pollutant emissions and environmental certification, which the company has no specific targeting.

Some practices are used relative and partial way, extending only certain operations, while others have no link with the company's line of business and therefore not using stems from the lack of alignment and not of inefficiency. There are also company characteristics that serve more than a practice. Therefore, it is classified as existing ones that in some way, the

company applies in the course of their processes.

It is worth noting that some practices are related to each other and their impact on the environment are given directly or indirectly. For example, practices that generate reduced mileage directly influence the greenhouse gas emission reduction, as those relating to product quality operate indirectly because, among other factors, reduce transport flows that, in turn, imply in the reduction of emission of these pollutants.

It is also possible to identify some company conducts linked to green logistic not listed in the literature findings, as the following:

**1) Acting with employees and the community to develop actions related to environmental, cultural and social development:** The Company develops, since 2010, the Safe Collection Program: Environmental Fate Waste Veterinary Products, which collects animal health waste on farms in the area. This project provided the company winning the Trophy Green Wave of the 24<sup>th</sup> Ecology Expression Award for Pollution Control.

Table 2

*Adhesion to logistic green practices listed in the literature by taxonomy component*

Components	Analyzed	Used	Used (%)
Green transport	24	23	95,8%
Loading and unloading green	3	3	100,0%
<i>Green design</i>	4	3	75,0%
Green packaging	6	6	100,0%
Green shopping	7	4	57,1%
Green storage	7	7	100,0%
Green production	3	3	100,0%
Reverse logistic	5	3	60,0%
Marketing Green	3	1	33,3%
General	22	17	77,3%
<b>Total</b>	<b>84</b>	<b>70</b>	<b>83,3%</b>

Source: Prepared by the authors

<sup>4</sup> *Turminha da Reciclagem* is an existing project, launched in 1999, that has reached more than one hundred thousand children in Brazil. This project serves municipal, state and private schools, from pre-school to universities in actions

and exhibitions focused on environmental issues. The aim is to guide the public on matters related to sustainability, such as consumer awareness, proper disposal of waste, separation of materials, reuse and selective collection.

Other actions in the community are the projects in partnership with Aury Luiz Bodanese Foundation (FALB), maintained by the company: (i) *Turminha da Reciclagem*<sup>4</sup>, on the environmental issue; (ii) Wheel Body Reading and Voices for cultural issues; and (iii) Attitude Now, Amigo Energy, Living Health and Family is Everything in the social sphere. In addition, on commemorative dates to the environment, every year the company promotes awareness actions of employees and the community. On World Environment Day, there is a recyclable material collection campaign as cans and PET bottles, in which participants receive reusable bags in exchange for collected materials. During the week of the International Cooperative Day the company promotes the campaign «Carona Amigo», which encourages employees to seek alternative means of transportation other than the car itself to reduce carbon dioxide release in nature. In celebration of Arbor Day are distributed native tree seedlings to employees, in partnership with the municipal nurseries. Also performs the revitalization of areas of the company. On the water, they are promoted meetings called environmentally friendly for cleaning streams near the company's units.

**2) Seek recognition through environmental awards:** The Company does not disclose environmental information to report rates of emissions or green logistic practices, nor has certifications in the area, such as ISO 14001 and its standards support, as proposed by the green marketing practices. However, it has numerous environmental awards that aim enhancing the company's image in order to demonstrate its performance.

**3) Establish water-saving policies:** In the process of cleaning the plants, vehicles and equipment, the maximum cubic meters of water to be consumed are established before use and it is confronted with the actual consumption. It is a variable controlled by quality programs.

**4) Recover degraded areas and invest in reforestation:** The Company invests in reforestation areas for the use of wood to generate steam and power from biomass. These forests are owned and leased and seek self-sufficiency of the process, to reduce the impacts of environmental resource extraction.

As already mentioned, every year on the water day, activities as cleaning rivers located next to the Company are carried out.

**5) Disclose in manuals and packaging the potential risks and use and disposal recommendations:** All packages have recommendations and guidelines for their proper disposal. Some products also have preparation suggestions on the back of the pack.

**6) Having a specific plan for reducing carbon emissions:** The Company has a plan internally set, which compiles various actions and their potential for reducing greenhouse gas emissions, tracing goals and deadlines for this range.

Identified the practices of green logistic existing in the company (Step 1) it is analyzed the cost elements related to these practices and how these are measured and managed by the company (Steps 2 and 3).

## 5. COST MANAGEMENT ANALYSIS OF GREEN LOGISTICS

It is understood as green logistic cost elements the share or type of expenditure arising from the environmental suitability in logistics operations. Altogether, there are 70 identified costs elements, which do not exhaust the existing possibilities. It is highlighted that the company knows the total expense, as are values already incurred that relate to existing processes. However, the portion or variation of costs arising from adaptation to the principles of green logistics is often not known or treated as such, which inhibits strategic actions in this direction.

