Reverse logistics and the sectoral agreement of packaging industry in Brazil towards a transition to circular economy

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Abstract:
The objective of this article is to describe the first phase of the implementation of the Sectoral Agreement of Reverse Logistics of Packaging in Brazil, from the perspective of the transition to the circular economy. For this purpose, a case study was carried out, considering as analysis unit the Brazilian sectoral agreement of reverse logistics of packaging. The data collection was conducted through documental analysis and interviews with waste pickers associations, managers in the business sector and government representatives, who are the key signatories of the agreement in focus. The results were triangulated in order to show different perspectives unveiled by the research sources and methods. The analysis of results was carried out based on content analysis proposed by Bardin (1977), in which categories were defined *a priori* and adjusted *a posteriori*. The main results show that the concept of circular economy, although not formally expressed in the Brazilian law and sectoral agreement, guides the actions developed by the signatories of the agreement. This article can serve as an input for researchers and practitioners interested in sectoral agreements in Brazil and in developing countries, as well as input for managers in the public and private sectors and other key stakeholders concerned with the implementation of reverse logistics under relevant legislations on solid waste management that reinforce transitions to the circular economy.

Keywords: Brazilian Policy of Solid Waste; Circular economy; Recycling of packaging waste; Reverse logistics; Sectoral agreement of reverse logistics of packaging; Shared responsibility

1. Introduction

Recycling and related issues have received an increasing attention in the past decades, due to this fact, some countries have created legislations focused on waste management (Guarnieri, Silva & Levino, 2016). This phenomenon is observed mainly in developing countries, in which practices related to waste management and reverse logistics are in state of infancy (Bouzon et al., 2015; Ferri, Chaves & Ribeiro, 2015).

Brazil is one of these countries, in 2010 the law 12,305 related to Brazilian Policy of Solid Waste was enacted. Under this law some innovations were established, such as the principle of shared responsibility on waste management among supply chain actors, the adoption of reverse logistics enabling closed-loop of materials and the inclusion of waste pickers in materials recovery processes (Brazilian Policy of Solid Waste, 2010). It is important to point out that the law established the obbligation to implement reverse logistics for several types of residues, among them are the packaging in general (Brazilian Policy of Solid Waste, art. 33, 2010).

With regard of the principle of shared responsibility, it is still surrounded by complex issues. In this context, sectoral agreements have been proposed in order to enable the implementation of reverse logistics (Guarnieri, Silva and Levino, 2016). The sectoral agreements are contractual acts that aim to guarantee that residues return to their related manufacturer through reverse logistics. With its formalization, it is expected that the companies in supply chains feel stimulated to implement reverse logistics systems for residues (Brazilian Policy of Solid Waste, 2010). The most advanced sectoral agreement, which is currently in progress, is the one related to packaging in general.

The packaging segment has interesting particularities in Brazil, due to the involvement of waste pickers in the return process of packaging residues in general. In many municipalities in Brazil, the collection of recyclable materials is in charge of waste pickers, who act in different stages of waste return cycles (Guarnieri and Cerqueira-Streit, 2015). Informal waste recycling is a common activity in developing countries, as it represents an important source of income for informal workers. It is estimated that around 300,000 people act as waste pickers in Brazil (Brazilian Organization of Waste Pickers, 2013).

Over the last years quite a few studies were developed with focus on the Brazilian Policy of Solid Waste and its implications. For instance, Jabbour et al. (2014) discussed key aspects of this Brazilian law and the implications for various stakeholders, also identifying the opportunities and lessons to be learned. Ferri, Chaves and Ribeiro (2015) considered guidelines of the Brazilian law to propose a reverse logistics network for municipal solid waste management, with the inclusion of waste pickers, in order to solve the challenge of economically managing waste. Bouzon, Govindan and Rodriguez (2015) investigated the development of reverse logistics in Brazil and identified 25 barriers that need to be overcome for the success of its implementation.

Guarnieri and Cerqueira-Streit (2015) discussed the implications for waste pickers of the Distrito Federal, Brazil, from the obligation of the reverse logistics of residues determined by the Brazilian law. Guarnieri, Silva and Levino (2016) studied problems concerning the implementation of the sectoral agreement of the e-waste in Brazil, and proposed the use of the Strategic Options Development Analysis (SODA) methodology to specify key variables supporting strategic decision making in the context. Similarly, Caiado et al. (2017) studied the credits of reverse logistics of e-waste in Brazil, motivated by the Brazilian Policy of Solid Waste.

The material recovery aspects involved in the studies above mentioned, as well as the economic, social and environmental sustainability dimensions they address, can be related to

important practices of the circular economy, which is predicated on production systems that take into account opportunities for reverse cycles not only of products, but also of residues such as packaging (Dervojeda et al. 2014; Ellen MacArthur Foundation 2014).

However, to the best we know, no research has addressed the sectoral agreements in Brazil after their implementation, analysing the aspects related to waste picker inclusion. In addition, thus far no research approaches the Brazilian Policy of Solid Waste, under the perspective of the transition to circular economy. To fill this gap, the purpose of this article is to describe the implementation of the 'Sectoral Agreement of Reverse Logistics of Packaging' in Brazil, which is a key instrument of the Brazilian Policy of Solid Waste law, from the perspective of the transition to circular economy, as presented in the Figure 1:

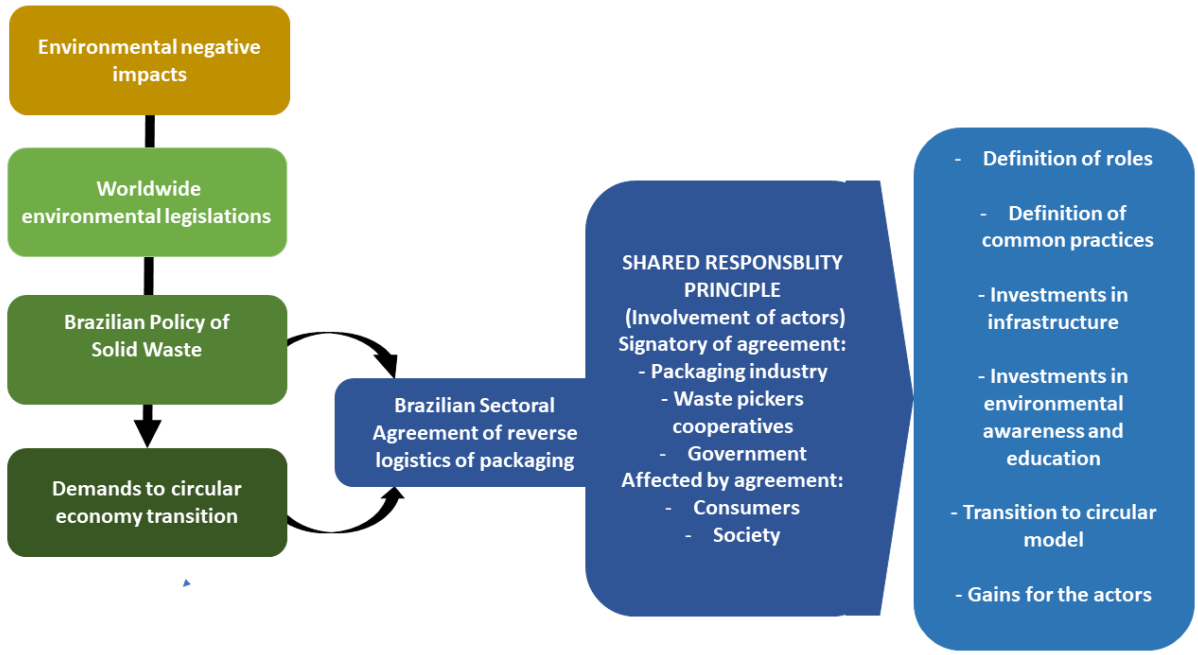

Figure 1. Graphical abstract

Source: The authors.

As illustrated in Figure 1, the negative impacts in environment caused by the incorrect disposal of waste and by the scarcity of raw materials impells governments worldwide to implement restrictive environmental legislations. Among many countries, mainly developed ones with waste management legislations, we can detach in this research, Brazil. Brazil is considered the pioneer in Latin America and Caribbean countries to implement such legislation related to waste management. It is important also to highlight that, in this worldwide context, arises the demands for circular economy models transition.

