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Circular economy strategies and practices: A case study with multiple participants in the packaging sector in Brazil

Estratégias e práticas de economia circular: Estudo de caso com múltiplos participantes do setor de embalagens no Brasil

Estrategias y prácticas de economía circular: Un estudio de caso con múltiples participantes en el sector del embalaje en Brasil

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ABSTRACT

This research analyses the leading strategies and practices for transforming Brazil's Circular Economy of packaging. In-depth semi-structured interviews (n=53) were conducted with stakeholders active in the Brazilian packaging sector and triangulated with document analysis. The main strategies identified were environmental education programs, MSW diversion practices, environmental crimes (regeneration) inspection, efficient use of products, and waste reduction (optimisation). As for sharing, the inequality resulting from regional differences in logistics infrastructure was highlighted. The paper has theoretical contributions, such as applying the ReSOLVE method and practices for generating social, environmental and economic benefits.

Keywords: circular economy; ReSOLVE; packaging; urban solid waste; stakeholders.

RESUMO

Esta pesquisa objetiva analisar as principais estratégias e práticas para a maturação da Economia Circular de embalagens no Brasil. Foram realizadas entrevistas semiestruturadas (n=53) em profundidade com *stakeholders* atuantes no setor de embalagens brasileiro, trianguladas com análise documental. As principais estratégias identificadas foram programas de educação ambiental, práticas de desvio de RSU, fiscalização de crimes ambientais (regeneração), eficiência do uso dos produtos e redução de resíduos (otimização). Quanto ao compartilhamento, destacou-se a desigualdade decorrente das diferenças regionais de infraestrutura logística. O trabalho possui contribuições teóricas, como a aplicação do método ReSOLVE, e práticas para a geração de benefícios sociais, ambientais e econômicos.

Palavras-chave: economia circular; ReSOLVE; embalagens; resíduos sólidos urbanos; stakeholders.

RESUMEN

Esta investigación tiene como objetivo analizar las principales estrategias y prácticas para la maduración de la Economía Circular de los envases en Brasil. Se realizaron entrevistas en profundidad semiestruturadas (n=53) con actores activos en el sector de embalaje brasileño, trianguladas con análisis de documentos. Las principales estrategias identificadas fueron programas de educación ambiental, prácticas de desvío de RSU, fiscalización de delitos ambientales (regeneración), uso eficiente de productos y reducción de residuos (optimización). En cuanto a compartir, se destacó la desigualdad resultante de las diferencias regionales en la infraestructura logística. El trabajo tiene aportes teóricos, como la aplicación del método ReSOLVE, y prácticas para la generación de beneficios sociales, ambientales y económicos.

Palabras clave: economía circular; ReSOLVE; embalaje; residuos sólidos urbanos; stakeholders.

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1 INTRODUCTION

Packaging in general comprises the primary recyclable materials: paper, plastic, glass, and aluminum, among other metals. It is estimated that at least 30% of Municipal Solid Waste – MSW is composed of potentially recoverable materials (MDR, 2020a). Official data from the Ministry of Regional Development – MDR assume that, annually, approximately 16 million tons of MSW are still destined for controlled dumps and landfills, considered inadequate disposals by the National Solid Waste Policy – NPSW (MDR, 2020a). That is, a considerable volume of potentially recyclable material is going to landfill in inappropriate places. It is still worth remembering the waste that goes to landfills (considered suitable places of destination in Brazil) without proper sorting, separation and sending to the recycling industry, which represents waste since these materials have a high potential for recycling and recovery.

Even the countries belonging to the European bloc (mostly considered developed) are constantly searching for improving their waste management. In 2015 the European Union launched the "Circular Economy Package" to launch programs to combat waste by promoting this new economic model in which it values the extension of a product's useful life to the maximum possible (Bourguignon, 2016; European Commission, 2015).

The Ellen MacArthur Foundation – EMF, one of the leading organisations that disseminate the Circular Economy – EC, highlights the increased competitiveness of European companies due to EC and places the "involvement of stakeholders" as of fundamental importance (EMF, 2015). This same organisation launched the ReSOLVE method to help public and private organisations implement EC, indicating the 6 (six) necessary strategies: Regeneration, Sharing, Optimisation, Promotion of circuit creation, Virtualization and Exchange (EMF, 2017).

At the end of 2019 comes a challenge that would convulse the globe: the COVID-19 pandemic. This pandemic has directly impacted supply chain management. According to Jabbour C. and Jabbour A. (2020), the risk of shortages in the industry has increased, including in the supply of raw material based on plastic, aluminum and metals in general. Packaging waste management has also changed in this period. According to Vanapalli et al. (2021), the consumption of disposable packaging has increased, consequently the search for recyclable materials. Ecologically less degrading packaging (bioplastics, for example) is still far from the majority of the population. Therefore, the packaging waste volume has grown during the pandemic period (Vanapalli et al., 2021).

In addition to the management challenges, research gaps were identified among which the following stand out: i) the need for critical studies in countries that seek to make the transition towards EC (Jia, Zuluaga-Cardona, Bailey, & Rueda, 2018); and, ii) the lack of studies that identify the motivators for EC adoption, from the perspective of

stakeholders (Jabbour C. et al., 2020).

Given these complexities and gaps presented, this research aims to analyse the leading strategies and practices for the maturation of the Circular Economy of packaging in Brazil. The present analysis made use of the first three strategies described by the ReSOLVE method (Regenerate, Share, Optimise). To bring more depth to the discussion, this research focuses only on these strategies, evidencing from now on the importance of future studies investigating other practices, such as looping, exchange and virtualisation. Equally relevant, we sought to understand the perception of 53 (fifty-three) stakeholders who act directly or indirectly in the packaging sector through in-depth interviews (in Appendix A, there is a list of research participants).

After contextualising the theme, presenting the main objective, and highlighting the research gaps that are intended to be remedied, this work also has four other sections. The literature on reverse logistics is examined in the national context. The ReSOLVE method is presented according to the publication that launched it and studies that used it are exemplified. Next, the methodological classification of the research is explained as well as the form of collection and analysis of the data obtained through the case study. In the results, each of the three strategies chosen will be presented in detail and discussed according to the categories created from the literature and the speech of the subjects. Finally, the final considerations are concerned with synthesising the main findings, the limitations of the research and giving suggestions for future research.

