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STAKEHOLDERS AND RESPONSIBILITIES IN REVERSE SUPPLY CHAINS: A LITERATURE REVIEW

STAKEHOLDERS E RESPONSABILIDADES EM CADEIAS DE SUPRIMENTOS REVERSAS: UMA REVISÃO DA LITERATURA

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Abstract - Technological advances have increased depreciation rates and stimulated the growing consumption of new products, leading to an increase in the generation of waste. In some countries, the current capacities for waste collection operations have been ineffective in properly reusing or disposing of these large quantities generated. Additionally, preliminary surveys indicate a scarcity of research associating stakeholders and responsibilities in RSC. Thus, is imperative to develop research to identify stakeholders and responsibilities for the recovery or proper disposal of waste. This paper sought to characterize the current literature context regarding stakeholders and responsibilities in Reverse Supply Chains (RSC). This research was based on a systematic literature review which consisted of six steps: Research protocol application, Bibliographic survey, Data extraction, Selection of papers, Results analysis, and Conclusion and future research. From the 144 publications initially identified, 65 were excluded due to duplication or download impossibility, and 34 were excluded based on exclusion criteria, resulting in 45 papers selected for the full reading, and the answers related to the Research Questions (RQ) were identified and raised. A summary of the main results and opportunities for new research was presented at the end. The research findings will contribute to identifying opportunities for developing new research and promoting theoretical and practical advancements on the subject. Such outputs will also enhance understanding of RSC structure and organization, supporting context-specific both sustainable public policies and business models, encompassing economic, environmental, social, cultural, political, and regulatory aspects.

Keywords: Extended Producer Responsibility (EPR), Shared Responsibility, Reverse Logistics, Circular Economy, Waste Management.

Resumo - Os avanços tecnológicos têm aumentado as taxas de depreciação e estimulado o consumo crescente de novos produtos, levando ao aumento na geração de resíduos. Em alguns países, as capacidades atuais das operações de coleta de resíduos têm sido ineficazes para reutilizar ou descartar adequadamente essas grandes quantidades. Além disso, pesquisas preliminares indicam escassez de estudos que associem *stakeholders* e responsabilidades nas CSR. Assim, é imperativo desenvolver pesquisas para identificar *stakeholders* e responsabilidades para recuperação ou descarte adequado de resíduos. Este artigo buscou caracterizar o contexto atual da literatura em relação aos *stakeholders* e responsabilidades nas Cadeias de Suprimento Reversas (CSR). Esta pesquisa baseou-se em uma revisão sistemática da literatura, composta por seis etapas: aplicação de protocolo de pesquisa, levantamento bibliográfico, extração de dados, seleção de artigos, análise de resultados e conclusão e pesquisas futuras. Das 144 publicações inicialmente identificadas, 65 foram excluídas devido a duplicação ou impossibilidade de download, e 34 excluídas com base em critérios de exclusão, resultando em 45 artigos selecionados para leitura completa, sendo as respostas relacionadas às Questões de Pesquisa (QP) identificadas e levantadas. No final, foi apresentado um resumo dos principais resultados e oportunidades para

novas pesquisas. Os resultados contribuirão para identificar oportunidades ao desenvolvimento de novas pesquisas e promover avanços teóricos e práticos sobre o tema. Tais resultados também aprimorarão o entendimento da estrutura e organização das CSR, apoiando políticas públicas sustentáveis e modelos de negócios, abrangendo aspectos econômicos, ambientais, sociais, culturais, políticos e regulatórios.

Palavras-chave: Responsabilidade Estendida aos Produtores (EPR); Responsabilidade Compartilhada; Logística Reversa; Economia Circular; Gerenciamento de Resíduos.

1 Introduction

The technological advances resulting from the Industrial Revolution, encourage a clear change in production methods and techniques. The increase in production quantity and the search for higher profit margins have become increasingly essential for the survival of organizations, consuming in the same proportion inputs such as raw materials, equipment, labor, renewable and non-renewable natural resources (SANTOS, 2016; NAGATA et al.,2023).