In this context, in order to guarantee the law enforcement, Brazil established in the Brazilian Policy of Solid Waste, the creation of sectoral agreements, which are drived by the 'Shared

Responsibility' principle. This principle comprises all actors involved in some supply chain, making them responsible for the waste management and the adoption of circular models. In the case of packaging sector we can detach: packaging Industry (suppliers, manufacturers, recyclers); waste pickers cooperatives (performing the packaging waste collection); Brazilian government (fiscalizing the law enforcement); consumers (discarding packaging).

However, in order to make the sectoral agreement operational, we need to define: i) What are the roles of the actors involved? ii) What are the common practices to enable the circular economy transition? iii) Who will perform the investments in infrastructure and in environmental awareness and education of the consumers? iv) What are the gains to actors involved in the process?

In order to answer these research questions, it was conducted an exploratory and descriptive research based on qualitative approach. An holistic single case study was performed, focusing on the Sectoral Agreement for reverse logistics of packaging in Brazil. The data collection was conducted through interviews with representatives of signatories of the agreement and, documental analysis.

Our study found that although the concept of circular economy is not formally expressed in the Brazilian Policy of Solid Waste law, and in related reports such as the 2017 Packaging Coalition Report, some elements of this concept were incorporated in both documents. This article provides a more detailed characterization and progress of the 1st phase of this sectoral agreement, clarifying the role of the key actors involved in integrated waste management, the existing infrastructure and the related circular economy perspectives for the business sector and for the cooperative of waste pickers.

Singh, Ashton, Buch, Babbitt & Seager (2019) highlight that in this context, not only the opinions of members of non-governmental organizations and industry representatives should be heard, but also, the opinions of formulators and implementers of public policies. Qualitative research based on case studies provide a helpful methodological approach to demonstrate how circular economy is being implemented in real world scenarios and the role that regularoty mechanisms can play in the context.

Moreover, we recognize that circular economy is a wide concept based on resource efficiency systems with a broad spectrum of restorative approaches such as Reuse, Repair, Remanufacture, Recycling and so forth (Batista *et al*., 2019). This paper is particularly related to the Recycling approach of the circular economy, enabled by the Reverse Logistics systems that operationalize the return and revalorization of the waste, in the same or diverse industrial sectors.

2. Literature Review

2.1 Circular Economy

The concept of circular economy has received increasing attention in the last decades, especially by lawmakers, lawyers, consultants and scientists who approach the theme with a focus on a more sustainable society (Reike, Vermeulen and Witjesb, 2018). There are many initiatives to implement circular economy, as such as, stock optimization, eco-efficiency and eco-effectiveness, waste reduction and the 4Rs, developed by the main actors involved, which arethe legislative and governmental bodies, non governamental organizations (NGOs) and consultancy firms (Kalmykova, Sadagopan and Rosado, 2018).

The life cycle of a good or service, represented by the stages of the production and marketing process, from the extraction of raw materials to the final disposal of waste, was commonly known by the expression 'cradle to grave', in which the cradle is the environment from which natural resources are extracted, and the grave is the environment where the final destination of waste takes place. The concept of 'cradle to cradle' goes beyond the view 'cradle to grave', including waste again in the productive cycle as resource (Braungart, McDonough and Bollinger, 2007).

Although the first article on circular economy was published by Andersen (2007), which presented an overview of the fundamental principles and approaches in environmental economics aiming the sustainability, this concept seems to be implicit in the concept of 'cradle to cradle'. Considering the residue as the "food" for a new product in the same production process or in different processes, which makes the product life cycle infinite (McDonough and Braunart, 2002). The need to extend the useful life of products is a fundamental premise of the circular economy, which encourages reduction of materials disposal to landfill and incineration, returning the residues to productive business cycles (Reike, Vermeulen and Witjesb, 2018).

Japan and China were the first to formally introduce circular economy policies at the national level. In the European Community, several countries have implemented initiatives, policies and guidelines, among which can be cited: Denmark, Germany, the Netherlands and the United Kingdom (Reike, Vermeulen and Witjesb, 2018). The circular economy deals with the production cycle, starting from product design, selection of suppliers and raw material, production, distribution, consumption and at the end, its collection for recycling, remanufacturing or reuse (Zhang et al., 2012).

These tasks aim to mitigate the maximum, but not eliminate, waste at the end of the process (Zhang et al., 2012; Ghisellini, Cialani and Ulgiati, 2016). As stated by Andersen (2007) the

circular economy cannot ensure zero waste. This approach is focused on material efficiency, providing residues at the same level of economic value, reducing waste, environmental impacts and allowing easy implementation in existing production structures. Daly (1977) apud Ghisellini, Cialani and Ulgiati (2016) already emphasize the impossibility of a fully circular economy, with products and energy turning back to raw materials forever, considering the entropy law.

Considering that the residue must to return as raw material for the same or for another production cycle, through the reverse cycle, the reverse logistics is needed. To his end, the residues need to be collected, transported, sorted, and then conducted to recycling, remanufacturing, recondicioning or refurbishing processes (Braungart, McDonough and Bollinger, 2007).

2.2 Sectoral agreements for reverse logistics in the Brazilian context

The law no. 12,305 deals with the Brazilian Policy of Solid Waste and it was enacted on August 2, 2010, after aproximately twenty years of discussions in the Brazilian Government. It is based on principles such as shared responsibility and it also establishes goals, guidelines, instruments and actions for the integrated management of solid waste. According to Article 33 of the aforementioned law, all the supply chain of agrochemicals, batteries, tires, lubricating oils, fluorescent lamps, electronic products and their components, and packaging in general are obliged to implement systems of reverse logistics through sectoral agreements (Brazilian Policy of Solid Waste, 2010). Jabbour et al. (2014) emphasize that the implementation of reverse logistics in Brazil, imposed by Brazilian Policy of Solid Waste is a challenge.

It is important to note that in Latin America and the Caribbean, nine countries already have regulations for solid waste management, in which the principle of shared responsibility is also adopted. Some of these countries, including Brazil that is considered a pioneer, consider the insertion of waste pickers in the reverse logistics process, differently from what happens in developed countries, which do not have the presence of this category of workers (Ferri, Chaves and Ribeiro, 2015, Guarnieri and Cerqueira-Streit, 2015).

Although in the text of the Brazilian law there is no mention to the circular economy, which can be explained by the recency of the concept, it has some guiding principles and objectives which are typical of the circular economy concept, among them, we emphasize the following ones: i) the non-generation, reduction, reuse, recycling and treatment of solid waste, as well as environmentally appropriate disposal; ii) the stimules to adoption of sustainable patterns of

production and consumption of goods and services; iii) the adoption, development and improvement of clean technologies as a way to minimize environmental impacts; iv) the reduction of the volume and hazardousness of hazardous waste; v) the incentive to the recycling industry, with a view to promoting the use of raw materials and inputs derived from recyclable and recycled materials; iv) the integrated solid waste management; vii) the articulation between the different spheres of public power, and these with the business sector, with a view to technical and financial cooperation for integrated solid waste management and, viii) the technical training in the area of solid waste (Brazilian Policy of Solid Waste, art. 7, 2010).

The shared responsibility in waste management requires that all actors involved in the generation of the waste, namely: manufacturers, importers, government, resellers and, mainly, consumers, besides waste pickers (collecting mainly the packaging in general) work together, with individual responsibilities in each link of the reverse logistics process (Brazilian Policy of Waste Management, 2010, Guarnieri and Cerqueira-Streit, 2015, Ferri, Chaves and Ribeiro, 2015; Guarnieri, Silva and Levino, 2016).

Among the instruments to the implementation of the law in Brazil, we emphasize in this paper that the sectoral agreements are importante to make feasible the implementation of reverse logistics systems (Guarnieri, Silva and Levino, 2016; Guarnieri and Cerqueira-Streit, 2015). The Brazilian Policy of Solid Waste (2010), in its Article 3, defines sectoral agrement as an act of a contractual nature entered into by public authorities, manufacturers, importers, distributors or traders, with a view to implementing shared responsibility for the product life cycle.

Some sectoral agreements are still being negotiated, as is the case of the electronics segment. According to data from the National Information System for Solid Waste Management - SINIR (2018), another three sectoral agreements are already in the implementation phase: i) Plastic Packaging of Lubricating Oil (signed in December 2012); ii) Sodium and Mercury Fluid Light Lamps and Mixed Light (signed in November 2014) (SINIR, 2018). Both involve few actors in the process, considering the legal requirements for the handling and treatment of components considered to be highly toxic (Guarnieri, Silva and Levino, 2016).