Examples of identified cost elements are: Changes in the value of freight for alternative modes; opportunity cost when making return freight; cost of destruction of the pallet/cage/container, net gain of recycling; cost of separation and submission of materials for recycling, net of gain on sale; cost of disposal of non-recyclable materials; cost reforestation areas in contrast to a decrease of acquisition of inputs; opportunity cost of using outsourced freight; variation in the number of charges for respecting the capabilities of vehicles and roads; cost variable compensation of carriers depending on the prerequisite

requirements; variation in the delivery time of the products subject to compliance peak hours in urban centers; cost for special treatment of hazardous substances; variation in the amount of returns, loss, death, decay and obsolete products and the purchase of materials for maintaining the quality of the production, storage and handling and have reuse; cost and low-power variation in electricity consumption lamps; among others.

Despite the identification of these elements be guided by existing practices of green logistics in the company, there is not an individual link, as each cost element groups different practices, and each practice can be linked to different cost elements.

As for the internal procedures of the company relating to the management of these costs, it is found that information systems are all integrated, as proposed by Zbib *et al.* (2011), which allows the traceability information to detailed level since the power system occurs in a specific manner. Thus, it is possible to have the information in an appropriate unit cost of the company, sectors or subsectors, activities, areas, lots purchased, produced batches and other groups as well as you can have different ratings for the same release. However, the main classification used by the company is given in relation to the costs of tree (Figure Nº 5), which defines five centers of logistics costs: (i) agriculture, (ii) primary, (iii) secondary, (iv) export and (v) administrative and pallets.

As for how to record and green logistic costs reports, it appears that for accounting purposes the company has a plan to lean accounts that adds a lot of information on the same item. However, because the system is built, you can issue specific management reports, to segregate accounts in detailed levels, since the information is entered into the system. However, many of the green logistic costs are not introduced into the isolation system and its analysis, although possible, requires checks on the backgrounds of the releases.

Thus, the creation of specific reports automatically generated and can bring more control to the company and informational base for decision making, which may offset the investments and changes in the form of

inclusion of the data. According to the responsible for the controlling area if requested by management, these controls are already possible with the limitation that occur from the following accounting period. The stipulation that period is given to ensure comparability of information in the current year and for the adequacy and training of the personnel that feeds the system.

Currently, there is no analysis of isolated green logistic criteria, nor their costs because this is not a clear concept for managers. However, many green logistic costs elements are already possible check, mainly through comparative. For practices that the company has always acted in a manner consistent with the principles of green logistic without even having this direction, data confrontation to give in relation to forecasts. For those in which the company has adapted over time, known the period in which they occurred ecological adaptations you can make comparative efficiency based on this breaking point (before/after). Still, there are comparative to consider what the company currently practices in relation to what could make the case acted differently.

In order to measure and monitor the efficiency of costs and processes, the company also works with compliance indicators. These indicators enable comparative analysis between what was planned and effected, pointing out the discrepancies and allowing the verification of their motivations and consequences. These indicators are used for various analyses, among which-quotes: mortality; loss; weight and yield of the animals; food consumption; daily slaughter; milk demand; product quality; assistance to commercial demand; among others. For each window the company determines a safe range (minimum and maximum) that is established based on an ideal setting and inefficiencies in the known and accepted, for example, the head of the PPCA reported that the animals slaughtered in the summer tend to be thinner and generate less leftovers, reducing raw materials for industrial products and hence influence in determining the production mix. Moreover, these indicators guided in statistical predictions in order to verify trends and discrepancies and take preventive

measures to ensure that the results do not escape the established range. These indicators are based on information available in the system and so long as there is parameterization can expand to specific information green logistic to check trends and discrepancies and take preventive measures to ensure that the results do not escape the established range.

During the interviews and follow-ups were not cited by the company-specific cost management tools, even without involving the theme of green logistics, unless the cost method. According to responsible for controlling, the company uses the cost method absorption and industrial sector for a unit of self-produced effort. The company did not pass on more detailed information, nor allowed to disclose how is the use of this production unit of effort.

Managerially it is also used the variable costing method, which identifies the specific costs of each unit and type of product and deducts from its selling price. For products that are transferred between sectors (remains of animals that cuts become industrialized products) is assigned a transfer price, *i.e.*, the amount of revenue from one sector and cost of another. Based on the contribution margin, market demands and restraining factors such as the availability of raw materials depending on earnings of animals and human and technical capacities of each plant, it is stipulated the production mix, with a view achieve the best possible financial results. For this process, it is not considered the pollution potential of each type of product. However, according to the responsible for the controller area, once the products and their demands are established, they are sought to standardize and correct the processes so that their impacts on the environment and society are the smallest possible.