Given this context, new global concerns arise: the proper disposal of waste and what to do with the waste generated by individuals and companies become a global necessity. Concepts such as Sustainability and Reverse Logistics (RL) emerge as possible areas aimed at reducing waste generated by consumers and manufacturers, through sustainable and innovative actions that can promote materials reuse, avoiding the waste of resources. Due to the extreme importance of Waste Management (WM), environmental legislation and international agreements began to be developed with the objective of standardizing and disseminating the correct methods for treating these materials, as well as assigning responsibilities to each organization in the supply chain (ADAMS, 2006 as cited in FEIL and SCHREIBER, 2017; MELO et al., 2022).

These shared responsibilities direct materials generated from post-consumption, but with potential for reuse (waste), back to the supply chain of the same product or another, enabling their recovery. Thus, manufacturers, importers, distributors, and retailers are responsible for investing in products geared towards post-consumer reuse and recycling, promoting information on collection, recovery

methods, or proper disposal, as well as implementing integrated WM actions (BIMBATI & RUTKOWSKI, 2016; MELO et al., 2022).

In Brazil, there is evident concern about waste management. According to Abrelpe, in 2022, each Brazilian produced an average of 1,043 kg/day, with 39% of Urban Solid Waste (USW) being improperly disposed of. However, there has been a slight improvement compared to 2021, indicating progress in selective collection, reverse logistics (RL), waste recovery, and other sustainable actions (ABRELPE, 2022). Legal actions such as the National Solid Waste Policy (NSWP), Law 12.305, and Decree No. 10.936 have played a role in these changes by promoting shared responsibility among public authorities and the private sector (i.e. stakeholders in reverse supply chains - RSC), providing technical-financial support and establishing guidelines for proper WM, closure of landfills, increased reuse, and investments (BRAZIL, 2010; BRAZIL, 2022).

Considering so many possibilities for studies on WM, this paper focused on characterizing the current context of research related to stakeholders responsibilities in RSC, aiming to answer the following question: What is the current context of literature regarding research on stakeholders and responsibilities in RSC?

2 Materials and Methods

This research was based on the method used by Godinho Filho and Saes (2013), which consists of six steps presented as follows.

2.1. Research protocol

It presents the necessary guidelines for the development of the research, from which the parameters of this research were defined, such as: research databases, language, type of publication, search string, and inclusion and exclusion criteria. Table 1 presents the protocol of this research.

Table 1 - Research Protocol

Main Research Question: "What are the stakeholders and responsibilities in Reverse Supply

<table>
<tr><td colspan="4">Chains presented in the current literature?"</td></tr>
<tr><td>Keywods</td><td>Period</td><td>Inclusion Criteria</td><td>Databases</td></tr>
<tr><td rowspan="7">" Extended Producer Responsibility" "(EPR)"; "Reverse Channels"; "Reverse Logistics"; "Circular Economy"; "Shared Responsibility"; "Waste Management"</td><td rowspan="3">No restrictions</td><td>Articles and Reviews in journals</td><td rowspan="2">Scopus</td></tr>
<tr><td>Articles that address at least 2 of the considered keywords simultaneously in their contente</td></tr>
<tr><td>Texts in which the keywords can be identified in the title, abstract, and/or keywords of the identified article</td><td rowspan="2">Science Direct</td></tr>
<tr><td>Articles in english and portuguese</td></tr>
<tr><td>Document type</td><td>Exclusion criteria</td><td rowspan="3">Web of Science</td></tr>
<tr><td rowspan="2">Articles and Reviews</td><td>Articles that only address research on one of the keywords</td></tr>
<tr><td>Articles that the researchers did not have access to</td></tr>
<tr><td colspan="4">String de Pesquisa: Responsibility AND (shared OR extended) AND (Models OR Approach) AND Stakeholder AND (“Waste Management” OR “Circular Economy” OR "Reverse Logistics")</td></tr>
</table>

Source: Authors (2023).

2.2. Bibliographic survey

It was carried out through searches in the Scopus, Web of Science, and Science Direct databases. Initially, the publications were gathered, the duplicate articles were identified and excluded, and then subjected to readings of titles, abstracts, and keywords with the application of inclusion and exclusion criteria. In this reading, the relationship of publications with the theme "stakeholders and responsibilities in RSC" was also verified. At the end of this stage, the quantity of publications considered for full reading and data extraction was defined.

