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Progress of the circular economy in Brazil: What are the main challenges in the packaging chain?

Progresso da economia circular no Brasil: Quais são os principais desafios na cadeia de embalagens?

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Abstract: The implementation of Circular Economy (CE) principles has the potential to make solid waste management more effective. In Brazil, packaging is a fraction of urban solid waste (dry and recyclable). Therefore, this paper analyses the challenges of implementing a CE in the post-consumption Brazilian packaging chain. This research conducted documentary analysis and in-depth interviews based on a semi-structured script. Fifty-three stakeholders from the sector were interviewed. The interviewees were from the public, private sector and non-governmental organizations. Agents from the executive, legislative and judiciary represented public power. Representatives from packaging manufacturing companies, logistics operators, the recycling industry, startups and waste pickers attended the sample, covering several players in the chain. The results were divided into three categories of operationalization of the circular economy (micro, meso and macro), contributing to academia by demonstrating this division in an

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empirical study. The main managerial contribution is to list the challenges, including the lack of consumer awareness, the low level of logistics infrastructure, double taxation of recycling and greenwashing. Additionally, is the need for more supervision of actors who misbehave and the lack of political will to change to a circular model. Finally, we highlight the limitations and suggest future researchers in the area.
Keywords – Supply chain management; Reverse logistics; circular economy; Waste management; Developing countries.

Resumo: A implementação dos princípios da economia circular (EC) tem o potencial de tornar a gestão de resíduos sólidos mais eficaz. No Brasil, as embalagens representam uma fração dos resíduos sólidos urbanos (secos e recicláveis). Assim, este artigo analisa os desafios para implementar a EC na cadeia de embalagens pós-consumo no Brasil. A pesquisa utilizou análise documental e entrevistas em profundidade, baseadas em um roteiro semiestruturado. Foram entrevistados 53 *stakeholders* do setor, incluindo representantes dos setores público, privado e organizações não governamentais. O poder público foi representado por agentes dos poderes executivo, legislativo e judiciário. Já a amostra do setor privado incluiu representantes de empresas fabricantes de embalagens, operadores logísticos, indústria de reciclagem, *startups* e catadores, abrangendo diversos atores da cadeia. Os resultados foram divididos em três categorias de operacionalização da economia circular (micro, meso e macro), contribuindo para a academia ao demonstrar essa divisão em um estudo empírico. A principal contribuição gerencial foi listar desafios como a falta de conscientização dos consumidores, o baixo nível de infraestrutura logística, a bitributação da reciclagem e o *greenwashing*. Adicionalmente, destaca-se a necessidade de maior fiscalização de atores que apresentam má conduta e a falta de vontade política para a transição para um modelo circular. Por fim, são ressaltadas as limitações do estudo e sugeridas direções para pesquisas futuras na área.
Palavras-chave – Gestão da cadeia de suprimentos; Logística reversa; Economia circular; Gestão de resíduos; países em desenvolvimento.

Introduction

Even with so many concepts in the literature, Circular Economy (CE) is seen as a way to achieve Sustainable Development. After all, it is a regenerative economic model by design, which uses several collective strategies to eliminate the idea of waste in order to preserve natural resources. Given the need for integration between actors, implementing the CE is increasingly related to supply chain management (Kirchherr et al., 2023).

More sustainable supply chain management is related to several Sustainable Development Goals SDGs. For example, SDG 12 and 17 that requires coordination between participants in the chain to achieve benefits related to quality, deadlines and costs. It is also worth highlighting the importance of aligning actions with external stakeholders, such as local government, NGOs and the community (Fritz, 2019). It is important to remember that this global pact in pursuit of the 17 Sustainable Development Goals (SDGs) was agreed upon in 2015, with a compliance horizon of up to 2030 (United Nations, 2015).

In 2010, the National Solid Waste Policy (Law 12,305/10) obliged all companies to implement the Reverse Packaging Logistics System (Brazil, 2010). In 2015, packaging manufacturing companies, importers and distributors shared the Packaging Sector Agreement, with the consent of the Ministry of the Environment and other interested parties. This document defines packaging as the entire dry fraction of urban solid waste, the whole fraction that is not organic or rejected disposal (Coalizão de Empresas, 2015).

According to the National Sanitation Information System (SNIS), Brazil has 1438 municipalities with selective collection. However, a few paper, plastic, and aluminium, among other packaging materials, are still recovered (MDR, 2020). Data from the Brazilian Association of Public Cleaning and Waste Companies (ABRELPE) indicate that only 4% of Municipal Solid Waste (MSW) passes through the collection stages and is sent for recycling (ABRELPE, 2021).

Higher recovery rates would allow the private sector to extract more value from products and their components, even after consumption. However, efficient integration of the chain is necessary (Cerqueira-Streit, Endo et al., 2021). The basic prerequisite for this integration to occur is the preparation of managers to abandon traditional ways of logistics management and move towards a less degrading model (Batista, Gong, Pereira, Jia, & Bittar, 2019).

In this way, Sehnem, Pandolfi, & Gomes (2019) highlight the importance of managers fully understanding the concept of Circular Economy (CE). Similarly, Jabbour et al. (2019) lacks empirical work that takes advantage of the knowledge of experts to understand the demands related to logistics and operations management in the context of CE.

It is also worth highlighting the gap indicated by Oliveira, Luna, & Campos (2019) who, when investigating the circularity in polystyrene chain in Brazil, highlights the scarcity of studies on the barriers found in the country. Brazil has a high degree of informality in the recycling sector, and according to Dias

et al. (2022), it is necessary to investigate and analyze alliances between public, private, and collector cooperative actors to expand Circular Economy.

Analysing publications by Brazilian researchers in eleven national scientific journals and twelve international journals in operations and logistics, Freitas and Partyka (2022) found that Circular Economy and corporate social responsibility are emerging themes. Alongside themes such as "Agricultural and extractive supply chains" and "Industry 4.0 and innovation in operations and supply chains", the authors state that "Circular Economy" is among the growing themes in the literature on operations management. Even so, the authors suggest in the research agenda that researchers should better explore the Brazilian context to insert new theoretical and practical insights into the local reality.

Given the gaps identified in the literature, the following question guided this research: What are the main challenges in implementing a Circular Economy of packaging in Brazil? Therefore, this paper analyses the challenges of implementing a circular economy in the post-consumption Brazilian packaging chain. This investigation carried out documentary analysis and in-depth semi-structured interviews with 53 (fifty-three) stakeholders who work directly or indirectly in this chain. Although the research also included analysis of bibliography and document analysis (grey literature), the primary data collection technique was interviews with stakeholders.

Among the interviewees are waste pickers, industry representatives, experts and Non-Governmental Organizations (NGOs). Additionally, public servants from the three government spheres (executive, legislative and judiciary) and the three levels of government (municipal, state/district and federal) of 20 (twenty) states and the Federal District.

After the Introduction, the article is organized into four more sections. First, the literature review presents similar cases that raise challenges for CE in different parts of the world. Next, the methodology highlights the classification, data collection method and analysis, specifying the software and version used. Finally, the results demonstrate the main challenges divided into the three levels of CE operationalization (micro, meso and macro). Finally, the final considerations assume the limitations and indicate possibilities for future investigations.

Literature Review

Economy as a business model that reduces waste

In the last decade, the Circular Economy (CE) has aroused increasing interest among researchers and managers, thus emerging as an innovative and captivating topic (Tseng, 2024). There are many understandings of what Circular Economy is. However, there are small divergences regarding the idea that the primary goal of CE is achieving sustainable development (Kirchherr et al., 2023).

For this research, Circular Economy is a new way of doing business, and it aims to use materials as much as possible. Kirchherr et al. (2023) analysed 221 articles to survey scholars' understanding of CE. According to the authors, the term "supply chain" was used in at least 10% of the identified definitions and typically concerned the role of manufacturers and downstream and upstream members of the supply chain in driving CE. Specifically, circular practices in the supply chain are related to the collective search for waste reduction and actions that minimize waste generation, such as reuse and recycling (Tseng, 2024).