The third agreement, currently being implemented, considered as the most advanced one in terms of implementation phasis, is the 'Sectoral Agreement for the Implementation of the Reverse Packaging Logistics System in General', which was signed in November 2015 (SINIR, 2018). Considering the particularities related to packaging, it was planned the support for cooperatives of waste pickers and partnerships with retailers for the installation of voluntary delivery points (SINIR, 2018; Batista *et al*., 2019). In this context, it is important to point out

that in Brazil, waste pickers account for almost 90% of recycled waste (Institute of Applied Economics Research - IPEA, 2012). The discusson around the recycling of packaging, mainly related to plastic, has increasing mainly considering the marine plastic pollution and quantification of the environmental losses of plastics in the world (Ryberg et al., 2019). Thus, the implementation of innitiatives related to packaging, mainly related to plastic, are pressing.

From the discussion above, we summarize the following points concerning the implementation of legislation and sectoral agreements for reverse logistics of packaging in Brazil.

- The implementation of reverse logistics imposed by the Brazilian Policy of Solid Waste faces operationalization challenges due to the variety of players involved in packaging recovery value chains.
- Differently from developed countries, waste pickers in Brazil play an important role in the implementation of reverse logistics for packaging recovery. Their organization into cooperatives seems to be a key step to enable their formal participation in sectoral agreements.
- Sectoral agreements are critical instruments to establish the individual responsibilities required in the shared responsibility approach necessary to implement reverse logistics systems involving different actors. However, some sectoral agreements are still being negotiated and the practical benefits of their adoption in the operationalization of reverse logistics of packaging seems to be overlooked by the industry, which tends to see the matter from a legislation compliance perspective only.

Besides the issues summarised above, as previously mentioned it is possible to find clear links between the Brazilian legislation and policy guidelines on the matter and sustainable practices and principles advocated by the circular economy. Yet, there is no clear reference to circular economy in the law narrative, which demonstrates lack of awareness and understanding of the key role that sectoral agreements can play to enable industrial transitions to the circular economy.

3. Methodological procedures

Considering the purpose of this article, this research can be categorized as applied, descriptive and explorative, based on qualitative approach. We use the single case study as strategy, in which the unit of analysis is the ‘Brazilian Sectoral Agreement for the implementation of reverse logistics of general packaging’. In analyzing such unit, we consider

three actors with conflicting points of view and interests related to the unit namely: waste pickers association; packaging industries association and, government. To keep methodological coherence, we take their different viewpoints into account in order to develop a holistic characterization of a single case study.

It is important to point out that in Brazil, after the Law 12,305 has been enacted, several supply chains have organized initiatives to implement reverse logistics practices enabling the waste return and revalorization in new products, which is aligned with the circular economy principles. This law forces the implementation of the waste management and the reverse logistics, among other issues, of several types of residues: i) agrochemicals and its packaging; ii) batteries; iii) insufferable tires; iv) lubricant oils, its residues and packaging; v) lamps in general; vi) electronic waste and, vii) packaging in general (Brazil, art. 33, 2010).

Since 2010, the sectors are trying to set up sectoral agreements, involving the whole supply chain under this transition to circular economy, however only the packaging sector was concluded the negotiation and has ongoing process of implementation. Following methodological recommendations by Yin (2017), we opted to study this sectoral agreement, because of its originality and representativeness of the case in relation to the subject matter considered. That is, the unit of analyzis provides a typical and revealing case.

In order to provide internal validity to this research, the data colletion was conducted through documental analysis and interviews with different members of the packaging industry. By considering a diversity of actors involved in the case, it is possible to obtain valuable information from participants in one group of actors that might not be provided by other groups.

The documental analysis was based on the ‘Technical Report of Sectoral Agreement of Packaging from Brazil”, published in November 2017. This pivotal report is a demand from agreement signed by Brazilian Goverment, Brazilian Asssociation of Waste Pickers and Brazilian Business Sector related to Packaging.

This document was elaborated by the Technical Consultancy Lenum Ambiental with the Technical Commitee of Coalizion of Packaging Companies represented by Cempre (Business Commitment for Recycling). The report shows the performance related to the first phase of implementaion of the sectoral agreement, based in actions performed between 2012 and 2017. It is importat to highlight that the Brazilian Association of Waste Pickers, which is also a signatory of the agreement is elaborating another report, which is not concluded yet. The reports are demanded in sectoral agreement in order to assess and monitor the related reverse logistics systems.

The interviews were carried out in order to validate and complement data obtained from documental analysis. Three key people were interviewed: i) Technical coordinator of the Brazilian Association of Waste Pickers (Interviewee A); ii) Environmental Analyst of the Ministry of Environment from Brazilian Government and (Interviewee B), iii) Senior Consultant from the Technical Commitee of Coalition of Packaging Companies (Interviewee C). The participants of the study comprised key representatives of each signatory group of the sectoral agreement, who also were engaged in the discussion and elaboration of it. More specifically, the participants were key signatory representatives in their groups. For instance, the waste pickers representative represents an important Brazilian association of waste pickers cooperatives, the government representative is an expert in the top echelon of the central government who is directly involved in the application of sectoral agreements in Brazil, and the industry representative represents the coalision of 22 industries in the packaging sector. Due to the important managerial and technical functions they are responsible for, they were very knowledgeable on the subject matter, being able to provide in-depth, comprehensive and relevant information.

The sampling is characterized as non-probabilistic, which is more suitable for a qualitative research. The respondents' choice was made considering the criteria of representativeness and accessibility, given their positions and the strategic information they possess, which is essential for a better understanding of the problem studied in this article.

The names of the research participants were omitted for non disclosure agreement purposes, the interviews were conducted in person and by phone, and complemented by electronic mailing. The content of the interviews was transcribed in order to enable content analysis. The interview script comprised ten questions divided in four categories: 1) Characterization of the Sectoral Agreement; 2) Understanding on Circular Economy concepts; 3) Infrastructure and Operacionalization of Sectoral Agreement and, 4) Perspectives for the transition to Circular Economy with the Sectoral Agreement. After the transcription of the interviews, we sent the transcripted data to the interviewees in order to proceed with the validation of the data gathered. It is important to emphasize that all participants agreed with the content of the interviews. This procedure also reinforces the internal validity of the research, as stated by Silverman (2005), who considers tape recording, carefully transcribing, using fixed open questions as much as possible, and presenting long extracts of data as important means to guarantee the reliability of the results. In addition, to ensure the reliability of the data provided we maintained the data in original format stored for future consultation. The transcribed data was analyzed by two researchers in order to check for coherence of the text and interpretation.

To guarantee the internal validity of the research, as pointed out by Gibbert, Ruigrok & Wicki (2008), we proceed with the triangulation process. The triangulation consists of adopting different angles of the same phenomenon, by using different data collection strategies and different data sources (Denzin & Lincoln, 1994). Accordingly, the results from documental analysis were compared with data obtained from the interviews, enabling the triangulation between data instruments. In addition, we proceed with another triangulation process, comparing the perceptions of the three interviewees in relation to the fixed questions in the interview script ddressing the sectoral agreement results and the transition to the circular economy.

External validity is related to generalizations of the case study that are aimed at analytical generalizations and not at statistical generalizations (Gibbert, Ruigrok & Wicki, 2008). To adress this type of validity, it is necessary to consider similar studies approaching the same variables. As this is a single original case study on the subject considered, we did not have other identical case studies with the same characteristics of ours. However, we add a certain degree of generalizability to this study by considering recommendations from Gibbert and Ruigrok (2010) and in the Discussion section (Section 4.6) we compare the results of this case study with other similar studies in the area.

The case study had as objective to answer the following research questions:

RQ1 - What is the role of supply chain members in the Brazilian Sectoral Agreement of Packaging, considering the three signataries of the agreement: waste pickers cooperatives association; packaging industries association; Brazilian government?

RQ2 – Who are the responsible by the infrastructure and the operationalization of the agreement?

RQ3 – How the sectoral agreement will contribute to the transition to circular economy in Brazil?

RQ4 – What are the gains for cooperatives of waste pickers and supply chain of packaging with the agreement?

Considering the research questions stated above, it is important to point out that, the consumers were not considered in this research because they did not sign the agreement through any association, however we recognize that the consumers can be affected by the agreement.