2.3. Data extraction

This step was carried out based on the papers defined in the previous stage, considering relevant information such as authors, year of publication, country of origin, as well as other information aimed at the full development of this research, extracted from the Research Questions (RQ). Each RQ inquired about relevant information for

the classification of the analyzed articles. These RQ and their objectives are presented in Table 2.

It was considered that RQ 1 and 2 should be answered with a single alternative, but arranged in a large list of options. RQ 2 considered only one year of publication, but there should be a great possibility of years in which the research could have been published. For RQ 3, 6, 7, 8, and 9, it would be possible more than one answer among the options considered. For RQ 3, the possibilities considered were Survey; Literature Review; Case Study; Interview; Mathematical Modeling; Documentary Research; and Bibliographic Research. For RQ 6, the options were Agriculture; Industry; Trade/ Services; Non-Governmental Organizations (NGOs); Society; Government; or Not applicable, considered when the analyzed article did not address any of the previous aspects. For RQ 7, the alternatives were Construction and Demolition Waste (CDW); Solid Waste (SW); Waste Electrical and Electronic Equipment (WEEE); Packaging; or Not applicable. For RQ 8, the alternatives were Reverse Logistics; Recovery; Proper Disposal; Not Applicable; or Not Identified, selected when, even if some aspects have been presented, they would not be compatible with those considered in RQ 8. For RQ 9, the options were: Economic; Environmental; Social; Sustainable; Not Applicable; and Not Identified. Regarding RQ 4, only one answer was considered acceptable, among the options Basic (B) or Applied (A). In RQ 5, only one response was accepted, which could be quantitative (Qt), qualitative (Ql), or mixed-methods (QlQt). RQ 10 was defined with open-ended answers regarding the main results found in the articles surveyed.

Table 2 - Research questions and objectives

ID	Research Question	Objectives
RQ1	What is the country of origin of the article?	To identify the regions/countries of origin of the papers that address research on the research theme (i.e. stakeholders and responsibilities in Reverse Supply Chains).
RQ2	What is the year of the paper?	To evaluate the evolution of research related to the research theme.
RQ3	Which research methods have been used?	To identify the most commonly used research methods for addressing the research theme in the current literature.
RQ4	What the nature of the research has been identified?	To verify the current level of maturity of papers associated with the research theme.

RQ5	Which research approaches have been adopted?	To identify the most commonly used research approaches in the current literature on the research theme.
RQ6	Which stakeholders have been identified?	To identify the stakeholders most addressed in the current literature regarding the research theme.
RQ7	Which types of waste have been considered?	To identify the waste or waste classes most addressed in the current literature on the research theme.
RQ8	Which stakeholders' responsibilities have been identified?	To identify the stakeholders' responsibilities or groups of stakeholders' responsibilities in RSC in the current literature.
RQ9	Which sustainability perspectives have been addressed?	To identify which sustainability perspectives regarding the research theme have been addressed in the current literature.
RQ10	What were the main results presented?	To highlight the main results related to the research theme identified in the current literature.

Source: Authors (2023).

2.4. Selection of papers

In this stage, the selected papers were organized according to the extracted data, considering the construction of a table with information extracted from the RQ to be analyzed, taking into account the objectives of these questions. Such information were organized and presented in Tables 3 and 4.

2.5. Results Analysis

The results were analyzed and graphs were proposed to characterize the current research panorama from various perspectives, such as evolution of papers over time, main wastes, responsibilities, and stakeholders, recovery alternatives, sustainability perspectives, as well as topics not yet discussed (research gaps).

2.6. Conclusion and future research

The results were synthesized in order to expose the behavior of the identified papers and characterize the current scenario of the literature related to the subject,

thus achieving the main objective of the research. Finally, new research opportunities related to the topic were proposed, regarding the research gaps identified in the analysis of the results.