In the waste treatment hierarchy, reducing and reusing before recycling is preferable. Since the 1970s, the European Union has published this logical sequence for waste treatment (European Commission, 2024). Incorporated in article nine of the Brazilian Solid Waste Policy (PNRS), this sequence highlights that burning waste to generate energy is an alternative. However, one must try to recycle as much as possible before making this option. The landfill is the last preference for disposing of post-consumer waste (Brazil, 2010).

According to the National Confederation of Industry (CNI), some concepts in this policy are essential for implementing the Circular Economy in the Brazilian context, namely the principle of shared responsibility for the product life cycle and reverse logistics (CNI, 2019). The principle of shared responsibility for the product life cycle is the national version of the Extended Producer Responsibility (EPR) in force in Europe. As it is a less incisive version than the EPR, it is clear that manufacturers, importers, and retailers invest less in closing the production loop in Brazil (Rutkowski, 2020).

Regarding reverse logistics (RL), during 2015 and 2017, the implementation of the packaging RL system began. Although this first phase presented advances in the inclusion of waste picker organizations,

environmental education and the installation of voluntary delivery points, associations of packaging companies discontinued this implementation (Guarnieri et al., 2020).

Pereira et al. (2020) highlight the importance of the country having a more specific public policy for the Circular Economy. This way, the issue will be addressed with due investment by companies and government compliance. In this sense, the prospects are positive since the Project of Law 1874/22 that establishes the Brazilian Circular Economy Policy was approved by the Federal Senate and, after approval by the national congress, goes to the final signature of the president of the republic (Senado Federal, 2024).

Challenges related to the transition to Circular Economy in emerging countries

Considering the studies investigating the transition to the Circular Economy outside of China or Europe (pioneer regions), it is worth highlighting the study by Mativenga et al. (2017) because it compares a country whose model is more advanced with a developing country (United Kingdom versus South Africa). The authors administered 157 questionnaires to workers in the United Kingdom (UK) and 50 respondents from South Africa. It was possible to observe that legislation is the primary motivator for companies to adopt circular actions in the UK. On the other hand, in South Africa, the primary motivation is to reduce production costs. Although both countries use landfills as the leading destination for their waste, in the United Kingdom, the end consumer is seen as a critical actor, while in South Africa, respondents indicated that the most significant power lies with the local government. Therefore, the South African population has little chance of participating in the transition process (Mativenga et al., 2017).

Equally comprehensive, investigating the transition to the Circular Economy of an entire country (macro-level), the case study by Ezeudu & Ezeudu (2019) was also applied in Africa. Using a questionnaire was also a methodological option, but it was added to semi-structured interviews and non-participant observation in data collection. Ezeudu & Ezeudu (2019) investigated different Nigerian sectors. The results point to the need for more logistical infrastructure and the need for regulation for the management of industrial waste. Furthermore, the lack of formal integration of waste pickers, poverty, and widespread unemployment was found to delay the Circular Economy in the Nigerian recycling chain (Ezeudu & Ezeudu, 2019).

Both papers aimed to analyse waste management policies and practices to generate insights into the main challenges and opportunities of these countries on the path towards Circular Economy. Therefore, for implementing and functioning a circular system, the commitment of stakeholders driven by solid legislation it is fundamental (Mativenga et al., 2017; Ezeudu & Ezeudu, 2019).

Investigating a multinational packaging company (Tetra Pak) in two strong emerging economies (Brazil and China), Batista et al. (2019) provide valuable findings regarding the advantages and challenges of creating a circular supply chain. TetraPak's multilayer packaging (a mixture of cardboard, aluminium and polyethene) cannot be produced from recyclable materials. However, after use, the packaging components can be used through recycling.

In China, the company can separate each item for sale on the secondary market. At the same time, in Brazil, the technology only allows the paper to be separated from the PolyAl (as the combination of plastic and aluminium). Brazil, in turn, has a more efficient selective collection system because it has door-to-door public service in most cities and collectors organized in cooperatives, unlike Asian countries (Batista et al., 2019).

Still, concerning the barriers found at the meso-level (eco-industrial park) in Argentina, as well as in Brazil, waste pickers are fundamental actors in the management of urban solid waste, working to close the cycle and transform waste into resources (Gutberlet, Carenzo, Kain, & Azevedo, 2017). Despite traditionally operating with the Circular Economy, this worker category is excluded from most supply chain negotiations. In the opinion of Gutberlet et al. (2017), industries must dedicate themselves to reengineering their products and processes to create flows that save energy and materials and even productively include vulnerable workers already working through circularity before the issue gains importance for industries.

Just as the lack of infrastructure and stronger regulation was presented, the literature points to the high degree of informality in the packaging chain as a challenge in developing countries. When not included in the formal chain, these workers end up performing an invisible service, which contributes to the non-recording of recycled fees, in addition to social and environmental problems (Rutkowski, 2020).

In addition to insufficient government support or inefficient legislation, the transition to the Circular Economy is challenged by other obstacles, such as the lack of financial incentives, information

deficit or even a lack of qualified human resources (Farooque Zhang, & Liu, 2019). Farooque, Zhang, & Liu (2019) state that the government has launched a billion-dollar package of financial policies and measures to encourage circularity in industries in the Chinese food sector. They find that collaboration between actors in the chain is still lacking to implement this restorative and regenerative system by design.

Adelina & Archer (2024) highlight Thailand's difficulty in implementing selective household collection. In this way, packaging waste is contaminated with organic waste before it is discarded, compromising the quality of recycling these materials. In addition to the low level of environmental education, they reinforce the difficulty of integrated action in a chain whose material is dispersed, with many actors acting outside the regulated environment (Adelina & Archer, 2024). After presenting the debate on the Circular Economy concept and demonstrating the challenges in different parts of the world, the literature review fulfills its role. The following section explains the methodology used for the research to survey the challenges encountered by the packaging sector in Brazil in the post-consumption chain.

Research Method

This paper analyses the challenges of implementing a circular economy in the post-consumption Brazilian packaging chain. It is classified as applied concerning nature, as the data were obtained from observing a reality (waste management in Brazil). The intention was to answer questions such as “How” and “Why” within a context where the researcher cannot control the variables. In this sense, qualitative interviews help the construction processes, where the research participant is active, as it is considered that a lot of valid information can be lost if the participant is limited or acting passively in the process (Yin, 2015).

The researchers used document analysis to list the most relevant names for understanding the packaging sector. By seeking different data sources, the authors makes the research more robust, ensuring triangulation (Oppermann, 2000). Therefore, the triangulation of collection techniques occurred with the combination of semi-structured interviews and document analysis. The main documents relevant to the country's waste management area were listed. The Table 1 exposes the documents covered not only to

obtain information about the sector in Brazil but also to capture the leading names of management to invite them for interviews.

Table 1.
Main documents on waste management and circular economy in Brazil

Nº	Document title	Reference
1	Panorama dos Resíduos Sólidos no Brasil	(ABREMA, 2023)
2	Atlas da Reciclagem	(ANCAT, 2023)
3	Anuário da Reciclagem	(Instituto Pragma, 2023)
4	Pesquisa Ciclosoft 2023	(CEMPRE, 2023)
5	Gestão de Resíduos: Estratégias de atuação interinstitucional	(CNMP, 2023)
6	Plano Nacional de Resíduos Sólidos	(Planares, 2022)
7	Diagnóstico do manejo de resíduos sólidos urbanos	(MDR, 2020a)
8	Do SNIS ao SINISA Informações para planejar o Manejo de Resíduos Sólidos Urbanos	(MDR, 2020b)
9	Diagnóstico do manejo de resíduos sólidos urbanos. Programa Nacional Lixão Zero	(MMA, 2019)
10	Economia Circular: Caminho Estratégico para indústria brasileira	(CNI, 2019)
11	O ciclo da cadeia produtiva do material plástico: Modelo linear de produção e consumo Modelo circular	(Abiplast, 2019)
12	Uma Economia Circular No Brasil: uma abordagem exploratória inicial	(EMF, 2017)
13	Relatório Técnico do Acordo Setorial de embalagens em geral: Fase 1	(Coalizão Embalagens, 2017)
14	Acordo setorial para implantação do sistema de logística reversa de embalagens em gera	(Coalizão Embalagens, 2015)
15	Embalagem e Sustentabilidade: Desafios e orientações no contexto da Economia Circular	(ABRE, 2016)
16	Manual de Orientações Técnicas para Elaboração de Propostas para o Programa de Resíduos Sólidos	(FUNASA, 2014)
17	Guia de atuação ministerial: encerramento dos lixões e Inclusão social e produtiva de catadoras e catadores de materiais recicláveis	(CNMP, 2014)
18	O catador é legal: Um guia na luta pelos direitos dos Catadores de Materiais Recicláveis	(MPMG, 2013)

19	Prestação de Serviços de Coleta Seletiva por Empreendimentos de Catadores: instrumentos metodológicos para contratação	(INSEA, 2013)
20	Diagnóstico dos Resíduos Sólidos Urbanos: Relatório de Pesquisa	(IPEA, 2012)

Source: Prepared by the authors

According to Noy (2008), the choice of sampling through "snowball" or chain sampling is relevant in empirical research, especially those in which informants are difficult to access. This procedure allows interaction between the researcher and people who lead him to other members who can later be incorporated into the sample (Biernack & Waldorf, 1981). In this way, based on the authors and interested parties in the documents in Table 1 and the indication of the participants themselves, contacts were shared, and the researchers were able to seek out other actors in the packaging chain.