2 NATIONAL SOLID WASTE POLICY AND PACKAGING WASTE MANAGEMENT

In 2020, the central Brazilian public policy in solid waste, the National Policy on Solid Waste – NPSW, was completed a decade (BRASIL, 2010). While Law 12.305/10 (NPSW) advances in apathetic stages of implementation, the amount of solid waste continues to grow in the country (Besen, Silva & Jacobi, 2021). The Brazilian Association of Public Cleaning and Special Waste Companies – ABRELPE, founded in 1976, annually gathers data from the sector and points out that per capita generation increased from 348 kg/year (in 2010) to 379 kg/year (in 2019) (ABRELPE, 2020).

Although the NPSW has set goals for eliminating and recovering dumps since its sanction in 2010, there are currently more than 3,000 open dumps and controlled landfills in the country, according to the National Association of Waste Pickers – ANCAT (ANCAT, 2020). These unsuitable places for waste disposal received 30,277,390 tons of waste in 2020 alone, representing 40% of the waste formally collected and accounted for in the country (ABRELPE, 2021).

For the operationalisation of selective collection and reverse logistics, NPSW reiterates the importance of

integrated management among actors in the same sector. The Sectorial Agreement – SA and the Term of Commitment – TC are instruments to agree on the responsibilities of the business sector with the Union. Regarding packaging, the Sector Agreement signed in 2015 for the implementation of reverse logistics presents limited results. According to Steigleder (2021), the fact that there are no economic incentives for the production of packaging made with recycled raw materials and the law does not provide sanctions for those who do not comply with the agreement, in part, justifies the shy performance of the Sector Agreement of packaging in general.

Selective collection is the collection of waste segregated at the generating source according to its constitution or composition (BRASIL, 2010). In Brazil, the agents that execute the selective collection usually are: i) the city hall itself; ii) a private company that won a competition and was hired; iii) cooperatives and associations of collectors of recyclable materials, under the Business Commitment for Recycling – CEMPRE (CEMPRE, 2020), and it is also appropriate to add the iv) autonomous collectors, not cooperating.

Thus, after going through direct logistics (from extraction to use by the final consumer), the product (and its respective packaging), advances in the supply chain thanks to the work of one or more of these 4 (four) actors. Depending on the municipal model, both municipalities and

contractors can use waste pickers' cooperatives as a destination to sort materials before being sent to controlled dumps or landfills.

Because it does not have a shed, the autonomous collector usually cannot accumulate much waste and quickly passes it on to an intermediary (scrap dealer or *aparista*). This intermediary can also be a buyer of waste pickers' cooperatives, which adds value by being able to gather more material, press and weigh it before reselling it to the recycling industry. Some waste pickers' cooperatives already have enough management and negotiation capacity to negotiate directly with the recycling industry, but in general, they still depend on intermediaries.

In addition to transferring this to waste pickers' cooperatives, municipalities and urban cleaning companies can forward waste directly to controlled dumps/landfills and sanitary landfills. This model (without integration with cooperatives) usually has a higher cost for municipalities because often the waste is weighed before entering the landfill, and the amount charged is per ton.

Finally, it should be noted that the loop closes when the recycling industry sells the material to the component industry, which, in turn, is concerned with reinserting the material into the cycle of producing new packaging. Below, Figure 1 illustrates the flow of a package from the origin (nature) to the final destination (controlled dumps/landfills, sanitary landfills or recycling industries).

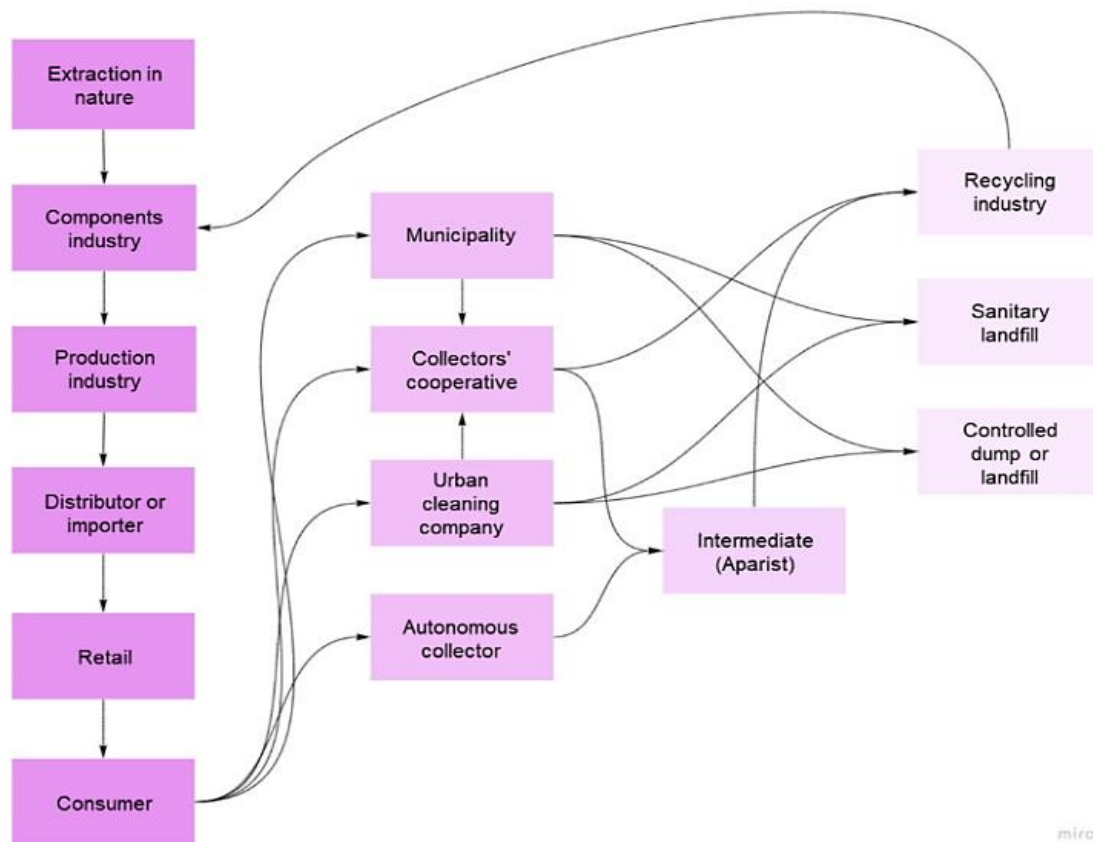


Figure 1. Production flow in the packaging chain in general in Brazil. Source: Prepared by the authors with the aid of *Miro.com*.