3 Results and Discussions

3.1. Selection of papers and Data Collection

At the conclusion of the review protocol application, out of the initially identified 144 publications, 57 were eliminated due to duplication, 8 were excluded due to the inability to download, and 34 were excluded based on exclusion criteria. This resulted in a selection of 45 papers for the subsequent stage. Table 3 presents certain general information about these publications.

Based on the characterization of the selected articles, it proceeded with the full reading of their texts and, through content analysis, the answers related to the RQ were identified and raised. Such information is summarized in Table 4.

Table 3 - Selected articles and general information

ID	References	Title	Journal
1	Shooshtarian, Caldera, Maqsood, Ryley and Khalfan, (2021)	An investigation into challenges and opportunities in the Australian construction and demolition waste management system	Engineering, Construction and Architectural Management
2	Islam, Iyer-Raniga (2022)	Lithium-Ion Battery Recycling in the Circular Economy: A Review	Recycling
3	Pereira, Riveiro (2021)	Stakeholders' participation in environmental regulation: A case study of the sectoral agreement of packaging reverse logistics in Brazil	Waste Management & Research
4	Jalalipour, Jaafarzadeh, Morscheck, Narra and Nelles (2020)	Adoption of sustainable solid waste management and treatment approaches: A case study of Iran	Waste Management & Research
5	Schamber, Bon (2022)	Extended Producer Responsibility (EPR) and Packaging Regulations in Argentina: Reflections on the aspects associated with the blocking of the draft legislation initiatives	Detritus
6	Andersen (2021)	A comparative study of national variations of the European WEEE directive: manufacturer's view	Environmental Science Pollution Research
7	Chaabane, Nassour, Bartnik, Bunermann and Nelles (2019)	Shifting Towards Sustainable Tourism: Organizational and Financial Scenarios for Solid Waste Management in Tourism Destinations in Tunisia	Sustainability
8	Prata et al. (2019)	Solutions and Integrated Strategies for the Control and Mitigation of Plastic and Microplastic Pollution	International Journal of Environmental Research and Public Health
9	Shan, Yang (2019)	Promoting the implementation of extended producer responsibility systems in China: A behavioral game perspective	Journal of Cleaner Production
10	Bhaskar, Turaga (2017)	India's E-Waste Rules and Their Impact on E-Waste Management Practices: A Case Study	Journal of Industrial Ecology
11	Mmereki, Machola, Mokokwe (2019)	Status of waste tires and management practice in Botswana	Journal of the Air & Waste Management Association
12	Kuashal, Nema (2013)	Strategic Analysis of Computer Waste Management Options: Game-Theoretic Approach	Journal of environmental Engineering
13	Silva, Fontana (2021)	Integrative multi-attribute negotiation model to define stakeholders' responsibilities in the reverse flow channel	Journal of Cleaner Production
14	Pan, Wong, Li (2022)	Circular economy practices in the waste electrical and electronic equipment (WEEE) industry: A systematic review and future research agendas	Journal of Cleaner Production