Data collection and analysis

With the interviewees' consent, the interviews were recorded via video calls (through Zoom Meetings), considerably facilitating subsequent transcription. Given the enormous volume of data, the audios were extracted separately from the videos.

Tables 2 detail the information of the 53 respondents and the organizations to which they are linked. Interviewees' names were not used to preserve the identity of the people involved. The recordings ranged about 62 minutes and were later transcribed. The transcription work was partly carried out by the researcher (with the help of Google Docs) and partly by professionals in the field.

Table 2
Datasheet of respondents and organizations

Government (Municipal)		
Code	**Post**	**Institution**
PPM1	Inspector of contracts	Companhia Municipal de Trânsito e Urbanização (CMTU)
PPM2	Civil Engineer	Companhia de Urbanização de Goiânia (COMURG)
PPM3	Assistant Secretary	Secretaria Municipal de Meio Ambiente (SMMA)
PPM4	Assistant Secretary	Secretaria Municipal de Meio Ambiente e Agricultura Sustentável
PPM5	General Coordinator Superintendent	Comitê Gestor de Limpeza Urbana
PPM6	Superintendent	Secretaria de Meio Ambiente e Sustentabilidade (SEMAS)

PPM7	Biologist Solid Waste Division	Secretaria Municipal de Desenvolvimento Urbano e Meio Ambiente
Government (State)		
Code	**Post**	**Institution**
PPE1	Technical Advisor	Sistema de Limpeza Urbana (SLU)
PPE2	Coordinator of the Environmental Protection Operational Support Center	Ministério Público do Estado do Rio Grande do Sul (MPRS)
PPE3	Superintendent	Consórcio Público de Saneamento Básico da Grande Aracajú
PPE4	Civil Engineer Solid Waste Department	Companhia Ambiental do Estado de São Paulo (CETESB)
PPE5	District Deputy	Câmara Legislativa do DF (CLDF)
PPE6	Prosecutor and member of the Environmental Defense and Action Group	Ministério Público do Estado de São Paulo (MPSP)
PPE7	Prosecutor and Director of Environmental Core	Ministério Público Estadual do Mato Grosso do Sul (MPMS)
PPE8	Coordinator of the Support Center of the Environmental Justice Department	Ministério Público Estadual do Mato Grosso (MPMT)
PPE9	Coordinator of Solid Waste Policy Implementation	Secretaria de Estado do Meio Ambiente (SEMA-DF)
Government (Federal)		
Code	**Post**	**Institution**
PPF1	Environmental Analyst	Ministério do Meio Ambiente (MMA)
PPF2	Coordinator of National Sanitation Information System	Ministério do Desenvolvimento Regional (MDR)
PPF3	Public Health Agent - Department of Health and Environmental Education	Fundação Nacional da Saúde (FUNASA)
PPF4	Chief Advisor for Social and Environmental Management	Superior Tribunal de Justiça (STJ)
PPF5	Technical Advisor	Ministério da Economia (ME)
Enterprises		
Code	**Post**	**Institution**
EMP1	Founding partner	Selletiva Sistemas de Resíduos
EMP2	Founding partner	Lixiki
EMP3	Founding partner	Green Ambiental
EMP4	New business specialist	New Hope Ecotech (EuReciclo)
EMP5	Executive Director	Teoria Verde
EMP6	Chief Executive Officer (CEO)	LRT Engenharia e Ambiente
EMP7	Environmental Analyst	Trombini Embalagens S.A
EMP8	Sustainability Manager	Tetra Pak
EMP9	Project Analyst	Compromisso Empresarial para Reciclagem (CEMPRE)
Waste Pickers		
Code	**Post**	**Institution**
CAT1	President	União Nacional dos Catadores e Catadoras de Material de Reciclagem do Brasil (UniCatadores)
CAT2	Coordinator	Movimento Nacional “Eu sou Catador” (MNEC)
CAT3	Production Coordinator	Associação Nacional dos Catadores e Catadoras de Materiais Recicláveis (ANCAT)

CAT4	Member of the National Articulation Team	Movimento Nacional dos Catadores de Materiais Recicláveis (MNCR)
Non-governmental organization		
Code	**Post**	**Institution**
ONG1	Chief Executive Officer (CEO)	Instituto Nenuca de Desenvolvimento Sustentável (INSEA)
ONG2	Vice-President	Instituto Lixo Zero Brasil (ILZB)
ONG3	Vice-President	Associação Brasileira de Engenharia Sanitária e Ambiental (ABES-Distrito Federal)
ONG4	Director	Instituto Ecosocial
ONG5	Accountant and Executive Coordinator	Instituto Lixo e Cidadania (ILIX)
ONG6	President	Amigos de Belém
ONG7	President	Insituto Arapoti
ONG8	President	Centro de Estudos e Aplicações em Logística e Meio Ambiente (CEALMA)
ONG9	Technical Consultant	Fundação de Apoio ao Instituto Federal do Rio Grande do Norte (FUNCERN)
Experts		
Code	**Post**	**Institution**
ESP1	General Director	Cicla Brasil
ESP2	Member of the Steering Committee	Núcleo de Economia Circular (NEC)
ESP3	Partner and Consultant	Sustenta Mais Consultoria
ESP4	Professor Dr. Sustainability Specialist	Centro Universitário FEI
ESP5	General Secretary of Environmental Management of UFSCar	Universidade Federal de São Carlos (UFSCar)
ESP6	Professor Dr. Interdisciplinary Center for Environmental Engineering and Sanitation	Universidade Federal de Mato Grosso (UFMT)
ESP7	Partner and Consultant	Ipê Amarelo Negócios Sustentáveis
ESP8	Partner and Consultant	Terceiro Setor Consultoria e Projetos Ambientais
ESP9	Partner and Consultant	Consultoria de Ideias Afins
ESP10	Partner and Consultant	A2 Consultoria Ambiental

Source: Prepared by the authors

The interview script was developed based on the research objective, therefore, categorization occurred a priori, based on the questions defined in the script: main advantages of implementing the circular economy for the supply chain and for the city/country; obstacles to the implementation of the circular economy in the packaging sector for the supply chain and for the city/country; benefits for the packaging sector with the implementation of the circular economy. After analysing the core meanings of the interviewees' statements, whose interviews were recorded and transcribed, the analysis was conducted using NVivo software. The questions used to define the categories are listed in Table 3.

Table 3.
Questions asked to achieve the research objectives.