In most Brazilian cities, selective collection systems segregate into basic types: recyclable waste (dry waste), organic waste (wet waste) and tailings (those materials that

do not have the possibility of using the available technologies). Specifically on recyclable materials (the focus of this study), there is a combination of door-to-door

collection systems in households as well as the existence of Voluntary Delivery Points – PEVs. Regardless of the agent formally responsible for the collection the available forms, the presence of cooperative and non-cooperative waste pickers is recorded throughout the country (Rutkowski & Rutkowski, 2015). Cooperative waste pickers tend to have more access to the federal government's training and technical support policies, as well as expand the ability to make greater profits by buying and selling collectively (Guarnieri & Cerqueira-Streit, 2015).

Also, concerning collectors of recyclable materials, it is worth highlighting the work of Rutkowski (2020), who investigated the Brazilian version of the Extended Responsibility of the Packaging Producer. The author notes that unlike in Europe, the Brazilian model needs to include the waste picker to obtain positive results, especially regarding the volume of resources recovered. In addition, inserting this actor in the process tends to bring advantages to the industry by increasing the supply of raw materials for its products. In the social sphere, other benefits are perceived because these enterprises, based on the Social and Solidarity Economy – SSE, usually generate work and income for a portion of the population that would not find opportunities in the conventional labour market (Rutkowski, 2020).

3 THE STRATEGIES OF REGENERATION, SHARING, OPTIMISATION AND THE RESOLVE METHOD

The concept of Circular Economy has been gaining attention since the late 1970s and is understood as a restorative and regenerative system by design that aims to maintain the highest utility and value of products, components and materials (EMF, 2013). The principles of the CE serve as guidelines for the development with preservation of natural resources (aware of their finitude), with the extension of the useful life of the products (both in the technical and biological cycles). In addition, circular models tend to contribute to including negative externalities in production costs (such as pollution and damage to human health).

The ReSOLVE method developed and disseminated by EMF provides six strategies for EC implementation: Regeneration, Sharing, Optimisation, Promotion of circuit creation, Virtualization and Exchange (in English Regenerate, Share, Optimise, Loop, Virtualize and Exchange). It should be noted that the EMF itself made the translation of the terms for the Portuguese in its report in Portuguese, which stimulates the adoption of this new economic model in companies installed in Brazil (EMF, 2017). Figure 2 below presents examples of practices related to the strategies of the ReSOLVE method suggested by EMF (2017).



Figure 2. Practical examples of ReSOLVE method strategies.
Source: Prepared by the authors based on EMF (2015).

Thus, observing the strategies prioritised in the present study, an organisation would contribute to regenerate ecosystems (Regenerate) by changing its energy source to renewable matrices or seeking to protect water resources as well as restore soil quality with composting practices or less sending waste for grounding, for example (EMF, 2015). Sharing contributes to the

transition towards CE by maximising the use of products, as several users enjoy this utility. It should be noted that the products, when made under this concept, usually have a design made to last and with easy maintenance and disassembly. In this sense, optimisation also increases in product efficiency, stimulates Bigdata and reduces waste because it stimulates the use of components (EMF, 2015).

To answer the question, "Is sustainability a motivator of the circular economy?", Sehnem, Pandolfi and Gomes (2019) seek in the reports of Natura (a Brazilian multinational cosmetics company) the overlapping of the themes. The ReSOLVE method was used to check the symmetry between the company's sustainability practices, CE is a practice that contributes to the search for a dynamic balance between the economy, the environment and society. Although the premises of CE have been found in most of the company's practices, the authors perceived opportunities for improvement, especially concerning sharing and virtualisation (Sehnem et al., 2019).

Another study that uses the ReSOLVE method to measure actions consistent with the principles of CE is that of Jabbour C. et al. (2020). The authors applied questionnaires with six categories of stakeholders to understand the barriers and motivators to implement CE at the micro level (organisational level) in Brazilian industries. Finally, the authors suggest that future studies may complement the research by indicating how each actor participates in the transition to CE and evidence of the importance of using organisational theories in the analysis (Jabbour C. et al., 2020). In addition, critical studies in developing countries (Jia et al., 2018) that understand the motivations for adopting CE practices are lacking (Jabbour C. et al., 2020).

Based on the strategies that make up the ReSOLVE method proposed by EMF (2015), this study verified how the implementation of CE in the Brazilian packaging sector takes place through the practices applied by different stakeholders concerning the regeneration, sharing and optimisation of inputs from the packaging production chain.

4 METHODOLOGY

First, regarding the approach, it was used the qualitative perspective. According to Silverman (2000), researchers who seek to explore participants' life stories and experiences tend to opt for this approach. Concerning to its nature, it is an applied research because it is characterised by the intention of exposing the experience of the actors participating in the packaging chain, reporting and discussing them (Patton, 1990).

Given the main objective of this research, concerning technical procedures, a case study was chosen. After all, according to Bhattacharya (2017), this methodological choice is adequate when the researcher intends to understand the context of the problem in the depth of a predetermined scope and place.

According to Opperman (2000), methodological triangulation in the social sciences refers to the mixture of means to analyse the object of interest. In the case of the

present research, we aggregated the documentary analysis with the semi-structured interviews and the objective of confronting the opinions of the various stakeholders in the packaging sector. Among the documents analysed, it is worth mentioning the "The Guide to ministerial action: closure of landfills and social and productive inclusion of waste pickers" (CNMP, 2014), the "Preliminary Version of the National Solid Waste Plan" (MMA, 2020) and the "Recycling Yearbook 2021" (ANCAT, 2021).