15	Engeland, Belien, Boeck and Jaeger (2020)	Literature review: Strategic network optimization models in waste reverse supply chains	Omega
16	Larrain, Billen, Passel (2022)	The effect of plastic packaging recycling policy interventions as a complement to extended producer responsibility schemes: A partial equilibrium model	Waste Management
17	Kuo et al. (2021)	Toward a circular economy: A system dynamic model of recycling	Journal of Cleaner Production
18	Rubio, Ramos, Leitao and Povoa (2019)	Effectiveness of extended producer responsibility policies implementation: The case of Portuguese and Spanish packaging waste systems	Waste Management
19	Jain, Sharma, Gupta (2022)	The transition to the circular economy of the construction industry: Insights into sustainable approaches to improve the understanding	Renewable and Sustainable Energy Reviews
20	Charef, Lu, Hall (2022)	End-of-life management of solar PV waste in India: Situation analysis and proposed policy framework	Journal of Cleaner Production
21	Richter, Koppejan (2016)	Extended producer responsibility for lamps in Nordic countries: best practices and challenges in closing material loops	Journal of Cleaner Production
22	Pani, Pathak (2021)	Managing plastic packaging waste in emerging economies: The case of EPR in India	Journal of Environmental Management
23	Wang, Gu, LI, Liu and Zuo (2017)	Operating models and development trends in the extended producer responsibility system for waste electrical and electronic equipment	Resources, Conservation & Recycling
24	Kumar, Gaur, Liu and Sharma (2022)	Sustainable waste electrical and electronic equipment management guide in emerging economies context: A structural model approach	Journal of Cleaner Production
25	Gunarathne, Alwis, Alahakoon (2020)	Challenges facing sustainable urban mining in the e-waste recycling industry in Sri Lanka	Journal of Cleaner Production
26	Souza, Clímaco, Sant'Anna, Rocha, Valle and Quelhas (2016)	Sustainability assessment and prioritisation of e-waste management options in Brazil	Waste Management
27	Springle, Li, Soma, and Shulman (2022)	The complex role of single-use compostable bioplastic food packaging and foodservice ware in a circular economy: Findings from a social innovation lab	Sustainable Production and Consumption
28	Börner, Hegger (2018)	Toward design principles for sound e-waste governance: A research approach illustrated with the case of the Netherlands	Resources, Conservation & Recycling
29	Leclerc, Badami (2020)	Extended producer responsibility for E-waste management: Policy drivers and challenges	Journal of Cleaner Production
30	Yu, Tong (2021)	Producer vs. local government: The locational strategy for end-of-life photovoltaic modules recycling in Zhejiang province	Resources, Conservation & Recycling
31	Koshta, Patra, Singh (2022)	Sharing economic responsibility: Assessing end user's willingness to support	Journal of Cleaner Production

		E-waste reverse logistics for circular economy	
32	Veiga (2013)	Analyzing reverse logistics in the Brazilian National Waste Management Policy (PNRS)	Sustainable Development and Planning
33	Hu, Jia (2019)	Behavioral game analysis of stakeholders in closed-loop supply chain of electrical and electronic products under the extended producer responsibility system	Recycling
34	Parthasarathy (2021)	Challenges and emerging trends in toner waste recycling: A review	Recycling
35	Gupta, Kaushal, Shukla (2018)	Multi-stakeholder policy modeling for collection and recycling of spent portable battery waste	Waste Management & Research
36	Sulami, Murayama, Nishikizawa (2017)	Current issues and situation of producer responsibility in waste management in Indonesia	Environment and Natural Resources
37	Mazhandu, Muzenda, Mamvura, Belaid and Nhubu (2020)	Integrated and consolidated review of plastic waste management and bio-based biodegradable plastics: Challenges and opportunities	Sustainability
38	Ritchie (2021)	Leadership for a climate resilient, net-zero health system: Transforming supply chains to the circular economy	Sage Journals
39	Purwani, Hisjam, Sutopo (2020)	Municipal solid waste logistics management: A study on reverse logistics	AIP Conference Proceedings
40	Achillas, Moussiopoulos, Karagiannidis, Vlachokostas and Banias (2010)	Promoting reuse strategies for electrical/electronic equipment	Waste and Resource Management
41	Demajorovic, Augusto, Souza (2016)	Reverse logistics of E-waste in developing countries: Challenges and prospects for the Brazilian model	Ambiente & Sociedade
42	Campos, Fonseca, Morais (2014)	Reverse logistics of E-waste in developing countries: Challenges and prospects for the Brazilian model	Waste Management and The Environment
43	Schamber, Bon (2022)	Extended producer responsibility for packaging wastes and WEEE - A comparison of implementation and the role of local authorities across Europe	Detritus
44	Gupta, Kaushal, Shukla (2018)	Strategic policy modeling for stewardship program of spent portable batteries	J. Hazard. Toxic Radioact. Waste
45	Wiesmeth, Starodubets (2020)	The management of municipal solid waste in compliance with circular economy criteria: The case of Russia	Economy of Region

Source: Authors (2023).