Level	Opportunities	References	Challenges	References
Micro	Could you point out the **main advantages** for individual companies (retailers, traders, cooperatives...) and consumers in general of having Circular Economy actions properly implemented?	(Jesus & Mendonça, 2018; Jia et al., 2018)	In your opinion, **what hinders the implementation of Circular Economy for packagin**g by retailers, merchants, and consumers in general?	(Jesus & Mendonça, 2018; Jia et al., 2018)
Meso	In your opinion, what would be **the benefits for the packaging industry** and its supply chain if they had a properly implemented Circular Economy?	(Casarejos et al., 2018; Moreno et al., 2019; de Oliveira et al., 2019)	In your perception, what are **the obstacles to implementing the Circular Economy for packaging** within the group of industries participating in the packaging supply chain?	(Bressanelli et al., 2019; Oliveira et al., 2019)
Macro	In your understanding, what **would be the benefits for your city and the entire country if Brazil had a Circular Economy** properly implemented?	(Batista et al., 2018; BITC, 2018; Park et al., 2010)	In your opinion, **what hinders the implementation of the Circular Economy** for packaging in cities, states, or the entire country?	(Ezeudu & Ezeudu, 2019; Farooque et al., 2019)

Source: Prepared by the authors

The content analysis followed the model proposed by Bardin (2011), which suggests the creation of categories based on the fragments of this communication. To guarantee robustness in creating these categories and, consequently, in subsequent analysis, at least four rules must be respected: homogeneity, exhaustiveness, exclusivity, and relevance. Table 4 details the criteria adopted to carry out the content analysis.

Table 4.
Description of criteria for content analysis

Criteria	
Homogeneity	Each category was clearly defined and consistently applied, for this purpose we defined the following criteria for each Category to maintain internal consistency. Ot was obtained with the alignment of the subjects' speech, while exhaustiveness is linked to the repetition and frequency in which it appears in the response of the participant.
Exhaustiveness	The list of categories covered all potential aspects of the data.
Exclusivity	The categories defined were mutually exclusive, where each piece of data fits into one and only one Category and an excerpt of the message was categorised only once.
Relevance	The categories are directly relevant to the research question and objective of the paper, and were validated by experts previously the application.

Source: Prepared by the authors

The NVivo software was chosen and used in this research to assist the categorization and the analysis of data, according to Bardin (2011). In this way, the responses were grouped into categories to highlight the main challenges faced by the Circular Economy of packaging in Brazil to be adequately implemented. The results will be presented and discussed in the next section, based on the content analysis of the interviews.

Towards the Circular Economy: Challenges in the Brazilian packaging chain

This section of the article presents the results in the order of CE coverage (micro, meso and macro). The interviewees' speech is interspersed with the discussion made with the support of the literature in the area. When analysing circularity at the micro-level, practices are investigated at the story of a single organisation or the consumer itself (Franco, 2017). Therefore, interviewees were encouraged to reflect on why individual companies or consumers did not seek to adapt to the practices related to circular economy of post-consumption packaging, which presupposes the consideration of reverse logistics. Most cited lack of knowledge and engagement as barriers to inaction by entrepreneurs and consumers.

Increasing levels of engagement through environmental awareness and education policies are essential for citizens to know not only the advantages of circular models but also their role in the process (Farooque, Zhang, & Liu, 2019). The manufacturing industry plays a fundamental role in this educational process. For Reverse Logistics to work correctly and less packaging to end up in the country's landfills and landfills, the consumer needs to be better informed about the flow that will follow after consumption (Pincelli, Castilhos Jr, Matias, & Rutkowski, 2021).

An aggravating factor for education in the 21st century is the so-called post-truth. The dissemination of fake news or disbelief in science also hinders socio-environmental causes and, therefore, the importance of consumers learning to evaluate data and identify fake news (Glavic, 2020). The results of this research lead us to deduce that a low level of environmental awareness is observed, concerning to the experts interviewed in this study. From this deduction, it is inferred that this characteristic tends to create a mass of consumers indifferent to corporate socio-environmental responsibilities.

The consultant with more than 20 years of experience in the area (ESP7) summarizes: “The Circular Economy involves environmental education for consumers and managers alike”. In other words, the consumer must have more knowledge and awareness about the topic to exercise their supervisory role.

If the client does not ask or charge, it is unlikely that Brazilian businesspeople will adopt the socio-environmental agenda. After all, the number of consumers who change their habits and brands because they do not approve of particular packaging or understand the degree of recyclability or the destination that waste will have at the end of its useful life is still tiny. According to Abuabara et al. (2019), changing consumer behaviour is fundamental to building more circular businesses. It appears that individual retailers, traders and organizations will be more motivated to adopt practices linked to reduction, reuse, reintegration and other circular actions when pressured by their customers, who are sensitive to these issues.

In addition to the low level of environmental awareness diagnosed in consumers and entrepreneurs, the high logistics cost is also seen as a barrier to implementing packaging EC in Brazil, considering the macro level. The large dimensions of the fifth largest country in the world in terms of territorial extension (Statista, 2021) are reported as a complicating factor, especially when added to the lack of infrastructure,

the low level of integration between actors and non-stimulating public policies. The thoughts of one of the interviewed businesspeople illustrate this idea:

> EMP6: Our country is not Switzerland. Switzerland is smaller than the State of Espírito Santo. It's calm, more accessible to implement, and the challenge is much smaller. In the country, we have huge distances and very specific regionalities. We don't have linearity, and what we do in São Paulo is not the same as in the North or Northeast. Companies would have to understand this, and public policies should be different in each region, reducing bureaucracy and the complexity of the public machine in proportion to the size of the city or state.

Despite being important, national guidelines are insufficient to combat solid waste problems in Brazil. The interviewees corroborate the demand for local solutions to implement the federal law, as highlighted by Cavalcante (2014). The author highlights the importance of municipalities, including encouraging conduct through cheerful instruments such as incentives, subsidies, or exemptions or discouraging behaviour through harmful mechanisms such as increasing applicable taxes (Cavalcante, 2014).

In macro level, it is worth remembering that tax, financial and credit incentives are instruments of the Brazilian Solid Waste Management Policy (PNRS) (Brazilian Law 12.305/10, art.8, inc.IX) and must be implemented. After all, state action is fundamental to promoting environmental protection (Goron, 2014).

Even though the National Solid Waste Policy was completed a decade in 2020, its implementation has several challenges. Authors such as Leite et al. (2021) warn about the Federal Government's inability to establish transparent goals and indicators and coordinate inspection actions. The harmlessness presented by the current management of the federal executive transfers the responsibility for controlling actions in favour of integrated solid waste management to other stakeholders (Leite et al., 2021).

Participants of this research also highlighted the lack of government supervision as one of the main obstacles to achieving a more circular packaging economy. Therefore, to institutionalise a packaging CE, it is necessary to create strict control measures capable of applying fines at all stages of waste management. Thus, it is expected to guarantee the involvement of Brazilian businesspeople without depending on their requests.

During the interview with the 53 people who work directly or indirectly with solid waste management in Brazil, questions were also asked about the challenges the group of industries participating in the packaging chain faces in implementing circularity actions. It is worth noting that Murray et al. (2017) also treat this set of industries as a meso-level or eco-industrial park level of analysis.

A recent study launched by the National Confederation of Industry (CNI) presents proposals that seek to reduce Brazilian costs (structural difficulties that reduce the competitiveness of national companies). According to the publication, the industrial sector produces less than in 2010. It estimates that the country needs to grow its GDP (Gross Domestic Product) by at least 3% per year over the next ten years to recover the development achieved in the previous decade (CNI, 2021).

Uniting the packaging chain with the recycling chain demands another factor often neglected by the industry: the feasibility (technical and commercial) of recycling packaging. The more quality there is in the destination, collection, separation, and sorting phases, the more sales capacity this material has, the cleaner this material reaches the recycler and consequently, the more social and environmental impact this process generates (Demajorovic & Massote, 2017).

However, some interviewees reported that many packages are difficult to recycle because they are not commercially available and are treated as waste, going directly to landfills and landfills. The difficulty of recyclability in particular packaging contradicts the concept of the Circular Economy, which states that it must be regenerative and restorative by design. This problem is derived from the linear economy. If the circular economy concepts were fully implemented the quality and recyclability of packaging would be taken into consideration and at the end of life the packaging would not be a problem. In their applied case study in Belgium, Nimmegeers & Billen (2021) state that multilayer plastics represent obstacles to the recycling system. Despite its usefulness, mainly for packaging food and drinks that require light, oxygen and carbon dioxide barriers, this material is difficult to recycle.

Innovation and Circular Economy are themes related to the extent to which new processes and products (or services) are generally necessary to create cyclical flows and reduce waste (Sehnem et al., 2019). In the opinion of Jesus & Jugend (2021), collaboration between stakeholders is fundamental to innovatively resolving problems linked to product returns, and society must be called upon to contribute to developing new products more aligned with the principles of CE.