Fifty-three professionals who work directly or indirectly in the packaging chain participated in this research. Among the participants are representatives of Ministries (federal government), state and municipal secretaries of the environment, prosecutors, waste pickers, entrepreneurs, logistics operators, and environmental consultants, among others. The experience time of the research participants ranged from a minimum of 1 year of the Project Analyst of the Business Commitment to Recycling (CEMPRE) and two years of the Superintendent of the Secretariat of Environment and Sustainability of Pernambuco (PPM6). Among the interviewees with more time experience is the Prosecutor of Justice and member of the Group of Action and Defense of the Environment of the Public Ministry of the State of São Paulo (PPE6) with 25 years and the Professor Dr. of the Interdisciplinary Center of Engineering and Environmental Sanitation of the Federal University of Mato Grosso (ESP6) with 30 years. The table in Appendix A of this paper details the date of the interview, place of residence, agency, position, time of experience in the role as well as the identification given to the person to, for ethical reasons, keep the name confidential.

The selection of participants was intentional, following the criteria of representativeness, accessibility and convenience, since participants needed to confirm interest voluntarily, accept the terms, schedule time and dedicate 62 (sixty-two minutes, on average) for each interview.

Against the backdrop of the COVID-19 pandemic, one of the health recommendations was social distancing. Thus, it was not possible to conduct the interviews in person nor to conduct on-site visits to the organisations, making it impossible to use the "observation" collection technique (participant or not), typical of qualitative case studies. On the other hand, the use of technology to conduct interviews via teleconference (Zoom Meetings® software), allowed the greater coverage of the national territory in number of representatives and Federative Units – UFs contemplated.

Thus, the fifty-three interviewees represent fifty-three distinct organisations in twenty Brazilian states and the Federal District. Figure 3 illustrates the FUs represented by participants of the present research with the respective number of interviewees.

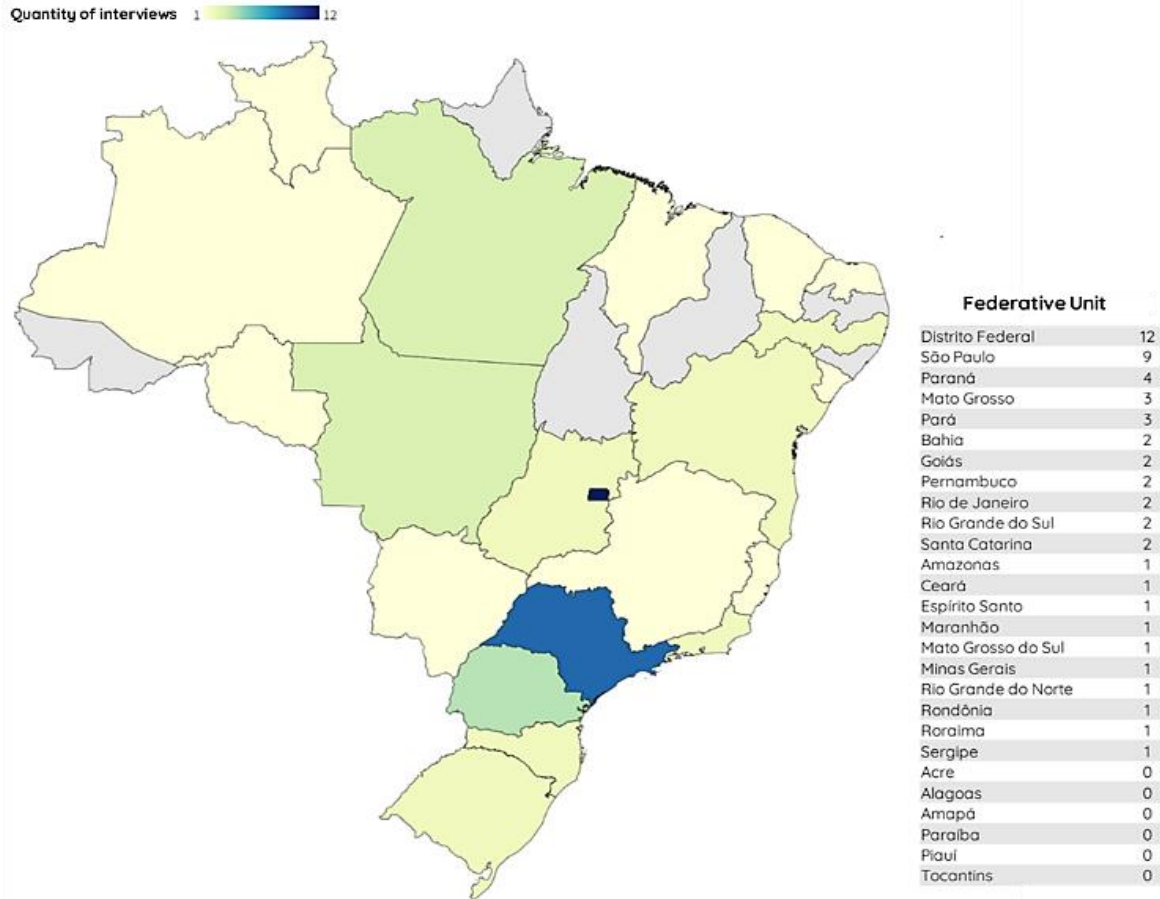


Figure 3. Participants of the research by UF.
 Source: Prepared by the authors with the aid of *Flourish.com*.

For the semantic evaluation of the script for the semi-structured interview, in addition to the organisation and objectivity, the experts evaluated the instruments following criteria indicated by Greco, Perez Morales, Aburachid & Silva (2015): Language clarity, practical pertinence and theoretical relevance. Five specialists in the area and PhD professors in Operations Management and Logistics from different universities participated in this validation stage. The specialist professors worked in the following institutions: Foundation Getúlio Vargas – FGV-SP; University of the West of Santa Catarina – UNOESC; Federal University of Minas Gerais – UFMG; Federal University of Espírito Santo – UFES and the Catholic University of Santos – UniSantos.

The 53 interviews lasted, on average, 62 minutes and the transcription was carried out with the help of professionals and by the researchers themselves, using Google Docs. In addition to allowing researchers to interact in social groups that they would not usually have access to (Noy, 2008), the snowball sampling technique was also helpful in indicating the saturation point of the sample of research participants since the names of the nominees began to repeat. It should also be noted that the present research reached the level of saturation that is, the number of interviewees proved to be sufficient for the analysis of the object since the repetition of the content of the interviews intensified (Biernacki & Waldorf, 1981).