In this research, we considered that the implementation of collection points, as well, the infrastructure necessary to enable the reverse logistics and the actions to aware and educate the consumers need great investments (Guarnieri, Silva & Levino, 2016). We also emphasized that,

related to the contributions to circular economy transition, we considered only the case of packaging, and were not considered the other type of waste. Moreover, we are considering only the part of Recycling processes and Reverse Logistics in our study.

Moreover, we highlight that the waste pickers are the most vulnerable actors in the agreement and the packaging industry has more bargaining power in the supply chain of packaging. On the other hand, the Brazilian government has the prerogative to fiscalize and guarantee the law enforcement (Guarnieri & Cerqueira-Streit, 2013).

The case study comprised the following steps, as proposed by Yin (2017): i) definition of the type of case study and delimitation the analysis unit: Single holistic case study with focus on Brazilian sectoral agreement of reverse logistics of packaging; ii) definition of research questions, which guided the elaboration of instruments to collect data (interview scripts and document analysis script); iii) data collection (interviews and documental analysis); iv) selection, analysis and interpretation of data (considering the transcription of the interviews and data gathered from documents); v) elaboration of a report with results gathered, with propositions and concluding remarks (based in each category of results), which are presented in Section 4.

The analysis of results obtained by documental analysis and interviews was carried out through categorial content analysis technique, as proposed by Bardin (1977). This analysis was based in categories defined *a priori* and, considering the transcription of the interviews some elements allowed to define some categories *a posteriori*. Table 1 presents the categories defined *a priori* and *a posteori*.

Table 1. Thematic *a priori* and *a posteriori* categories to analyze the sectoral agreement

***A priori* categories**	**A priori and a posteriori analytic categories**	**Authors**
Actors viewpoint about agreement	The role of actors involved in the sectoral agreement	Brazilian P/olicy of Solid Waste (2010); Zhang et al. (2012); Jabbour et al. (2014); Guarnieri and Cerqueira-Streit 2015); Bouzon, Govindan and Rodriguez (2015); Guarnieri et al. (2016); Ghisellini, Cialani and Ulgiati (2016); Murray, Skene and Haynes (2017); Ritzén and Sandström (2017); Batista et al. (2018a); Batista et al. (2018b); De Angelis et al. (2018).
Infrastructure	Infrastructure and investments in environmental awareness and education	
Sectoral agreement and circular economy	The contributions of the sectoral agreement to circular economy transition	
Benefits of sectoral agreement	Gains of sectoral agreement to waste pickers cooperatives and industries	

Source: The authors

Thus, the *a priori* and *a posteriori* analytical categories presented in Table 1 served as a basis for: i) a detailed analysis of the roles and responsibilites to be carried out by the actors

involved in the sectoral agreement (government, industries, waste pickers and consumers); ii) a detailed analysis for the infrastructure and investments demanded to implement collection points of packaging and environmental awareness and education of consumers; iii) The impacts and/or constributions of the sectoral agreement to the transition to circular economy in Brazil; iv) The benefits/gains of the sectoral agreement related to actors involved, mainly waste pickers cooperatives and industries. The categories were defined *a priori* based on the authors presented in Table 1 and then, adjusted when the interviews transcriptions were analyzed in depth. The content analysis involved the following steps, presented in Figure 2.

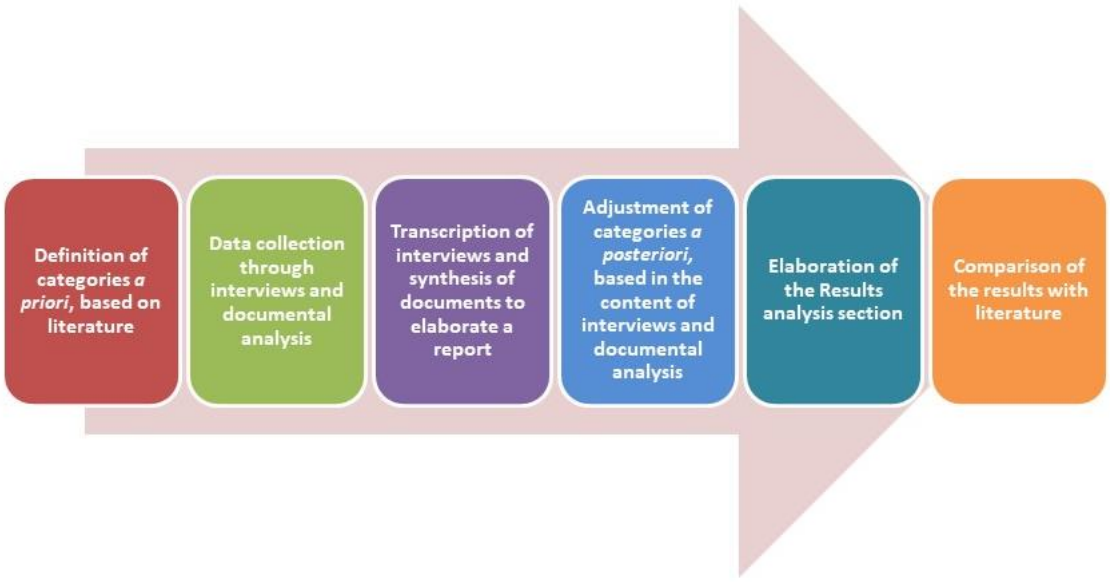

Figure 2. Steps of content analysis
Source: The authors

The outcomes of the conduction of these steps generated important findings, which are discussed in detail in the next section.

4. Results analysis

4.1 Characterization of the Brazilian Sectoral Agreement of Packaging

The scope of the reverse logistics system for packaging in phase was given priority to the FIFA World Cup host cities and its metropolitan regions, that took place in Brazil in 2014, namely: Belo Horizonte, Brasília, Cuiabá, Curitiba, Fortaleza, Manaus, Natal, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo. The composition of municipalities defined as Urban Agglomerations (AU), Metropolitan Regions (RM) and Integrated Regions of Economic

Development (RIDE) were also included. Thus, 258 municipalities are the total number of municipalities covered by Phase 1 of implementing the reverse logistics system in the packaging sector in Brazil.

By packaging, it is considered the dry fraction of solid waste collected, subject to recycling. Data from IPEA (2012) show the proportion of total collected waste, which 51.4% is organic matter, 31.9% dry recyclable materials and 16.7% are considered other. The dry recyclable materials can be subdivided into paper and cardboard (13.10%), plastic (13.5%), metals (aluminum 0.6%, steel 2.3%) and glass (2.4%).

The Technical Report 2017 shows the investments made by the business sector (in stocks and not in monetary amounts) in this first phase of operationalization. Basically, the actions are divided in: 1) improvement of the triage process (direct and indirect investments in cooperatives and or associations of waste pickers) and, 2) improvement in the process of waste collection through Voluntary Delivery Points, commonly implemented in retailers.

The signatories companies of the sectoral agreement joined in a coalition in order to gather efforts to make reverse logistics feasible. This group comprises representative organizations of the business sector of industry and commerce, including manufacturers, importers, distributors and retailers. These agents, at the time of the signing of the Sectoral Agreement (November 2015), numbered 3,786 companies belonging to 20 Brazilian associations. In 2016 two more associations joined the coalition. Table 2 shows these associations:

Table 2. Members associations of Packaging Coalition

Abbreviation	Description
ABAD	Brazilian Association of Wholesalers and Retailers of Industrialized Products
ABAL	Brazilian Association of Aluminon
ABIA	Brazilian Association of Food Industries
ABIHPEC	Brazilian Association of Personal Hygiene, Perfumery and Cosmetics industry
ABIMAPI	Brazilian Association of Industrialized Biscuits, Pasta, Breads and Cakes
ABINAM	Brazilian Association of Mineral Water Industry
ABINPET	Brazilian Association of PET Products Industry
ABIOVE	Brazilian Association of Vegetable Oils Industry
ABIPET	Brazilian Association of Polyethylene Terephthalate (PET) Industry
ABIPLA	Brazilian Association of Cleaning Products Industry
ABIPLAST	Brazilian Association of Plastic Industry
ABIR	Brazilian Association of Soft and Non-alcooholic Industry
ABPA	Brazilian Association of Animal Protein
ABRABE	Brazilian Association of Beverages
ABRAFATI	Brazilian Association of Paints Manufacturers
ABRALATAS	Brazilian Association of Aluminun Cans Manufacturers
ABRAS	Brazilian Association of Supermarkets
IBÁ	Brazilian Industry of Trees
PLASTIVIDA	Plastic Socioenvironmental Institute
SINDICERV	Brazilian Syndicate of Beer Industry
ASLORE	Brazilian Association of Reverse Logistics of Packaging
ANR	Brazilian Association of Restaurants

Source: Technical Report of Sectoral Agreement of Packaging from Brazil (2017).