At the meso-level, among other challenges, there is the difficulty of exchanging information from one company to another and thus being able to face similar problems together. Solid waste information systems are also criticized due to this lack of integration. For example, SINIS-RS (National Sanitation Information System – Solid Waste) has been criticized by authors such as Besen, Silva, & Jacobi (2021) for having little dialogue with SINIR (National Waste Information System) and still needing to provide more reliability in the data reported by city halls. The Table 5 presents the main challenges

Table 4.
The main challenges identified by the research

	Challenges	**Interviewess**	**References**
Micro	Lack of consumer knowledge/engagement	ESP1, ESP2, ONG1, PPF1, ESP4, EMP2, PPE3, PPE4, ONG3, ESP6, EMP5, PPM4, PPM5, ESP7, PPF4, ONG9, EMP8, PPE9.	(Abuabara et al., 2019; Bressanelli et al., 2019).
	Lack of knowledge/engagement among entrepreneurs	PPE1, ONG1, PPF1, ESP4, EMP3, PPM6, ESP7, ESP8, EMP7, CAT3, EMP9.	Bressanelli et al., 2019).
Meso	*Greenwashing*	ESP1, ONG3, ONG5.	(Jesus et al., 2016)
	High logistics costs (distance, infrastructure, and integration)	EMP2, CAT1, ONG4, PPM2, PPM4, PPE7, ONG8.	(CNI, 2021).
	Consumer lack of demand	PPF1, ESP4, ESP7.	(Abuabara et al., 2019).
	Double taxation of materials	ESP2, PPE4, EMP4, PPF2, ONG4, ESP5, PPE5, ESP9, EMP9.	(CNI, 2021).
	Difficulty/lack of recyclability in packaging (Ecodesign)	PPE2, ESP1, EMP1, PPM6.	Nimmegeers & Billen (2021).
	Lack of coordination to build solutions	ONG1, EMP3, ESP5, EMP5, PPE6, ONG8, EMP8.	(Leite et al., 2021).
	Lack of legislation specifying responsibilities	ESP4, PPE4, EMP4, PPE6, EMP7, EMP9.	(Rutkoviski, 2020).

	Lack of internalizing the costs of transitioning to the circular economy in production costs (Resistance to change)."	PPE1, PPM3, PPE6, PPE7, EMP8, ESP10, PPF5, CAT4.	Nimmegeers & Billen (2021).
Macro	Lack of knowledge/engagement of the population	ESP1, ONG1, PPF1, ESP2, ESP4, EMP2, PPE3, ONG3, ESP6, EMP5, PPE4, PPM4, PPM5, ESP7, PPF4, PPE9, ONG9, EMP8.	(Abuabara et al., 2019).
	Lack of knowledge/awareness of political agents	ESP2, ESP4, PPE3, ONG3, ESP6, PPE7, ONG8.	(Farooque et al., 2019).
	Lack of construction of local solutions	ONG1, ONG2, PPF2, ONG6.	(Cavalcante, 2014)
	Lack of political will among political agents	PPE1, ESP3, EMP2, CAT1, ONG3, ESP5, PPM1, PPE7, EMP6, EMP7, EMP9.	(Farooque, Zhang, & Liu, 2019).
	Lack of coordination between different spheres of government	ESP5, PPE5, PPE6.	(Leite et al., 2021).
	Lack of public policy and appropriate instruments	PPE2, PPE4, ESP5, ESP6, PPE8, ONG9, EMP9.	(Leite et al., 2021).
	Lack of logistics infrastructure / Lack of efficient collection systems	ESP1, ONG1, PPF1, ONG6, PPE7, EMP7, ESP9, ESP2, EMP4, EMP5, PPE6.	(Rutkoviski, 2020)
	Political pressure not to implement and/or change the PNRS	ONG1, ESP8, ONG7	(Zaneti et al., 2009)
	Industry lobbies overload the municipal budget	ESP1, ESP5, PPF2, PPE5, ONG5, PPF3, ONG7, CAT3	Cardoso (2021).
	Lobbying and/or corruption to maintain municipal public cleaning contracts	ONG4, PPM2, PPE5, PPF3, ESP9, EMP8	Godoy (2016); Cardoso (2021).

Sharing responsibilities for the product's life cycle is one of the principles of the National Solid Waste Policy, and the sectoral agreement should be the instrument capable of bringing together public

power with manufacturers, importers, distributors and traders to enforce this principle (Brasil, 2010). The paper of Guarnieri, Cerqueira-Streit and Batista (2020) evaluates the first phase of the packaging sector agreement with substantial gains, mainly related to investment by companies in infrastructure for cooperatives of recyclable materials collectors, the installation of PEVs (Point of Delivery Voluntary) in some Brazilian capitals with environmental education campaigns for the population (Guarnieri et al., 2020).

Despite recognizing the importance of these actions, the authors conclude the work by indicating that further research would be necessary to evaluate the subsequent phases of the packaging sector agreement, especially regarding the feasibility of the reverse logistics system operationalizing the return of these materials to production cycles. It should be noted that the second phase of the agreement should have started 90 days after the conclusion of the first. However, as political dynamics influence business behaviour, the proposal for phase 2 is still under analysis at the Ministry of the Environment (representative of the federal public administration in the packaging sector agreement). The first phase of the sectoral agreement occurred from 2015 to 2017 and the second phase should be initiated in 2018.

In addition to the lack of stimulus, there is also a disincentive to circularity actions at the industrial level. The taxation of the material occurs at the time of extraction and production of the product. Therefore, it should not be taxed once again when returning to the production cycle (Demajorovic & Massote, 2017). The representative of the company that acts as an intermediary between waste picker cooperatives and private logistics operators (EMP4) explains this challenge:

> EMP4: There is still the issue of double taxation because there is a tax when the cooperative sells to the recycler, and the recycler also pays tax when he barters the recycled material.

In this way, it appears that Brazilian society is discouraged from buying more sustainable products because they tend to be more expensive on the shelves. The overlapping of taxes also does not encourage the industry to invest in using more recycled material. The consumer's innocence also makes another industrial activity triumph that directly contradicts the basic principles of corporate socio-environmental responsibility: greenwashing. The greenwashing can be characterized as a barrier because it involves

companies or organizations deceiving the public by making false or misleading claims about the circular economy practices. This can create a false perception of environmental responsibility, confusing consumers and hindering the adoption of genuine circular economy practices.

According to one of the experts interviewed, ESP1: "Today, what guides the Circular Economy is still marketing, which can be dangerous as it also opens up space for greenwashing". The practice of greenwashing (selling itself as sustainable or environmentally friendly without actually being) makes it difficult to build "green markets" because, without transparency and credibility, customers reduce their willingness to pay to belong to this market (Jesus et al., 2016).

Regarding deadlines, Godoy (2013) indicates that it is one of the difficulties given the non-compliance with several of them. Not only were the deadlines for closing landfills not respected, but the deadlines for signing sectoral agreements and preparing plans at national, state, and municipal levels were also not respected (Godoy, 2013).

In addition to the challenges mentioned above, there is resistance to change at the industrial level, evidenced mainly by the lack of internalization of the costs of the transition to EC in production costs. When responding to the challenges of implementing CE in industry, the discussion naturally returns to the concepts of extended versus shared responsibility for the product life cycle. The first has been present in European legislation since the 1990s, while the second is a Brazilian version, more lenient for industry, included in the PNRS (Rutkowski, 2020).

Concluding the challenges, at the meso-level, that would be necessary to transition towards the Circular Economy of packaging in Brazil, the interviewees of this research consider the lack of legislation that specifies the industry's responsibilities. Despite of the lack of legislation is considered as a macro-level barrier, it hinders the adoption of circular economy in meso-level. Changing from a linear chain to a circular one requires drives to escape inertia. They need to change their current modus operandi. Not having legislation that clearly defines each person's role means that the transition happens slowly, depending on an ecological awakening that generates voluntary attitudes that are poorly integrated. Not having incentives to implement responsible actions is a problem, and knowing that there will be no penalties in case of non-compliance is also a problem. Although Brazil has a national solid waste law, it

lacks decrees and other legal instruments that pressure manufacturers to change their processes and products towards circularity.