Although the first editions of Bardin (2011) were published in the 1970s (from the French original *L'analyse de contenu*), computers and their programs were already understood as capable of supporting content analysis. As in Kakadellis, Woods and Harris (2021), the Nvivo® software was used to assist in the study of the speech content of the interviewed subjects. In this case, the authors sought to understand the behaviour of the stakeholders of the packaging chain about biodegradable plastic packaging and its form of treatment.

This tool (developed by QSR International) helped Kakadellis, Woods and Harris (2021) and the present research mainly to capture the existing thematic nodes and convergent themes that enabled the Union into thematic categories, classifying and relating the opinions of the participants. Finally, it is recalled that using the strategies of the ReSOLVE method as analytical categories was a practice carried out and validated by other CE researchers, as in Kalmykova et al. (2018), Merli et al. (2018), Jabbour A. et al. (2019) and Sehnem et al. (2019).

The following section details the results of the present research, which prioritised the first three strategies proposed by the method, namely: i) regeneration (Regenerate); ii) Share; and iii) optimisation (Optimise). From now on, it is anticipated that the focus on only three of the six principles is one of the limitations of this research. Therefore, future studies that contemplate the three other guidelines are recommended.

As for Reperate, he asked about actions that the organisation adopts or intends to adopt to save the planet's natural resources (soil, water, energy). Regarding the Share category, the interviewee was asked to comment on sharing goods, equipment or processes between actors in the packaging chain. Finally, when answering about Optimize, the professionals evidenced their perception of how the search for efficiency in using material resources or components of the products in the organisation they work in occurs.

5 ANALYSIS AND DISCUSSION OF RESULTS

5.1 Regeneration as a contribution towards the CE of packaging

At this research stage, the interviewees were invited to describe actions of preservation and regeneration of natural resources. By saving soil, water or energy, an organisation contributes to ecosystems' regeneration; therefore, these practices are aligned with the principle "Regenerate", according to EMF (2015).

Data in the National Sanitation Information System – SNIS, show that Brazil sends a growing amount of waste to composting units. Between 2018 and 2019, the increase was 141.9% in the volume of MSW with this type of destination (valid responses from 3,712 municipalities in 2019 compared to 3,468 in 2018). From the biological fraction of MSW, it is noteworthy the ability to produce organic compounds that revitalise the soil (MDR, 2020b).

Composting was cited as an alternative capable of regeneration by a significant part of the interviewees. The representative of the Urban Cleaning System of the Federal District – SLU-DF, identified as PPE1 for the present research, points out that this type of practice is carried out in the Federal District, even if biodigesters are lacking for the proper energy use of organic waste. In Recife-PE, the interviewee (PPM6) emphasises the importance of the Tax

on the Circulation of Goods and Services – socio-environmental ICMS so that municipalities motivate to prove to the state that they are composting.

The exchange of the energy matrix as well as the choice for lamps capable of "doing more with less" was remembered by the interviewees. The specialist in the area of sustainability who works in São Paulo, here identified as ESP4, indicates that he periodically places engineering students to calculate energy expenditure and expenses to evaluate the cost-benefit of LED lamps (Light-Emitting Diode). He says they have already managed to switch to this more efficient alternative throughout the campus of his institution. The interviewee, who provides consulting for industries of the Manaus Free Trade Zone (ESP3), goes further by recommending not only the change of lamps, but also elaborate processes of rainwater capture and advise on the treatment of water used in the industrial process.

For an organisation to create and capture value in a circular chain model, employees, its leaders, customers, and suppliers need to know and engage in the proposal (Urbinati et al., 2019). In addition to the representative of the environmental analyst of the Superior Court of Justice – STJ, most interviewees claimed that their organisations have environmental education programs aimed at greater waste management awareness, from generation to disposal.

It should be explained that, for the present research, environmental education programs were considered broadly: whether the provision of a consultancy for a company, the entrepreneur himself applying to government officials or secretariats and non-governmental organisations – NGOs raising awareness in society in general. According to the categories created from the interviewees' speech, Table 1 shows the primary practices of the participants in the solid waste management chain who use the "Regeneration" strategy to contribute to the circularity of packaging in the country.

Table 1
Strategy for packaging CE in Brazil: Regenerating

#	Regeneration practices	Reference (case study)	Reference (literature)
1	Perform Selective Collection and Composting	PPE1, PPM6, ONG5, PPM7, ONG7, PPE9	(MDR, 2020a).
2	Seek energy efficiency and/or water reuse	ESP4, PPE5, PPM4, PPF4, ONG7, EMP7, PPE9, ESP3	(McDonough & Braungart, 2003).
3	Implement Environmental Education Programs	EMP2, PPE3, PPE4, ONG4, ONG5, ESP7, PPM7, ONG6, PPE6, ESP2, PPF4, ONG8, ESP9, ONG1, ESP10, PPE9, EMP9, ONG2, ESP3	(Urbinati et al., 2019).
4	Divert solid waste to landfill	PPE1, EMP3, CAT1, PPM1, EMP4, ONG5, ESP8, EMP6, EMP7, CAT3, ONG1, CAT4, EMP9, ONG2	(Pereira et al., 2021)
5	Enforce environmental crimes	ONG3, PPE2, PPM1, PPM6, ONG5, PPM7, ONG6, PPE6, PPE7, PPE8, ONG8,	(Farooque et al., 2019)
6	Carrying out sustainable public procurement	ESP5, PPM7, PPF4, PPE9	(Oliveira & Santos, 2015)
7	Assist municipalities in basic sanitation measures	PPE2, ESP8, PPF3, PPE6, PPE7, PPE8	(Santiago et al., 2020).

Source: Prepared by the authors.

Diverting waste from the route that would take the materials to the dumps or landfills was an attitude remembered by several interviewees. This practice would

contribute to saving areas not yet degraded, soil and water. The speech of the employee of the fourth company interviewed (EMP4) evidences an innovative way to

contribute to diverting waste from dumps and landfills and still having positive social impact.

EMP4: Our solution is based on direct investment in the recycling chain, and on the remuneration of cooperatives and private operators. So we can raise the return, increasing the routing of material for recycling, a greater return of material for the production cycle, less grounded material and consequently, we end up saving natural resources of water and energy that are used to make the virgin raw material.