Analysing the report we could observe that although the coalition of companies states that 22 associations (Table 2) is a significant number, the number of companies that have adhered to the agreement is not yet enough. In addition, acccording to the interviewee A, the agreement still needs improvement, as can be seen in his speech: "*We (ANCAT) think that this is not the best agreement to implement reverse logistics in Brazil*." However, the interviewee A emphasizes the flexibility and, at the same time, the importante of recognition of the work performed by waste pickers, stating that "*even if it was not a perfect agreement, it was important to sign it to start effectively the implementation of reverse logistics in Brazil. In this sense, it was important also to guarantee the regulation of the agreement by some public agent and the fulfillment, even partially, of the interests of waste pickers*".

4.2 The role of supply chain members in the Brazilian Sectoral Agreement of Packaging

The documental analysis shows that Cempre (Business Commitment for Recycling) was elected as the organization responsible to facilitate and promote recycling in Brazil, coordinating the coalition of associations and companies. Cempre is a non-profit business association created in 1992 by large companies (such as Alcoa, BRFoods, Ambev, Coca-Cola, Danone, Dell, Tetra Pak, Unilever, Carrefour, Wallmart, Vivo, among others). This organization encourages the recycling through business engagement in solid waste management.

It was also possible to verify that in order to monitor the effectiveness of the implementation of the reverse logistics system, the coalition of companies has the following committees: Executive Secretariat; Technical Committee; Administrative Committee; Committee on Communication and Government Relations and, Legal Committee. Each of these committees have specific attributions, in common, aim at a better engagement of companies in the process of shared responsibility in the entire product life cycle.

The representative from Brazilian Government (interviewee B) added the following statement: "*Although Brazilian culture points out the public sector as main responsible for the sanitation agenda, economic activities related to the implementation of legislation open opportunities to several sectors. In this regard, the sectoral agreements open up a significant opportunity for appropriation by markets with free competition, making services cheaper and universalizing access to the waste collection*". However he admits that some regulatory and fiscal issues could be adjusted to positively reinforce the entry of private companies more strongly into these activities.

Given the principle of shared responsibility, some measures are needed to strengthen the structuration and the implementation of reverse logistics system. The business sector has made investments in cooperatives and associations. These investiments are not characterized as philanthropy or charity, but rather the finding that increasing efficiency in this type of organization is beneficial for the whole chain, considering the brazilian context.

When questioned about industry involvement, the interviewee A recognizes the shared responsibility as a challenge. At the same time he cites the trajectory of waste pickers category in recent years as positive. Especially when he states that "*even in this process of deceleration of the economy in Brazil and in a moment of weakening the regulatory power of the state, the Sectorial Agreement was signed. This can be considered as a great achievement of ANCAT*".

It is important to emphasize the interviewee A statement: "*It seems to me that the investment of the industries still falls short of what they can and what they owe!*". Nevertheless, the

interviewee A mentioned positive factors related to industries involvement: "*I do not doubt that there are a number of companies that have committed to the Sectoral Agreement. These companies have been performing concrete actions to give substance to the commitments they have signed*."

Regarding ANCAT's role in the sectoral agreement of packaging, according the documental analysis, it prioritizes actions aimed to waste pickers, whether or not acting in cooperatives and associations. The interviewee A highlights the historical importance of the waste pickers association stating: "*We deal with Government expressing the desire of waste pickers in sign the agreement, even considering that it was not the best possible agreement*." In addition, the interviewee defines the waste pickers association as "*a great center of aggregation of intelligences, technicians, partners, institutions that organize and assist cooperatives of waste pickers throughout Brazil*." The representative from coalition of companies, interviewee C, complements and agrees with this statement: "*Besides the association being the representative of waste pickers, we recognize its expertise, so the coalition hired us to conduct studies, develop systems and to perform the management and execution of projects to assist waste pickers' cooperatives*".

We observe with the interview that waste pickers association is also an agent of dissemination of information to waste pickers, related to gains, limitations and challenges of the sectoral agreement. Finally, it was pointed out by the interviewee C that "*our organization conducts the execution of the reverse logistics, while the industries meet the goals of investing in cooperatives in different ways: i) directly, ii) by hiring consulting firms or, ii) giving financial support to cooperatives through us*".

Regarding the role of the consumers, we could verify in the documental analysis that, the consumer starts the process by making proper separation of waste into recyclable and non-recyclabe ones, and directing it to a point of collection. Despite this, according to the interviewee C "*there is no voluntary involvement of consumers in the sectoral agreement*", which means that no organization representing these actors signed the agreement.

The interviewee A considers the role of the consumer to be fundamental, after all, the concept of shared responsibility is what prevails in the country and, the consumer is the responsible of waste before the environmentally friend disposal.

The representative from Ministry of Environment of Brazilian Government, interviewee B, states that: "*From the consumer's point of view, more effective communication and effective implementation of waste collection routines may also contribute to greater engagement with the agreement"*. The interviewee B also complements that: "*The role of the consumer*

materializes in three ways: i) consuming in a conscious and responsible way; ii) demanding improvements in production and quality processes from companies; iii) reusing packaging, and lastly, making correct disposal of packaging waste in points of collection".

These results corroborates the findings of Guarnieri et al. (2016), which studied the sectoral agreement of e-waste in Brazil and found that the environmental awareness is essential to enable the reverse logistics process. Zhang *et al*. (2012) also state that awareness is important to reduce waste generation.

4.3 Infrastructure and operationalization of sectoral agreement

Regarding infrastructure, the documental analysis shows that 2,082 poins of collection of waste were implemented between 2012 and 2017 in Brazil. 1,502 PEVs were located in municipalities in which the games of FIFA World Cup occurred. 24 states were contemplated with points of collection of waste. São Paulo is the state with more installed points of collection and, Acre and Pará are the states with less points of waste collection. In addition, it was provided by Cempre a website in which the people can search the points of collection closest to their residences.

Depending on the regional peculiarities, in each region there is a procedure for delivering the waste to sorting centres and subsequent destination to the recycling industry. Sorting centres are places in which the residues are classified and to trading. In this context, the interviewee B states: "*Increased number of points of collection of packaging waste is necessary, as well as the fair remuneration by the private sector to municipal urban cleaning services and waste pickers. This remuneration shall be proportional to the participation of the collected packages contemplated in the agreement. This issue is na essential point for the expansion and consolidation of the sectoral agreement of packaging*".

In addition, some actions related to environmental education were implemented, according the documental analysis, aiming to encourage the mobilization of the population in the correct disposal of packaging. Schools, residential condominiums, parks, among other places are strategic to the installation of points of collection of waste. However, it is importante to point out that not only the location, but especially the engagement of the population is necessary for this type of action, in order to produce the expected results.

In this context, the implementation of a communication plan is expected for the current year (2018). Several informative materials will be distributed to the population, in order to explain the actions to be followed in proper disposal of waste. Besides that, it is expected an increase

in the participation of national and international events by members of the Coalition of companies to disseminate the strategies of sectoral agreement, according to information from the report analized.

Another requirement of the Brazilian Policy of Solid Waste law is related to data transmission, which is essential for monitoring the implementation of the reverse logistics. In this sense, the Coalition of Companies is implementing two information systems. Regarding the first system, it was already implemented and according to the interviewee A: "*it informs the volume of financial investment that each company placed in each cooperative*". For reasons of competitive confidentiality, neither ANCAT nor other companies in the sector have access to this data, only the recycling companies and the cooperatives that transact and process waste.

The second system is under the responsibility of ANCAT and it is expected to be installed soon. This systems is specifically related to the monitoring of packaging. According to the interviewee A: "*all the cooperatives supported by the Coalition of Companies will be registered and must inform the quantities that are commercializing with the recycling industry. Thus, both the industry and ANCAT will have the information on volume and type of recycled material* ". The interviewee C points out that the system will be very usefull and reliable, however in the cases when there are intermediate companies between cooperatives of waste pickers and recycling industries, the reliability can be damaged, due to the informality of the contracts with these companies.