Another feature of green logistic cost management is that the costs are not limited to the internal operations of the company and may have links along the supply chain. This is because there are costs that are generated or increased depending on the collection and provision of conditions for the other chain participants are adequate social and environmental principles. As an example, it

cites, the purchase of materials, supplies and environmentally friendly packaging; maintaining partnerships only now, carriers and producers who have socio-environmental bias; and the development of green technologies. Ciliberti *et al.* (2008) and Wank and Li (2010) supports the idea that the management of green logistic costs should be extended to the supply chain, because in this way, you can identify higher value-added activities, eliminate those without value, optimize the operations and controlling the expenses.

## 6. CONCLUSIONS AND RECOMMENDATIONS

This study examined the suitability to green logistics practices and ways of managing their costs on a factory farm in southern Brazil. First, it can be seen that the company has environmental targeting in their logistics operations, since many of the practices analyzed are introduced, even though at different levels of fitness. However, there are factors to be refined and developed, related to practices not or partially introduced. Thus, we present the following suggestions to the company:

- Having greater control over the allocation of parts, tires and scrap vehicles, because though it is a liability of carriers, the company may, through the collection and monitoring, induce environmental fit between partners;
- Requesting to suppliers, carriers and producers, even before its registration with the company, the presentation of pollutant emissions report;
- At the time of purchase, it is indicated to analyze the pollution potential of inputs and their packaging and, if appropriate, to provide conditions for the delivery of suppliers use a minimum of materials;
- When entering the system data products, purchased materials and supplies, expanding its characterization to report data on ecological criteria and, on that basis, giving preference to those at the time of purchase;
- The plan of recycled materials cleaning process if performed internally, or charge the recycling company to do so in order to control the use of water and pollutants;

- Disclosing environmental report with information on pollutant emission rates and to measure these data, deploy methodologies and performance evaluation tools;

- Searching environmental certifications such as ISO 14001 and its standards support and expand the ISO 9001 certification for more units;

- Focusing on the realization of online sales, for how their customers are markets, warehouses and specific points of sale, the acquisition of which is a greater amount, one option is to carry out orders for the site;

- Investing through sponsorship or guaranteed markets in developing green technologies;

- Seeking alternative materials and equipment, to integrate suppliers in product design, especially for Styrofoam trays that do not allow the recycling and reuse; and,

- Searching for incentives or government support for financing projects and Aury Luiz Bodanese Foundation (FALB).

It should be noted that according to the operations manager, the realization of the above practices is not ruled out by the company, but requires financial, human and technological resources, and therefore must take place in a planned and carefully way, to ensure the economic efficiency of the company. Some actions also depend on the availability of infrastructure and incentives by governments, such as the use of more transport modes ecologically efficient. For this, besides providing structural conditions, government could reduce taxation in order to reduce costs for businesses and motivate the use of other modes types.

Still, according to the practices of green logistics, as well as the company in question, other companies may promote actions with this bias without recognizing them in this way. Therefore, it is clear that despite having widespread in practice, to be an incipient concept to managers is not recognized and exploited to its full potential.

On the costs management, it is clear that most of the spending exists in the company regardless of the ecological practices. However, they suffer changes according to the necessary adjustments. To manage these costs, if requested, the company primarily uses the

comparative analysis, since there is an integrated system that enables trace information. However, most of the costs are treated jointly in the accounting and management reports, without specific identification or registration for those arising from ecological practices. Thus, it appears that it is necessary to introduce this environmental approach in the informational demands of the business by automating reports and generate new indicators related to the theme.

Thus, as proposed by Szymankiewicz (1993), who states that the main contributions to environmental improvement have an associated cost reduction criterion, it can be seen that many of the ways to measure and record information on green logistics are focused on cost reduction strategies.

Overall, the study enabled the company to display existing shares and controls that are sometimes disregarded but can serve as a basis for their strategies and how sustainable marketing. It should be noted that much information collected during checks will be included in the Sustainability Report of the company, which is currently not disclosed, but which had already been thought of for the coming periods.

Given the above, it is clear that the understanding of green logistic can generate many benefits to companies, either through better management of costs, enhancement of practices that generate social and environmental benefits or through the enhancement of their image.

Even before the contribution of this study, it is worth noting that this study is limited to the possible identification through interviews and internal processes checks. As to space limitations, the study directs itself to a Brazilian agroindustry, whose results cannot be generalized, since the introduction of green logistic practices and management costs have influence of different factors such as the size, the technological level, the area of operation, strategies of management, marketing strategies, the economy, among others. However, the details of these analyses serve for other companies because, when transcribing for their reality, this study shows indicatives and possibilities to be fitted.

Given the importance of the issue, it is pertinent to the development of further studies to investigate this phenomenon in different companies, sectors and countries, using as a basis the script followed in this study. It is also suggested confrontation forms of green logistic cost management, which were here identified with tools and present approaches in the literature, even if linked indirectly to the subject, such as logistics cost management and supply chain, in order to seek similarities, frameworks and associations.

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