It should also be noted that, in Brazilian reality, the waste picker contributes directly to reducing the volume of recyclable materials landfilled. After all, they collect, sort and sell to the recycling industry. The speech of CAT3, leader of ANCAT in the state of Rondônia, shows that this action is the core business of the category.

CAT3: We contribute to the environment by enabling the commercialisation of tons and tons of material we remove from the environment. For more than 30 years, waste pickers have been doing this work in the municipality of Porto Velho.

Given the relevance and repetition of the content exposed in the interviewees' speech, it is still possible to affirm that "supervising environmental crimes", "carrying out sustainable public procurement", and "assisting municipalities in basic sanitation measures" are practices that contribute directly to the regeneration of natural resources. Consequently, these practices collaborate on the path towards CE.

5.2 Sharing as a contribution towards the EC of packaging

After the discussion of the practices that Brazilian organisations carry out to protect the environment (Regenerate), it is presented and discussed another way to move towards circularity: Sharing. It should be stated that the idea of sharing to maximise the use of products with objectives of financial savings and natural resources is not born with the term CE. Since the late 1980s, the Theory of Industrial Ecology has demonstrated that firms can derive more benefits by acting together than the sum of all individual efforts (Zhu et al., 2007).

For the reality of solid waste management in Brazil, the sharing of goods, equipment and processes was observed as operating positively only by a small part of the interviewees (11 of the 53 participants). People in business and public servants are among the actors who report actions to bring actors closer together. For example, Ministry of Economy – ME (PPF5) representative explains how the Federal Government acts in this regard.

PPF5: We have been working to promote public consortiums, from small municipalities to medium and large municipalities, so that they can ensure sustainability in waste management with a gain of scale. Therefore, the idea is to share both equipment, units, and waste management in integrated waste management. This will all promote increased recycling of the waste in these municipalities, because the idea is

always to implement mechanised sorting units in warehouses.

Public consortia are instruments to enable solid waste management in municipalities that seek this collective solution. Article 45 of the NPSW also provides that these municipalities have priority in receiving incentives from the Federal Government (Brazil, 2010). According to the International Solid Waste Association – ISWA, the Union between nearby municipalities tends to increase the viability of projects in the area of waste management, because of the judicial process for selecting the landfill site as well as the high costs of installation and operation (ISWA, 2016).

Most of the interviewees do not have a dichotomous opinion on the subject, and do not believe in polarisation concerning sharing in jail. In the opinion of most of the interviewees, there is sharing of goods, processes or equipment. However, it happens partially or unevenly. Much believes that the state assumes costs and expenses that should be of the industry.

In most Brazilian cities, it is up to the government to bear the costs of building or renting warehouses and sorting equipment. According to data from Panorama ABRELPE, 35% of MSW comprises dry materials (plastic, paper, cardboard, glass, metals and multilayer packaging) (ABRELPE, 2020). Therefore, many interviewees consider that manufacturers, distributors and importers should assume the responsibility after sales and after consumption of the packaging placed on the market.

The representative of the Federal Government that works in the MDR and works directly with the SNIS explains this complexity (PPF2).

PPF2: I see the absence of the participation of the public power as a problem because today, they are the ones who are left with the burden of logistics, and it is the citizen who bears it, since the resource comes from taxes. I don't see sharing, including financial sharing of the burden and then, at times, it's a reverse make-believe logistics.

The interviewee identified as PPE7, Prosecutor of the State Prosecutor's Office of Mato Grosso do Sul – MPMS reinforces this view.

PPE7: The pesticide packaging chain is excellent, has very well divided responsibility, and does not involve the government. Now, packaging in general, has a big problem of not dividing responsibilities clearly, despite the legislation being pretty much the same. So the first problem is the lack of division of responsibilities.

Among those who believe that sharing in the packaging chain happens unequally, another very common opinion is that the waste picker is exploited and that the remuneration received from municipalities or industries is derisory close to the important work he performs. The ANCAT 2020 Recycling Yearbook brings data from 1,829 organisations (of which 10,413 waste pickers are associated) that show that at least 355,000 tons of waste

were recovered by these organisations in 2019 (ANCAT, 2020).

The resentment is present in the speech of CAT4, representative of the National Movement of Collectors of Recyclable Materials of Rio Grande do Sul – MNCR-RS.

CAT4: We survive within a capitalist system in which the goal itself is not to share, it is precisely to accumulate. It's the opposite of the logic of sharing. And the logic of this competition is for accumulation, so it will cause it to accumulate on one side and seek to crush the others. The others are seen as enemies, as opponents, not as a chain process.

A portion of the interviewees are still critical of the sharing practices (Share) to the point of saying that it is inoperative or non-existent. Some factors have led to these responses, among which stand out the lack of sharing culture and the Western idea (in general) that people and companies need to have possession of their equipment and with this is showing power or reducing risks. There is a perception that the culture of associativism and closer relationships is lacking, with cooperation being a key factor for implementing CE.

Finally, the low level of implementation of Law 12,305/10 is evident, especially in the country's interior. According to Pinto (2021), NPSW is under "paralysis" at the moment. The action of local public managers driven by society's desire for cleaner and more sustainable cities would be able to reverse this situation and make the issue of waste relevant again in the national scenario. Although all these large brands and their respective packaging are also present in small cities, the industries (large generators) cannot act by doing reverse logistics in small municipalities. This obstacle can be observed in the speech of the federal server who helped nine municipalities of Roraima to elaborate their waste management plans (PPF3).

PPF3: I think this sectoral agreement was designed for large cities; it is not intended for Brazil. For example, glass is recyclable packaging, but how are you going to include glass in the circular economy process here in Roraima? There is no way because the very logistics of reusing glass are not cost-effective. If you exceed, for example, more than 180 kilometres, the transport of this glass will be costly for reuse, and here we would have to walk much more.

In this subsection of the work, the comments of the interviewees regarding the sharing of goods, equipment or processes between actors in the packaging chain were discussed. Most respondents believe there is an unequal/unfair sharing, where waste pickers are poorly paid and the omission of manufacturers, importers and retailers burdens municipalities.