4.4 The sectoral agreement of packaging and the transition to circular economy

Regarding the revaluation of packaging, under the perspective of the concept of circular economy, we can observe the absence of this term in the report from Coalition of Companies (2017), as well in the Brazilian Policy of Solid Waste and other regulations. Nevertheless, all the three interwiees agree that despite the absence this term in the Brazilian legislation, it considers in its essence relevant elements of the circular economy.

In addition, we recognize actions related to the concept of circular economy in the document analyzed. It was pointed out by the Coalition of Companies shows that today, Brazil has at least 858 recycling industries. From this total, 809 (94.2%) are companies that recycle and produce plastic packaging, 27 (3.14%) are paper recycling industries and 22 (2.5%) are aluminum packaging collection centres. These data denotes the importance of the reinsertion of the

packaging in the productive chain, which is a process highly encouraged by the circular economy.

The documental analysis also highlights the importance of the involvement of all members in the supply chain for the true operationalization of reverse logistics. The manufacturers, retailers, cooperatives of waste pickers and recycling industry needs to be aligned in all stages of the reverse logistics of packaging in order to guarantee its viability. These stages are directly linked to the concept of circular economy: environmentally sound disposal, collection, waste revaluation and recycling, enabling the use of the residue in the same or in other industrial process (EM Foundation, 2015).

The interviewee B states that: "*The recognition of the limitation of natural resources and the scarcity of energy and raw materials make the convergence and gradual transition from the current economic model to circular economy urgently*". In addition, he states that "*It is also important to understand the concept as an opportunity to reduce dependence on imported raw materials, contributing to the balance of the Brazilian's trade balance*".

Regarding the closed loop of the packaging waste, the documental analysis also shows that the principle of integrated management contributes to the implementation of the reverse logistics system. It is important to point out that the Brazilian Policy of Solid Waste (2010) and, consequently, the sectoral agreement (2015) aim to find solutions to waste taking into account not only the political and economic dimensions, but also cultural and social dimensions, based in a holistic perspective. In addition, the principle of shared responsibility, established by the Brazilian law, becomes relevant when it makes all supply chain members responsible for the waste they generate. Figure 3 shows the flow of reverse logistics of packaging in Brazil and the main actors involved.

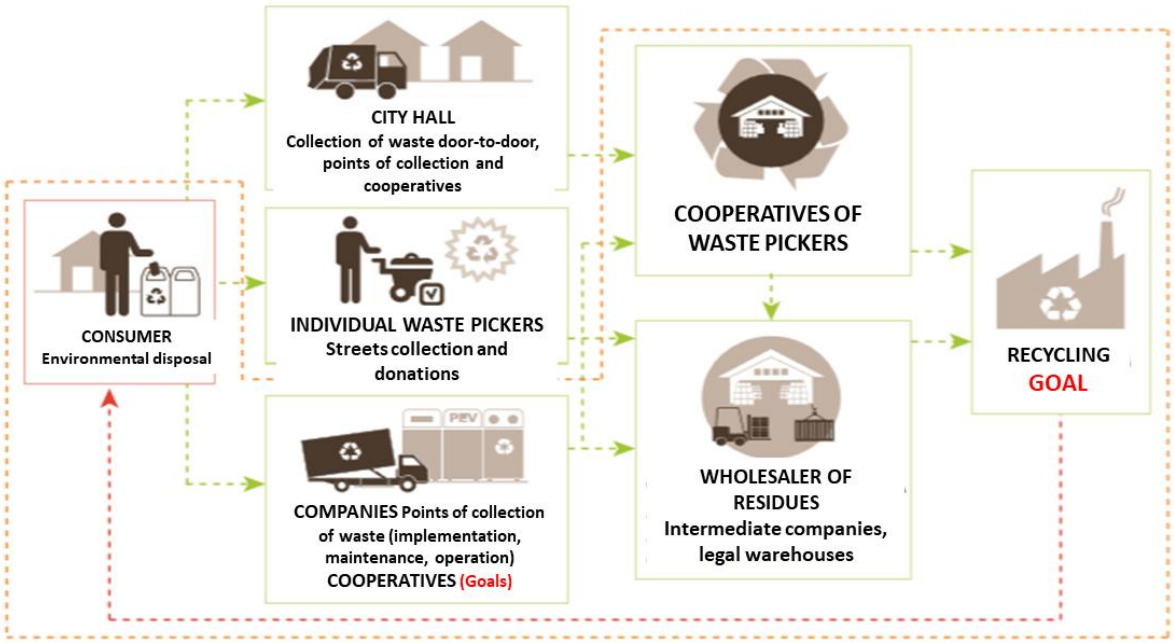

Figure 3. Reverse logistics flow of packaging in Brazil

Source: Report from Coalision of Companies for reverse logistics of packaging (2017)

As shown in figure 3, in the reverse logistics flow of packaging, the end consumer initiates the process, by making the environmental selective disposal of waste (recyclable and non recyclable). For this, end consumers deliver the waste in a point of collection, in general intalled in big retailers, or even collected in door-to-door by City Hall Services. In Brazil, we have the particularity of the active presence of waste pickers in this process, due to local culture and also, as established by the Brazilian law. The waste picker may play a role in this second stage by transporting packaging, or act only in the third stage, sorting waste. Sorting is the process of separation of materials, according to the demand of the recycling industry, since this material will be the input of the industrial recycling process. The report related to circular economy in Brazil, elaborated by Ellen MacArthur Foundation (2017) states that the informal sector in Brazil has, historically, developed a number of initiatives that apply principles of circularity, through markets of repair, reform,sale of secondary products and recycling chains, always incorporate of a strong social factor that drives these activities.

Waste pickers formally organized in cooperatives can also appear in the second and third stages, transporting and sorting the waste. When formally organized in cooperatives, the waste pickers may have partnerships with manufacturers, retailers, public companies and non-government organizations. Another possibility is the transporting and sorting carried out by City Hall Services of waste collection and the sorting carried out in sorting centres/warehouses.

The trading of residues can be performed by cooperatives of waste pickers as well by a wholesaler company, which is composed by intermediates, scrappers, popularly known in Brazil as "middleman". This configuration depends on the region, culture and the local organization of the waste pickers. Finally, there is recycling industry, in which the waste is converted in raw material, ready to be reinserted in further productive cycles. So, the closed loop supply chain of packaging is characterized. Closed loop supply chain are those composed of direct and reverse flows, forming "cycles" that make materials (used or not) return to previous points in the network for reuse or reprocessing for new use. Such circular supply chain archetype comprising a myryiad of material loops (or cycles) are typical of circular economy industrial systems (Batista *et al*., 2018a).

Likewise, the interviewee C states that "*The concept of circular economy advocates that the development of products be guided by life cycle studies indicating the least socio-environmental impact. Therefore, I understand that the concept is appropriate to society and needs to be pursued and continuously improved*".

The interviewee A considers that the 'circular economy' was contemplated in the Brazilian law and attributes the absence of the term in the legislation to the recent character of the concept. Besides that, he shows apprehension about the use of the term "circular economy", as stated: "*Throughout the process of discussion of the Brazilian Law (twenty years) several diferent names appeared in the academic and professional environments, and now we have the new name 'Circular Economy*'". The interviewee A explains that he truly fears that the theoretical/ideological discussion will shift the focus on the real problems generated by poor solid waste management, as stated "*I do not see a problem in creating a new label, which worries me is that we also begin to perceive a label dispute and, often we forget the real problem behind it*".

This statement is corroborated by Murray, Skene and Haynes (2017), which studied the antecedentes of circular economy concept. The authors found that there is no a consensus on the origin of circular economy, however there are several previous concepts related to it, like for example cyclical ecological system, closed loop supply chain/closed loop economy (based mainly in Germany and Japan practices), closed materials cycle economy or resources circulated economy, industrial metabolism (waste is food) and, industrial symbiosis. The main difference when compared to other concepts is that circular economy is largely emerged from legislation, mainly related to the Chinese context, rather than from the academy (Murray, Skene and Haynes, 2017).

Similarly, Ghisellini, Cialani and Ulgiati (2016) point out that the concept of circular economy has origin in different schools of thought. The authors indicate studies related to ecological economy, general systems theory, industrial ecology, regenerative design, performance economy, cradle to cradle, biomimicry and, blue economy, as antecedents of the concept of circular economy. A growing body of literature on the circular economy, however, indicates that the terminology 'circular economy' is being increasingly adopted by academics and practitioners as an umbrella term that embraces major antecedent sustainability-based disciplines, approaches and schools of thought applied in production and consumption systems (Batista *et al*., 2018b; De Angelis, Howard, and Miemczyk, 2018).