The NSWP law was processed for more than two decades in the national congress until it was sanctioned. Currently, more than ten years after its sanction, its implementation cannot be considered successful (Cardoso, 2021). The transition to a Circular Economy in Brazil depends on the successful implementation of the PNRS, which, in turn, depends on the actions of politicians.

When asked about the barriers to implementing packaging CE in Brazil at the macro-level, many participants indicated a lack of knowledge of political agents on the subject. As the topic of Circular Economy is relatively new (Bressanelli et al., 2019), the term itself is often unknown to political leaders.

Many public managers do not understand the interrelationship between sanitation, education and public health. According to Wichai-utcha & Chavalparit (2019), who qualitatively studied the problem of plastic waste in Thailand, it is up to the government to provide infrastructure for the effective collection and sorting of the material and coordinate the appropriate referral for recycling or energy use, if applicable.

Even though the lack of knowledge was verified, it must be differentiated from the lack of political will, another barrier found by the present research. Environmental education is the first step for the political agent to internalize the seriousness of the waste problem so that there is political will and, consequently, the effectiveness of public policies.

According to Dutra et al. (2018), most of the recyclables market in Brazil is carried out by micro, small companies and cooperatives that take care of logistical steps such as collection, transportation, sorting and marketing. The lack of infrastructure, at the same time as it is a cause, is also a consequence of the lack of efficient collection systems reported by participants in the present study. One of the waste pickers interviewed, a leader in Rio de Janeiro, renews his hopes in the Circular Economy for the creation of a model that values the collector's work:

> CAT2: Nobody recycles for environmental reasons in Brazil. The collector first gets his money and then realises the ecological importance of the activity, which is why he ends up liking it. However, every waste picker begins the movement to combat unemployment and hunger. Therefore, recycling in Brazil is still born out of poverty and social and economic exclusion. This issue has to be changed through the Circular Economy.

In addition to being one of the objectives of Law 12.305/10 (Brazil, 2010, art.7, inc.XII), including waste pickers in solid waste management in municipalities brings economic benefits (such as reducing operational costs). It also brings social benefits (such as reduction of enslaved persons or child labour) as well as environmental gains (reduction in pollution and less material in landfills and landfills (Dutra et al., 2018; Rutkowski & Rutkowski, 2015).

Even though the law is federal, each federative unit must regulate reverse logistics procedures for post-consumer packaging and monitor compliance with companies that must assume responsibility, independent of the public cleaning service. In this sense, Mato Grosso do Sul, São Paulo, Paraná and are among the most pioneering states, considering these states have legislation approved in this matter.

With the state Public Ministry active in solid waste, Mato Grosso do Sul pioneered by launching Decree 15,340 of 2019. Manufacturers, importers, distributors and traders operating in the state received guidelines to create a general self-regulatory logistics system for reverse packaging. (Mato Grosso do Sul, 2019).

Similarly, through board decision No. 008 of January 2021, the Environmental Company of the State of São Paulo (CETESB) determines the steps for environmental licensing of establishments required to carry out reverse logistics of their products and packaging. Among them are companies directly or indirectly selling food packaging, beverage packaging, personal hygiene product packaging, perfumery, cosmetics, and cleaning products (CETESB, 2021).

In Paraná, in June 2021, State Law No. 20,607/2021 was published and came into force. By establishing standards for the proper operationalization and supervision of the State Solid Waste Plan of the State of Paraná (PERS/PR), the law links the environmental licensing of companies generating waste to the presentation of the reverse logistics plan for post-consumer products, both in operating license phase and in its renewals. It is also worth mentioning that the law provides that the State of Paraná may seek the adoption of partial or total relief from the tax burden, among other tax benefits (Paraná, 2021).

It can be seen, therefore, that it is only recently, ten years after the sanction of the federal law, that state laws have been published and with fiscal and tax instruments foreseen, still without a compelling start. This approach enhances the obstacles some interviewees mentioned: A lack of public policy and adequate mechanisms.

The lack of federal coordination is one of the obstacles to implementing circular principles in waste management on a national level, which also generates other problems cited by interviewees, such as the lack of construction of local solutions. “Thinking globally and acting locally” (also known as “glocal”) is a Sustainability premise that requires the integration of actors and decentralization of various systems, including productive ones.

Creating municipal consortia is an instrument provided for in Law 12.305/10 as an alternative for cooperation to gain scale and reduce costs (Brasil, 2010, ART. 7º, Inc XVIII). However, interviewees who deal with this challenge still see consortia between municipalities as an underused instrument due to a lack of coordination from the federal government. This difficulty is present in the critical speech of the interviewed district deputy (PPE5):

> PPE5: I think there needs to be intergovernmental coordination and better coordination between the Federal government, states, and municipalities to guarantee the National Solid Waste Policy because it provides inter-municipal and interstate consortia.

Circular Economy is a relatively new topic that has little incorporation into Brazilian society. Even older terms, such as reverse logistics and selective collection, are unknown to most of the population. This challenge is evident in the statement by the head of legal advice for the Urban Cleaning Management Committee of São Luiz do Maranhão (PPM5).

> PPM5: To be quite honest, the mayor doesn't see any political gains in this, so he doesn't implement it. The mayors would move more if the population were more aware and charged.

Waste pickers are fundamental environmental agents for Brazil's Circular Economy of packaging (Guarnieri et al., 2020; Cardoso, 2021). However, despite the population's low awareness is a micro-level barrier, it hinders the attainment of the national policy, contributing to little participation in selective collection and negatively influencing the quality of the material reaching the cooperative. The speech of the leading collector in the state of Rondônia (CAT3) sheds light on this problem.

> CAT3: These companies' contracts with the city hall are worth millions. Guys get paid to bury recyclable material, and people don't want to separate it because the company collects everything. I think this hinders our work.

This obstacle raised by the interviewee is vital to complying with the PNRS and, consequently, for the country to move towards the Circular Economy since the packaging is a fraction of urban solid waste (dry and recyclable). The municipalities' contracts with companies, whose models may vary (bidding, auction, concession.) and in some of these contracts, the company's remuneration is established on a variable basis, per "ton of solid waste landfilled", for example.

Contractual conditions such as this go against the order of priority in article nine of the PNRS (non-generation, reduction, reuse, recycling and finally, the treatment and environmentally appropriate final disposal of waste) (Brazil, 2010, art 9). It is noted that this is a widespread problem since interviewees from all regions of the country reported this challenge. Below is the transcript from the representative of Goiás (PPM2):

> PPM2: Many people are making money with garbage. Who knows how they beat the competition, if they use straw man, etc. Many people live off the linear, degrading, exploitative economy, and for us to migrate to this new one, an enormous joint effort will have to come to break these old agreements.

Several forms of intermediation of interest between companies and governments include urban cleaning services (collection, pruning/sweeping, transportation, treatment and disposal of solid waste). Vested interests reach the public sector, including at the technical level. It has been proven that in the city of São Paulo, for example, the two largest urban cleaning companies paid bribes to administrative inspectors between 1997 and 2000 - an episode known as the "inspector mafia" (Godoy, 2016).

Waste management consumes an increasing portion of municipal budgets (ABRELPE, 2021). According to some interviewees, another barrier is the industrial lobby so that they do not bear the costs of reverse packaging logistics.

Finally, the last thematic category observed to represent the challenges for implementing the Circular Economy of packaging in Brazil, at the macro-level, is the political pressure not to implement and change the NSWP. In an interconnected way with the lobby exposed previously, this obstacle differs

from the industrial case, as the idea of non-compliance with federal law can come from the national executive itself, according to those interviewed.

Given the challenges cited by interviewees and the literature, the dimension of complexity of the transition from the current system to a Circular Economy for packaging is evident. The paradigm shift requires a change in individual perception of development, so citizen engagement helps change the relationships between businesspeople and public authorities. It is expected that inspection bodies will gain strength (such as the Public Ministry), just as it is likely that municipalities will be relieved of taxes and encouraged to extend the useful life of products.

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Final Considerations

The implementation of circular practices in solid waste management has proven useful in developed countries, mainly in increasing collection and recycling rates. Therefore, the question that motivated this research was: What are the main challenges in implementing a Circular Economy of packaging in Brazil?