5.3 Optimisation as a contribution towards the CE of packaging

In 2017, EMF presented a report on CE in Brazil, in order to identify possible opportunities and increase the

scalability of existing activities. The report focused on three sectors (biodiversity, electronics and construction) and ReSOLVE strategies were considered fundamental to leverage innovation towards a regenerative production and consumption pattern from design. Regarding the principle of optimisation, the present research found that in the country: i) there are practices to improve the performance/efficiency of the product; (ii) there are practices for the reduction of waste in the packaging chain; and iii) no large-scale actions, actions that seek automation, remote sensing or bigdata were reported (EMF, 2017).

It is evident from the interviewees' speech that manufacturers mainly aim to reduce costs and ensure the supply of raw materials, especially in this context of the COVID-19 pandemic. The specialist (ESP4), who is part of a think tank focused on CE, and the sustainability manager of a multinational packaging company (EMP8), exemplifies this position.

ESP4: Industries are even trying to reduce the use of raw materials, which necessarily involves the search for efficiency. We even have the term "material intensity". So the search for the improvement of production or exchange of raw materials is real, but this comes mainly because of the motivation to reduce the risk of raw material availability.

Again, the figure of the waste pickers of recyclable material is of significant importance for the operation of the reverse packaging chain in Brazil. Gall et al. (2020) conducted a case study with waste pickers from Nairobi (Kenya) and their results indicate that these workers could be perfectly included in the plastic chain, since they deliver a material with similar quality to the formal system in terms of composition, degree of cleanliness and engineering properties.

Applied to the Brazilian reality, the research guided by Rutkowski (2020) indicates that, in addition to the social benefits of the inclusion of waste pickers in the reverse logistics system, other advantages are perceived, such as increased recoverability rates of packaging and decreased operating costs.

The findings of the aforementioned authors, the results of the present research also pointed to the optimisation of the packaging chain by including collectors of recyclable materials in the formal system. The speech of the seventh expert interviewed (ESP7) makes it clear that for a true.

ESP7: It has to unite Circular Economy by integrating waste picker. The waste picker gives unique solutions because he has experience. While technicians "puzzle" in offices, waste pickers arrange exits because they have a lot of practical wisdom.

Figure 4 illustrates the main actions related to the optimisation strategy reported by the participants of this research.



Figure 4. Actions to optimise the Brazilian packaging chain.
Source: Elaborated by the authors using *Miro.com*.

As identified by Guarnieri et al. (2020) when investigating the results of the first phase of the Packaging Sector Agreement in Brazil, the present research also identified a timid and disintegrated action of government and industries in the objective of developing the recycling chain. Part of the interviewed actors claims to collaborate for the development of the chain in different ways.

PPE4 reports that in the state of São Paulo, companies must submit solid waste management plans to the Environmental Company of the State of São Paulo – CETESB when applying environmental licensing. ESP1, in the city of São Paulo-SP, states that it helped launch a platform to make investments in reverse logistics compatible with the productive sector. PPM4 shares the local currency project, in Alto Paraíso-GO, to help commercialise waste and ensure that resources are invested in local commerce, restricting certain products, such as alcohol or tobacco.

However, most stakeholders do not believe in the existence of actions to optimise the packaging chain in Brazil or cannot perceive their work reality. In order to thoroughly analyse the discourse of these actors, with the aid of NVivo® software created a word cloud (Figure 5) with the 20 most recurrent terms in the 17 responses classified in this category.



Figure 5. More frequent words in the speech of the interviewees who believe that there are no optimisation actions in managing packaging waste in Brazil.
Source: Prepared by the authors with the aid of NVivo®.

With the analysis of the content of the participants' speech, added to the observance of the terms highlighted in

the word cloud generated, it becomes possible to make inferences about the importance of including waste pickers in the formal public system. The work of cooperatives can increase the usefulness of the product and its components as it returns to the chain through recycling.

Other opinions related to the perception of a lack of actions linked to the principles of efficiency are due to the lack of reliable metrics and measurement systems. Following the logic that "what is not measured is not improved", the lack of integration can be the cause and consequence of this absence of information. According to Farooque et al. (2019), the lack of collaboration is also one of the main challenges to optimising a supply chain towards circularity.

Therefore, the research participants perceive actions that help improve the performance of the products (expanding their usability) and practices that try to reduce the environmental impacts in their assembly lines and reverse logistics. However, to optimise the packaging chain, there is still a lack of integration actions between actors, including waste pickers, expansion of the forms of measurement, and the use of automation or big data technologies, which were not even remembered.

6 CONCLUSIONS

Although the Circular Economy has a growing number of activists (in academia, business, government or the third sector), several gaps in the literature have been identified and may delay its implementation. These include the lack of critical studies in countries in transition and the absence of studies that list the motivators for adoption.

Given the complexity posed in the Brazilian scenario in waste management and the gaps identified in the literature, this research aimed to analyse the first three strategies and practices described by the ReSOLVE (Regenerate, Share and Optimise) method for the maturation of packaging CE in Brazil. In addition to the documentary analysis, we sought to understand the perception of fifty-three (53) stakeholders who act directly or indirectly in the Brazilian packaging chain. After the transcription, the NVivo® software was used to unite the

statements into thematic categories and the proper content analysis.

Regarding regeneration practices (Regenerate), the interviewees state that the main actions in this regard are: environmental education programs, practices of diversion of solid waste from the landfill and the inspection of environmental crimes (mainly due to the work of the state Public Prosecutors' Offices). Regarding the sharing strategy to maximise the use of products with financial savings and natural resources objectives, only entrepreneurs and a representative fraction of public servants claimed to have.

Most of the interviewees reported that there was sharing, even if partial or unequal. The differences in logistics infrastructure between the regions of Brazil would be one of the reasons for such inequality. The strengthening of municipal consortia to close dumps is seen as a possibility of expanding the sharing of resources in solid waste management in Brazil.

Concerning optimisation (Optimise), it was found that the search for efficiency in the use of products and waste reduction was reported as existing through Research & Development programs – R&D and cleaner production actions, for example. However, it was highlighted that the interest of manufacturers is more linked to the economic factor: cost reduction and risk reduction, especially those related to the supply of raw materials.

The socio-productive inclusion of recyclable material collectors is a positive practice. We infer that the work of cooperatives helps to increase the recoverability rates of recyclable material and reduce operating costs. Finally, it is noteworthy that no actions were reported that seek automation, remote sensing or big data, which could optimise the packaging chain in Brazil. In comparison with the existing literature to date, these results present innovations. After all, there are still no articles published in Brazil that analyse the opinion of the actors of the packaging chain using a framework of Circular Economy, validated in international studies.