4.5 Gains for cooperatives of waste pickers and supply chain of packaging

Investments of several types were carried out in cooperatives and associations of waste pickers after the sectoral agreements have been signed, according the documental analysis, as such as: training advisory; training and qualification of waste pickers; training and qualification of managers of cooperatives to enable the access of financial loans; technical diagnosis of cooperative demands, among other. Actions related to implementation, maintenance, and operationalization of points of collection of waste were also performed.

For this reason, the engagement with cooperatives of waste pickers is necessary. A survey conducted by the Coalition of companies of packaging shows that 90.5% of the participants consider the waste pickers as environmental agents. This result shows the great empathy that the population has for this category of professionals and the recognition, even though they are "invisible" (in the figurative sense) in the daily routine of the citizens.

Regarding the gains for the supply chain of packaging, it was possible to observe that, in order to enable the continuous improvement in the recycling sector in Brazil, it is important to avoid actions that create instability in the production cycle. Mainly actions (in the public or private sphere) that will jeopardize the process of maturation of cooperatives of waste pickers, since it is a gradual and usually slow process. Because they are considered priority actors in the chain, cooperatives or associations of waste pickers must enjoy business stability to make sustainable progress, according the documental analysis. The representatives from the coalition of companies and from government agree that the waste pickers are a priority and essential actors in the implementaion of reverse logistics of packaging in Brazil.

These results show the concerns of the coalition of companies with the inclusion of the cooperative of waste pickers, as demanded by the Brazilian law (Brazilian Policy of Solid

Waste, 2010). In a study conducted by Guarnieri and Cerqueira-Streit (2015) and published before the sectoral agreement to be signed, it was pointed out by the interviewees of 23 cooperatives of waste pickers in Distrito Federal, the fear of not actually being included in the reverse logistics process. The waste pickers depend on the collection of packaging to generate income and support their families. This category of workers are also found in other developing countries, as such as India, Africa, Latin America and Caribbean.

The large regional diferences is another challenge to be overcome in order to improve the recycling performance in the sector as a whole. It is necessary to minimize the great differences found regarding the concentration of recycling industries in the Southeast region in relation to the North and Northeast regions in Brazil. Increasing the scale of collection and sorting of waste in the North and Northeast regions in Brazil can contribute with new perspectives to take investment of recycling industries and thus, increase the recycling indices.

Based on the experiences and results obtained in the implementation of Phase 1 of sectoral agreement, companies will analyze the main obstacles and formulate strategies to implement the actions of the reverse logistics system of packaging in Phase 2. The second stage will basically consist of the expansion of the planned measures in Phase 1, however, with an increase in the number of municipalities. The municipalities to be covered will be defined numerically and geographically according to criteria determined by companies in the coalition, according the analysis of the report. According to the interviewee C: "*The coalition of companies has already made the necessary improvements related to management of the necessary structure to successfully meet the commitments proposed for the Ministry of Environment for Phase 2, which will go until 2022*".

Lastly, the interviewee A highlights the importance of guaranteeing the socio-productive inclusion of the cooperatives of waste pickers, according to the statement: "*Recycling in Brazil arises from the need of a group of men and women who did not have income and find in the waste segment an opportunity for survival*." He ends the statement as follows: "*Recycling in Brazil does not arise from environmental awareness of the population. It was the waste pickers who created recycling in Brazil*. "

4.6 Discussion of results

The report analyzed recognizes that there are obstacles to be overcome, such as regional differences, infrastructure, information systems and communication (related to environmental education). At the same time, it states that these obstacles are being identified and overcome,

and the resolution will be addressed more appropriately in the subsequent implementation phases.

The report accounts for what has actually been done in terms of partnerships with retailers, implementation of points of collection of waste, environmental education actions, and recognizes the need for a communication plan to be conducted in the current year (2018). It also demonstrates the investment in cooperatives that are recognized as an essential link in the system of reverse logistics of packaging. The report also recognizes that it is expected an evolution in terms of professionalization of the waste pickers, which must be achieved in the long term.

The recognition that the implementation of reverse logistics in Brazil constitutes a challenge has already been emphasized by Jabbour et al. (2014). In addition, the barriers to the implementation of reverse logistics pointed out by Bouzon, Govindan and Rodriguez (2015) in the Brazilian context were also found in this research. Based on the analysis conducted in this study, we identified the following barriers in the Brazilian context: i) Technology and infrastructure; ii) Governance and supply chain process; iii) Economic; iv) Knowledge; v) Policy; vi) Market and competitors; and vii) Management. These barriers also apply to obstacles hindering the implementaion of the circular economy, as pointed out by Ritzén and Sandström (2017). Additional barriers found in the documental analysis and the content of interviews and are related to: i) Financial; ii) Structural; iii) Operational; iv) Attitudinal and, v) Technological.

Regarding financial aspects, we can emphasize the desire of waste pickers to be remunerated by the coalition of companies of packaging and/or by the government related to the packaging collection services. Although the coalition of companies made some investment in the infrastructure of the cooperatives, the waste pickers' representative believes that this is not enough to compensate the work done by the collectors in the collection of the packaging.

The structural barriers are related to missing information on the collection and reverse logistics of packaging, mainly when the negotiation between cooperatives of waste pickers and recycling industries are made by intermediates. The operational barriers are related to the implementation of points of collection of waste, as well the instalation of recycling industries and sorting centres in disadvantaged regions, which are distant from industrial poles in Brazil. Regarding the atitudinal barriers, there are some difficulties related to awareness of population in make the correct separation and disposal of waste.

With regard to technologial barriers, according the report from the coalition of companies, we have much more industries of packaging than recycling industries. This situation hinders the processing of waste and its reinsertion as raw material again in the production cycle.

Comparing the opinions from the report of the coalition of companies, interviewees A, B and C, we can observe a more optimistic perception in terms of overcoming these barriers from the companies' side. These divergences are expected, when we consider that the sectoral agreement of packaging has several actors with different points of view, as emphasized by Santos, Guarnieri and Cerqueira-Streit (2016) and by Guarnieri, Silva and Levino (2016). This situation does not indicate that the agreement is not possible or feasible, but rather that there are aspects to be discussed, analyzed and refined by the signatories of the agreement.

The results found in Brazil are similar to those found by Yuan, Bi, and Moriguichi (2008). These authors state that although circular economy is a accepted concept in China and there are many opportunities derived from it, there are also many gaps to be filled before the ideal circular economy. Among the issues pointed out by the authors are: theoretical development of circular economy, a systematic regulation and policy system, a well-prepared and enhanced institutional system (the structure and function of central and local government systems), well-developed technologies, and a well trained and informed public.

The Brazilian law deals with the minimization and non-elimination of waste, which is stated in the report from the coalition of companies of packaging. This fact is corroborated by Andersen (2007), Zhang et al. (2012) and, Ghisellini, Cialani and Ulgiati (2016), which state that 'zero waste' is not a feasible strategy. Moreover in the analyzed report, it was pointed out the need of revaluation the waste of packaging, as well the need of its reinsertion in recycling industries in order to close the product cycle. This idea is consistent with the views of Reike, Vermeulen and Witjesb (2018) and, Braungart, McDonough and Bollinger (2007), who consider waste as a valuable input to the environment and to productive processes.

The transition to a circular economy predicated on production systems that take into account opportunities for reverse cycles (closed-loops) of waste outputs posits a crucial importance on the role that reverse logistics and reinforcing legislations, such as the sectoral agreements conidered in this paper, can play to enable circular flows involving the recovery of materials (Howard, Hopkinson, and Miemczyk, 2018). Indeed, the critical role of the legal framework to promote transitions to the circular economy is acknowledged in a recent study by Batista *et al*. (2019), who point out that the legal framework represents the cognitive, normative, and regulative pillars of the institutional environment of a country, and it can reinforce the implementation of existing recycling agreements by implementing more favorable policies and incentives to recyclers and related cooperatives. Some actions to implement circular economy as waste reduction and the 4Rs, as pointed out by Kalmykova, Sadagopan and Rosado (2018), it is already been implemented by NGOs, industries and consultancy firms in Brazil.