The interviewees reported challenges of different natures. In addition to the inefficient logistics infrastructure, given the size of the country, the lack of tax incentives and excessive bureaucracy for adaptation also represent barriers. Brazilian businesspeople do not have the economic motivation to implement actions in this sense. There is also criticism regarding the failure to monitor compliance with environmental laws involving waste. According to the subjects' statements, organizations often do not even know the content of the rules and, therefore, have a low level of engagement.

Concerning industrial parks, double taxation on recyclable materials is an obstacle, in addition to some manufacturers' use of false marketing (greenwashing). In many packaging, recycling is difficult (due to the design), and there is a lack of coordination between sectors for collective decision-making. Among other challenges, it is also worth highlighting the lack of consumer demands (which discourages appropriate behaviour) and the fact that the industry does not internalize the costs of the transition in production costs.

The macro-level (cities, states or country) was the unit of analysis in which interviewees encountered the most challenges. Brazilian governments lack the knowledge, awareness, and political will to overcome the barriers to the circular economy. As a result, no articulation between the different spheres of government, not even public policies, allows charging in a more specific and individualized way. This inaction is partially justified by the lack of demand from the population and the active lobbies. There is pressure for the PNRS not to come into force, both from industrialists and from current holders of municipal urban cleaning contracts. These stakeholders, in general, are interested in maintaining the profitable status quo and not assuming the costs and risks of a new model.

This research can contribute to both academics and managers. Managers found a list of challenges reported by those who know waste management in Brazil. In this way, the paper guides practices to better deal with government and consumers and even obtain commercial and marketing gains from circularity.

Despite making contributions, this work has limitations. Consumer opinions were left out of the data collection. Therefore, the research could not capture the challenges from the citizen's perspective. The various changes in the Brazilian regulatory scenario also open new avenues for research.

The so-called “ReCircula”, which is the proposal to replace the packaging Sector Agreement with a Term of Commitment with new participants and targets for reuse, increased recyclability and fees recycling for glass, paper, cardboard and plastic. The recently released decrees nº 10.936/22, nº 11.413/23 and nº 11.414/23 also require critical analysis by researchers to expose the real potential of this new regulation to overcome existing challenges. Even more recently, the progress of Law Project 1874 of 2024 stands out, which provides for the Institution of the National Circular Economy Policy, awakening the Brazilian market and academia.

In a country with such social vulnerability as Brazil, a circular system has the potential to bring social, economic, and environmental benefits. The higher quality the packaging presents, from collection to final disposal, the more social impact (work and income) this system would be able to generate. However, several challenges permeate this chain, which allows us to infer that to obtain the advantages provided by the CE, structural and institutional changes involving education and culture will be necessary at the most different levels of operation.

References

ABRELPE, Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais (2021). *Panorama dos Resíduos Sólidos no Brasil 2021*.

ABREMA, Associação Brasileira de Resíduos e Meio Ambiente (2023). *Panorama dos Resíduos Sólidos no Brasil* 2023.

Abuabara, L., Paucar-Caceres, A., & Burrowes-Cromwell, T. (2019). Consumers' values and behaviour in the Brazilian coffee-in-capsules market: promoting circular economy. *International Journal of Production Research, 57*(23), 7269–7288. https://doi.org/10.1080/00207543.2019.1629664

Adelina, A., Archer, D. (2024). Situated urban political ecology of plastics recycling in Bangkok. Cities *145*(1), 104671. https://doi.org/10.1016/j.cities.2023.104671

ANCAT, Associação Nacional dos Catadores de Materiais Recicláveis (2023). *Atlas da Reciclagem 2023.*

Bardin, L. (2011). *Análise de Conteúdo*. Edições 70.

Batista, L., Gong, Y., Pereira, S., Jia, F., & Bittar, A. (2019). Circular supply chains in emerging economies: a comparative study of packaging recovery ecosystems in China and Brazil. *International Journal of Production Research*, *57*(23), 7248–7268. https://doi.org/10.1080/00207543.2018.1558295

Besen, G. R., Silva, C. L., & Jacobi, P. R. (2021). 10 anos da Política Nacional de Resíduos Sólidos: indicadores de resíduos domiciliares. In *10 anos da Política Nacional de Resíduos Sólidos: caminhos e agendas para um futuro sustentável*. 18–29. IEE-USP: OPNRS.

Biernack, P., & Waldorf, D. (1981). Snowball Sampling. *Sociological Methods & Reseach*, *10*(2), 141–163. https://doi.org/10.4135/9781483365817.n1278

Boesen, S., Bey, N., & Niero, M. (2019). Environmental sustainability of liquid food packaging: Is there a gap between Danish consumers' perception and learnings from life cycle assessment? *Journal of Cleaner Production, 210*, 1193–1206. https://doi.org/10.1016/j.jclepro.2018.11.055

Brasil. (2010). *Lei nº 12.305 de 2 de agosto de 2010 que institui a Política Nacional de Resíduos Sólidos*.

Brasil. (2022). Decreto nº 10.936 de 12 de janeiro de 2022.

Brasil. (2023a). Decreto nº 11.413 de 13 de fevereiro de 2023.

Brasil. (2023b). Decreto nº 11.414 de 13 de fevereiro de 2023.

Bressanelli, G., Perona, M., & Saccani, N. (2019). Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study. *International Journal of Production Research*, *57*(23), 7395–7422. https://doi.org/10.1080/00207543.2018.1542176

Cardoso, A. (2021). A luta dos (in)visíveis que (r)existem. In *10 anos da Política Nacional de Resíduos Sólidos: caminhos e agendas para um futuro sustentável*. 166–179. IEE-USP: OPNRS.

Cavalcante, D. L. (2014). Instrumentos fiscais na efetivação da Política Nacional de Resíduos Sólidos: do poluidor-pagador ao protetor-recebedor. In *Tributação ambiental: reflexos na Política Nacional de Resíduos Sólidos*. 141–158. Editora CRV.

CEMPRE, Compromisso Empresarial para Reciclagem (2023). *Pesquisa Ciclosoft 2023: Resumo Executivo*.

Cerqueira-Streit, J.A., Endo, G. Y., Guarnieri, P., Batista, L. (2021). Sustainable Supply Chain Management in the Route for a Circular Economy: An Integrative Literature Review. *Logistics*. 81(5), 1-21. https://doi.org/10.3390/logistics5040081

CETESB, Companhia Ambiental do Estado de São Paulo (2021). Decisão de Diretoria nº 008/2021/P, de 29 de janeiro de 2021. *Diário Oficial Estado de São Paulo - Caderno Executivo I, 131*(21), 32–33.

CNI, Confederação Nacional da Indústria (2021). *Propostas para a aceleração do crescimento econômico*.

Coalizão Embalagens. (2015). *Acordo Setorial para implantação do sistema de logística reversa de embalagens em geral*.

Coalizão Embalagens. (2017). *Relatório Técnico do Acordo Setorial de embalagens em geral: Fase 1*.

Demajorovic, J., & Massote, B. (2017). Acordo Setorial de Embalagem: Avaliação À Luz Da Responsabilidade Estendida Do Produtor. *Revista de Administração de Empresas*, *57*(5), 470–482.

https://doi.org/10.1590/s0034-759020170505

Dutra, R. M., Yamane, L. H., & Siman, R. R. (2018). Influence of the expansion of the selective collection in the sorting infrastructure of waste pickers' organizations: A case study of 16 Brazilian cities. *Waste Management*, *77*(July), 50–58. https://doi.org/10.1016/j.wasman.2018.05.009

European Commission (2024). Waste Framework Directive. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

Ezeudu, O. B., & Ezeudu, T. S. (2019). Implementation of circular economy principles in industrial solid waste management: Case studies from a developing economy (Nigeria). *Recycling*, *4*(4). https://doi.org/10.3390/recycling4040042

Farooque, M., Zhang, A., & Liu, Y. (2019). Barriers to circular food supply chains in China. *Supply Chain Management*, *24*(5), 677–696. https://doi.org/10.1108/SCM-10-2018-0345

Franco, M. A. (2017). Circular economy at the micro level: A dynamic view of incumbents' struggles and challenges in the textile industry. *Journal of Cleaner Production*, *168*, 833–845. https://doi.org/10.1016/j.jclepro.2017.09.056

Freitas, K. A., Partyka, R. B. (2022). Operations and Supply Chain Management in Brazil: Where do we come from and where are we going? BASE – Revista de Administração e Contabilidade da Unisinos, 19(2), 911-940. https://doi.org/10.4013/base2022.192.02

Fritz, M. (2019). Sustainable supply chain management. In *In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) Responsible Consumption and Production. Encyclopedia of the UN Sustainable Development Goals.* 1–14. Springer. https://doi.org/10.1057/9780230116368

Glavic, P. (2020). Identifying key issues of education for sustainable development. *Sustainability (Switzerland)*, *12*(16). https://doi.org/10.3390/su12166500

Godoy, M. R. B. (2013). Dificuldades para aplicar a Lei da Política Nacional de Resíduos Sólidos no Brasil. *Caderno de Geografia*, *39*, 1–12.