This research has limitations because it did not cover all Brazilian states. After all, there was a lack of representatives from six UFs (Acre, Amapá, Tocantins, Piauí, Paraíba and Alagoas). In addition, it is limited because it could have interviewed other actors participating in the same chain, such as "middlemen" (intermediaries who buy from waste pickers and sell to industry) and autonomous waste pickers (those who do not participate in cooperatives). Another limitation that should be underlined is that this article focuses on analysing only three of the six principles contained in the ReSOLVE method.

Still, the present work contributes both to the theory and to the practitioners of the area by investigating the strategies and actions necessary to walk towards CE, presenting them as figures and tables and aligning them with the literature already published. The contributions to the theory are mainly found in 3 factors: i) application and validation of the ReSOLVE method for research of waste management in a developing country; ii) contribution to fill

research gaps from the lack of critical studies that seek to understand complexity from the perspective of the participants to the gaps that alert to the absence of studies that address social aspects of the supply chain; and, iii) suggestion of future studies based on the limitations of the present research.

It is suggested that future studies conduct quantitative surveys based on cluster analysis and probabilistic samples with a broader range of all UFs and stakeholders. It is also suggested that similar studies be conducted in other developing and developed countries for the purpose of comparison. In addition, similar research can be carried out with emphasis on different types of waste contemplated in the NPSW and that is in the initial stage of implementation of the Sector Agreement, such as electronic waste. Finally, the other strategies foreseen in the ReSOLVE method that were not contemplated in this study (Loop, Virtualize and Exchange) may be the object of future investigations aimed at analysing the implementation of Circular Economy practices.

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APPENDIX A – Information from research participants

#	UF	Identification	Organisation	Position	Years experience
Municipal Government – Interviewees					
1	PR	PPM1	Municipal Transit and Urbanization Company (CMTU)	Contract Inspector	8
2	GO	PPM2	Urbanization Company of Goiânia (COMURG)	Civil Engineer	13
3	SC	PPM3	Municipal Department of Environment (SMMA)	Assistant Secretary	1,5
4	GO	PPM4	Municipal Secretariat of Environment and Sustainable Agriculture	Assistant Secretary	2
5	MA	PPM5	Urban Cleaning Steering Committee	General Coordinator	6
6	PE	PPM6	Secretariat of Environment and Sustainability (SEMAS)	Superintendent	2
7	PR	PPM7	Municipal Department of Urban Development and Environment	Biologist Solid Waste Division	10
State Government – Interviewees					
8	DF	PPE1	Urban Cleaning System (SLU)	Technical Advisor	6
9	RS	PPE2	Public Prosecutor's Office of the State of Rio Grande do Sul (MPRS)	Operational Support Center Coordinator Environmental Protection	25
10	SE	PPE3	Public Consortium of Basic Sanitation of Greater Aracaju	Superintendent	4
11	SP	PPE4	Environmental Company of the State of São Paulo (CETESB)	Civil Engineer Solid Waste Department	7
12	DF	PPE5	Legislative Chamber of the Federal District (CLDF)	District Representative	2
13	SP	PPE6	Public Prosecutor's Office of the State of São Paulo (MPSP)	Promoter of Justice and member of the Group of Action and Defense of the Environment	25
14	MS	PPE7	State Prosecutor's Office of Mato Grosso do Sul (MPMS)	Promoter of Justice and Director of the Environmental Center	19
15	MT	PPE8	State Prosecutor's Office of Mato Grosso (MPMT)	Coordinator of the Support Center of the Environmental Prosecutor's Office	24
16	DF	PPE9	Secretary of State for the Environment (SEMA-DF)	Solid Waste Policy Implementation Coordinator	3
Federal Government – Interviewees					
17	DF	PPF1	Ministry of the Environment (MMA)	Environmental analyst	9
18	DF	PPF2	Ministry of Regional Development (MDR)	Coordinator of the National Sanitation Information System	2
19	RR	PPF3	National Health Foundation (FUNASA)	Public health agent - Department of Health and Environmental Education	22
20	DF	PPF4	Superior Court of Justice (STJ)	Chief Advisor for Social and Environmental Management	12
21	DF	PPF5	Ministry of Economy (ME)	Technical advisor	13
Private companies – Interviewees					
22	CE	EMP1	Selativa Sistemas de Resíduos	Founding partner	6
23	PE	EMP2	Lixiki	Founding partner	13
24	DF	EMP3	Green Ambiental	Founding partner	6
25	SP	EMP4	New Hope Ecotech (EuReciclo)	New Business Specialist	1,5
26	MT	EMP5	Teoria Verde	Executive Director	6
27	PA	EMP6	LRT Engenharia e Ambiente	Chief Executive Officer (CEO)	2
28	PR	EMP7	Trombini Embalagens S.A.	Environmental Analyst	17

29	SP	EMP8	Tetra Pak	Sustainability Manager	10
30	SP	EMP9	Compromisso Empresarial para Reciclagem (CEMPRE)	Project Analyst	1
Collectors of recyclable materials – Interviewees					
31	RJ	CAT1	National Union of Waste Pickers of Brazil (UniCatadores)	President	5
32	RJ	CAT2	National Movement "I am a Waste Picker" (MNEC)	Coordinator	5
33	RO	CAT3	National Association of Waste Pickers (ANCAT)	Production Coordinator	10
34	RS	CAT4	National Movement of Collectors of Recyclable Materials	Member of the National Articulation Team	20
Non-governmental organisation – Interviewees					
35	MG	ONG1	Nenuca Institute for Sustainable Development (INSEA)	President	12
36	SC	ONG2	Zero Waste Brazil Institute (ILZB)	Vice-President	4
37	DF	ONG3	Brazilian Association of Sanitary and Environmental Engineering (ABES-Distrito Federal)	Vice-President	2
38	BA	ONG4	Pangea Institute	Director	2
39	PR	ONG5	Trash and Citizenship Institute (ILIX)	Waste picker and Executive Coordinator	17
40	PA	ONG6	Friends of Belém	President	9
41	DF	ONG7	Arapoti Institute	President	3,5
42	PA	ONG8	Center for Studies and Applications in Logistics and Environment (CEALMA)	President	8
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