It is important to highlight that the interviewee B recognizes that some regulatory and fiscal issues could be adjusted to more positively enable the participation of the private sector. In terms of perspectives for the business sector and cooperatives of waste pickers, both sources of data (report from the coalition of companies and interviewees A and C) agree that it is important to avoid actions that create instability in the productive cycle. Some improvements required by the Ministry of Environment after the publication of report in 2017, are already planned and partially implemented to Phase 2.

In addition, both sources of data highlight the importance of the waste pickers and their formal organization in cooperatives, for the success of the implementation and operation of reverse logistics system of packaging waste. This can be explained by the fact that these professionals were the precursors of the incentive to recycling in Brazil. It is recognized that the investment in cooperatives is not about philanthropy. Rather, it refers to the socio-productive inclusion of waste pickers in the reverse logistics system. Thus, it is necessary to consider the reverse logistics and these actors in all phases of the product life cycle, from their conception to their reintegration into the productive cycle, as stated by Santos, Ferri, Chaves and Ribeiro (2015), Guarnieri and Cerqueira-Streit (2016) and Guarnieri, Silva and Levino (2016).

Additionaly, we can compare the results of this research with some other case studies, focusing on circular economy. Domenech *et al*. (2019) draw attention to the fact that from the many case studies carried out so far, just a few of them have studied industrial symbiosis linking with the circular economy topic. The industrial symbiosis is a concept that seeks to approximate the industrial system to the benefits associated with a more integrated chain, with the best use of materials, energy, capacity, expertise, among others. Considering this context, industrial symbiosis is one of the precursor concepts from which the circular economy originated. For instance, in a study by Ghisellini, Cialani and Ulgiati (2016) the authors carried out a descriptive mapping of industrial symbiosis initiatives in Europe through the identification of key characteristics and main obstacles to implement simbiotic realtionships between organizations. To achieve this goal, among other techniques, the authors performed 25 semi-structured interviews with public policy makers and public officials. The results suggest that the industrial symbiosis activity produced important environmental, economic and social benefits and contributed to increase the circularity of the manufacturing sector. As suggestions for future studies, the authors recommend that the role of public policies and institutional relationships be investigated to better understand the implementation of integrative models that can reduce waste and dependence on raw materials (Domenech et al., 2019). Their recommendations are

in line with our research, considering the policy makers as important agents to stimulate transitions to the circular economy.

Although in Europe packaging waste management has its own policies, since the 1990s, Mrkajić, Stanisavljevic, Wang, Tomas & Haro (2018) noticed that there was a discrepancy in the values presented between the countries of the European Union. In order to understand this problem, the authors divided the countries into three categories: the founding states of the European Union; the states that are recent members and those countries that want to join this economic bloc.

The authors evaluated both quantitatively and qualitatively the packaging waste management system of Serbia, which is based on the Producer Extended Responsibility Scheme (EPR). Quantitative data were obtained from government reports and qualitative data were obtained through fourteen interviews with experts from various areas such as municipal representatives, members of non-governmental organizations and recyclers of packaging waste. Formal selective waste collection is inefficient, besides there is a scarcity of qualified professionals in municipalities, no matter how much the environmental conscience of the citizen has grown (Mrkajić et al., 2018). The results of this case study have similarities with Brazil considering the existence of informal waste collection, which is commonly found in developing countries and, it is motivated by the ineffiencies in existing formal processes.

Moreover, through an extensive literature review, Alaerts, Augustinus & Van Acker (2018) describe the various plastic recycling processes currently applied in the industry. The results show that as much as biodegradable, collecting biologically based plastics with organic waste is not recommended. It is also not recommended to mix different types of plastic. According to the authors, the ideal is that bio-based plastics be collected as plastics and sent for recycling separately. Although their study provides interesting findings, the authors recommend that interviews should be carried out with companies in the plastic packaging chain in order to achieve better understand of the process. This reinforces the need for qualitative research based on case study approaches. Ryberg et al. (2019) emphasises the need to study the value chain of plastic, mainly related to mismanaged waste management.

Such approaches provide insightful evidence that take into account, the opinion of experts in non-governmental organizations, key industry sectors, as well as policy making officials in the public sector. Accordingly, the views of relevant participants in the case study considered in this study provide a helpful illustration of how circular economy can be implemented in the real world.

5. Concluding remarks

This article has the purpose of describing the first phase of the implementation of the 'Sectoral Agreement of Reverse Logistics of Packaging in Brazil' and the transition to circular economy. The data collection was based on documental analysis (report from coalition of companies of packaging) and in interviews. Thus, it was possible to verify what was accomplished until this moment (phase 1) and what is expected for the next phases of the agreement. The opinions of the actors interviewed are considered important since the Brazilian law establishes the shared responsibily principle for the waste management, which implies manufacturers, retailers, government, waste pickers and consumers.

Overall, the study presents an interesting case that illustrates a regional transition to the circular economy at government and systems level, where government policy and regulations reinforce business practices encouraged by the circular economy. The learning insigths derived from the transition case here presented point out opportunities, challenges and barriers that businesses may face when implementing materials recovery processes advocated by the circular economy. In this context, this study shows that specific policy targeted to relavent sectors of the economy (e.g. packaging sector) and sectoral agreements are of fundamental importance to enable successfull transitions to the circular economy.

Undoubtedly, both the Brazilian law and the sectoral agreement, which is an instrument of this policy, were based in principles of the circular economy, even though the term is not formally expressed in these sources. The possibility of reinsertion of packaging waste in the productive cycle as raw material brings environmental gains, by reducing the impact caused by the inadequate disposal of waste, as well as bringing economic gains to the waste pickers cooperatives. Another essential point is that the waste pickers performed the waste collection even before the Brazilian law enaction and, today they can be recognized as important environmental agents. The revaluation of packaging waste in the same or in other production cycles is a strategy of the circular economy. However it is important to highlight that the reinsertion of waste is only possible through reverse logistics systems, which operationalize this return through transportation, handling, storage and sorting activities.

On the other hand, some limitations of this article should be pointed out. Firstly, only the perceptions and data regarding the representatives from ANCAT, Coalition of Companies of Packaging and Ministry of Environment were considered. We did not interview the consumers, city halls', recycling industries', wholesalers and, retailers' representatives. In addition, we emphasize that this article is restricted to analyzing the first phase of implementation of the

sectoral agreement of packaging in Brazil. In addition, we emphasized that circular economy involves several restorative approaches such as resuse, repair, redesign, remanufacture, refursbish, recycling, etc., and many of these approaches are supported by reverse logistics systems. In this paper we particularly focused on the recycling approach and related reverse logistcs and sectoral agreement aspects. The singularity of the case represents a limitation to the external validity of the study due to the inexistence of other similar cases considering the same variables. Moreover, we did not use any measure of inter-rater reliability. The developement of future case study research that apply inter-rater reliability methods and analyze the implementation of sectoral agreements in similar contexts is therefore welcomed.

Further studies can also analyze and compare the results related to other phases of the implementation of this Sectoral Agreement, especially with respect to gains, overcoming obstacles/barriers. Studies based on the perceptions and information from city halls', recycling industries', wholesalers and, retailers' representatives can also be useful. Further research based on surveys and financial/economic quantitative analysis can also bring valuable insights to the area. Furthermore, future studies could also analyze the circular economy as a whole concept, involving all the steps in the product life cycle as design, production, distribution, comsumption, etc, that expand the scope and focus of the study here reported beyond recycling and reverse logistics systems. The Krippendorff's alpha proposed by Krippendorff (2009) and Hayes & Krippendorff (2007), can be used as measure of inter-rater reliability in order to increase the validity of the qualitative data obtained with case studies.

This article contributes to advance knowledge in the area by being the first to analyze the first phase of implementation of the 'Sectoral Agreement of Reverse Logistics of Packaging' in Brazil, making linkages with the circular economy perspective, and presenting relevant aspects of the agreement after its implementation. We also point out the role of the actors involved in the agreement and the gains obtained for the waste revaluation chain, as well as the main barriers in operational implementations. Mainly considering the particularities related to developing countries, which may include the presence of waste pickers organized in cooperatives or not, the study contributes to the discussion of the social benefits of the circular economy. This article can serve as an input for researchers and practitioners interested in sectoral agreements in Brazil and in developing countries, as well as serve as input for public managers, business sector and other actors concerned with the implementation of reverse logistics of the other segments covered by the Brazilian law.

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