Godoy, S. R. (2016). A economia política da limpeza urbana em São Paulo. *Novos Estudos - CEBRAP*, *35*(2), 55–76.

Goron, H. S. (2014). Incentivos fiscais e a Política Nacional de Resíduos Sólidos. In *Tributação ambiental: reflexos na Política Nacional de Resíduos Sólidos*. 229–245. Editora CRV.

Guarnieri, P., Cerqueira-Streit, J., & Batista, L. (2020). Reverse logistics and the sectoral agreement of packaging industry in Brazil towards a transition to circular economy. *Resources, Conservation and Recycling*, *153*, 104541. https://doi.org/10.1016/j.resconrec.2019.104541

Gutberlet, J., Carenzo, S., Kain, J.-H., & Mantovani Martiniano de Azevedo, A. (2017). Waste Picker Organizations and Their Contribution to the Circular Economy: Two Case Studies from a Global South Perspective. *Resources*, *6*(4), 52. https://doi.org/10.3390/resources6040052

Jabbour, A. B., Rojas Luiz, J. V., Rojas Luiz, O., Jabbour, C. J., Ndubisi, N. O., Caldeira de Oliveira, J., & Junior, F. H. (2019). Circular economy business models and operations management. *Journal of Cleaner Production*, *235*(20), 1525–1539. https://doi.org/10.1016/j.jclepro.2019.06.349

Jesus, A., Antunes, P., Santos, R., & Mendonça, S. (2016). Eco-innovation in the transition to a circular economy: An analytical literature review. *Journal of Cleaner Production*, *172*, 2999–3018. https://doi.org/10.1016/j.jclepro.2017.11.111

Jesus, G. M. K., & Jugend, D. (2021). How can open innovation contribute to circular economy adoption? Insights from a literature review. *European Journal of Innovation Management*, *1*(4), 1–34. https://doi.org/10.1108/EJIM-01-2021-0022

Kirchherr, J., Yang, N. H., Schulze-Spüntrup, F., Heerink, M. J., Hartley, K. (2023). Conceptualizing the Circular Economy (Revisited): An Analysis of 221 Definitions. Resources, Conservation and Recycling, 194, 107001. https://doi.org/10.1016/j.resconrec.2023.107001

Leite, C., Grimberg, E., Torres, F., Orlow, N., & ARZB. (2021). Aliança Resíduo Zero Brasil: ações e perspectivas para a implementação da Política Nacional de Resíudos Sólidos. In *10 anos da Política Nacional de Resíduos Sólidos: caminhos e agendas para um futuro sustentável*. 92–104. IEE-USP: OPNRS.

Mativenga, P. T., Sultan, A. A. M., Agwa-Ejon, J., & Mbohwa, C. (2017). Composites in a Circular Economy: A Study of United Kingdom and South Africa. *Procedia CIRP*, *61*, 691–696. https://doi.org/10.1016/j.procir.2016.11.270

Mato Grosso do Sul. (2019). Decreto nº 15.340 de 23 de dezembro de 2019.

MDR, Ministério do Desenvolvimento Regional. (2020a). Diagnóstico do manejo de resíduos sólidos urbanos. Brasília-DF.

MDR, Ministério do Desenvolvimento Regional. (2020b). *Do SNIS ao SINISA Informações para Manejo de Resíduos Sólidos Urbanos Manejo de Resíduos Sólidos*. Brasília-DF.

MMA, Ministério do Meio Ambiente. (2020). *Consulta Pública – Plano Nacional de Resíduos Sólidos - PLANARES*. Brasília-DF. Disponível em: http://consultaspublicas.mma.gov.br/planares/ . Acessado em: dezembro de 2022

Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*, *140*(3), 369–380.

https://doi.org/10.1007/s10551-015-2693-2

Nimmegeers, P., & Billen, P. (2021). Quantifying the Separation Complexity of Mixed Plastic Waste Streams with Statistical Entropy: A Plastic Packaging Waste Case Study in Belgium. *ACS Sustainable Chemistry and Engineering*, *9*(29), 9813–9822. https://doi.org/10.1021/acssuschemeng.1c02404

Noy, C. (2008). Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *International Journal of Social Research Methodology*, *11*(4), 327–344. https://doi.org/10.1080/13645570701401305

Oliveira, C. T., Luna, M., & Campos, L. (2019). Understanding the Brazilian expanded polystyrene supply chain and its reverse logistics towards circular economy. *Journal of Cleaner Production*, *235*, 562–573. https://doi.org/10.1016/j.jclepro.2019.06.319

Oppermann, M. (2000). Triangulation: A Methodological Discussion. International Journal of Tourism Research, *146*(2), 141–146.

Paraná. (2021). Lei Nº 20.607 de 10 de junho de 2021.

Park, J., Sarkis, J., & Wu, Z. (2010). Creating integrated business and environmental value within the context of China's circular economy and ecological modernization. *Journal of Cleaner Production*, *18*(15), 1494–1501. https://doi.org/10.1016/j.jclepro.2010.06.001

Pereira, A., Ribeiro, F. M., Jeffrey, R., Doron, A. (2020). Waste policy reforms in developing countries: A comparative study of India and Brazil. Waste Management and Research. 38(9). 987-994. https://doi.org/10.1177/0734242X20938435

Pincelli, I. P., Castilhos Jr, A. B., Matias, M. S., & Rutkowski, E. W. (2021). Post-consumer plastic packaging waste flow analysis for Brazil: The challenges moving towards a circular economy. *Waste Management*, *126*, 781–790. https://doi.org/10.1016/j.wasman.2021.04.005

Rutkowski, J. E. (2020). Inclusive packaging recycling systems: Improving sustainable waste management for a circular economy. *Detritus*, *13*, 29–46. https://doi.org/10.31025/2611-4135/2020.14037

Rutkowski, J. E., & Rutkowski, E. W. (2015). Expanding worldwide urban solid waste recycling: The Brazilian social technology in waste pickers inclusion. *Waste Management and Research*, *33*(12), 1084–1093. https://doi.org/10.1177/0734242X15607424

Sehnem, S., Pandolfi, A., & Gomes, C. (2019). Is sustainability a driver of the circular economy? *Social Responsibility Journal*, *16*(3), 329–347. https://doi.org/10.1108/SRJ-06-2018-0146

Senado Federal (2024). Projeto de Lei 1874/2022. Avaliable at: https://www25.senado.leg.br/web/atividade/materias/-/materia/153918

Statista. (2021). *The 30 largest countries in the world by total area*. https://www.statista.com/statistics/262955/largest-countries-in-the-world/

Tseng, M. L., Wu, K. J., Chien, C. F., Ali, M. H., Circular supply chain practices: challenges, innovation and development (2024). International Journal of Logistics Research and Applications, *27*(1), 1-5.

United Nations. (2015b). *Transforming our world: the 2030 agenda for sustainable development*.

Wichai-utcha, N., & Chavalparit, O. (2019). 3Rs Policy and plastic waste management in Thailand. *Journal of Material Cycles and Waste Management*, *21*(1), 10–22. https://doi.org/10.1007/s10163-018-0781-y

Yin, R. K. (2015). *Estudo de Caso: Planejamento e Métodos* (5th ed.). Bookman.

Zaneti, I. C. B. B., Sá, L. M., & Almeida, V. G. (2009). Insustentabilidade e produção de resíduos: a face oculta do sistema do capital. *Sociedade e Estado*, *24*(1), 173–192. https://doi.org/10.1590/s0102-69922009000100008

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