Table 4 - Answers extracted from selected articles based on the RQ

ID	RQ 1	RQ 2	RQ 3	RQ 4	RQ 5	RQ 6	RQ 7	RQ 8	RQ 9
1	Australia	2021	S; LB; DD	B	Ql	I; G	CDW	RL; WR; PD	EC; SL
2	Australia	2022	SLR; LB	B	Ql	I; C/S; G	WEEE	WR; PD	EC; EN
3	Brazil	2021	CS; I; DD	B	Ql	SC; G	P	RL	NI
4	Iran	2020	CS; LB	A	Ql	AG; I; C/S, NGO, SC, G	SW	RL; WR; PD	EC
5	Argentina	2022	I; DD; LB	B	Ql	I; C/S	P	RL; WR; PD	ST
6	Norway	2021	CS; I	B	Ql	ID; C/S	WEEE	RL; WR; PD	EC; EN
7	Tunisia	2019	I; DD	B	Ql	ID; NGO; S; G	SW	RL; WR; PD	ST
8	Portugal	2019	SLR; DD	B	Ql	ID; G	SW	RL; WR; PD	EC
9	China	2019	MM; CS; DD	B	QlQt	ID; C/S; G	SW	RL; WR; PD	EC
10	India	2017	SLR; CS; I; LB	B	Ql	ID	WEEE	RL; WR; PD	EC; SL
11	Botswana	2019	I; LB; DD	B	Ql	ID; C/S; G	SW	NA	NA
12	India	2013	MM; LB	B	Qt	ID; C/S; SC	WEEE	RL; WR	EC
13	Brazil	2021	CS; MM; LB	A	QlQt	ID; SC	SW	NA	NA
14	China	2022	SLR; LB	B	Ql	ID; G	WEEE	NA	NA
15	Belgium	2020	SLR; LB	B	Ql	ID; C/S; G	NA	RL	NI
16	Belgium	2022	MM	A	Qt	G	EB	NA	NA
17	Indonesia	2021	CS; MM	A	QlQt	ID; C/S; S	P	NA	NA
18	Portugal, Spain	2019	CS; I	B	Ql	G	P	RL; WR; PD	EC
19	England, Hong Kong, Switzerland	2022	SLR	B	Ql	NA	CDW	RL	EC
20	India	2022	CS	A	Ql	ID; G	WEEE	RL; WR; PD	ST
21	Sweden, Netherlands	2016	CS; I; MM	A	QlQt	ID; C/S; G	WEEE	RL; WR; PD	EC
22	India	2021	CS; DD	B	QlQt	ID; S	P	RL; WR; PD	EC
23	China	2017	LB; DD	B	Ql	ID; G	WEEE	RL; WR; PD	EC; EN

24	India	2022	SLR; MM; S	B	QlQt	S; ID	WEEE	RL; WR	EC; EN
25	Sri Lanka	2020	DD; CS; I	A	Ql	ID; G; S	WEEE	RL; WR; PD	EN
26	Brazil	2016	MM	B	QlQt	G	WEEE	NA	NA
27	Canada	2022	I	A	Ql	NA	P	NA	NA
28	Netherlands	2018	SLR	B	Ql	G; ID; S	WEEE	NA	NA
29	Canada	2020	S; DD	B	Ql	ID; S	WEEE	RL; WR; PD	EC
30	China	2021	CS; I; MM	B	QlQt	ID; G	WEEE	RL; WR	NI
31	India	2022	MM; S	B	QlQt	S; ID	WEEE	RL; WR; PD	EC
32	Brazil	2013	DD; LB	B	Ql	ID; G	SW	RL; WR	EC; EN
33	China	2019	MM	B	QlQt	ID; S; G	WEEE	RL	EC
34	India	2021	MM	B	Ql	ID; G	WEEE	RL; WR	EC
35	India	2018	I; MM	A	QlQt	ID; S; NGO; S	WEEE	RL; WR; PD	EC
36	Indonesia	2017	I	A	Ql	G; ID; NGO	SW	RL; WR; PD	NI
37	South Africa, Botswana	2020	LB	B	Ql	G; ID; C/S	SW	RL; WR; PD	NI
38	Canada	2021	DD; LB	B	Ql	ID; C/S; NGO; S; G	SW	RL; WR	ST
39	Indonesia	2020	DD; LB	B	Ql	C/S; G	SW	NA	ST
40	Greece	2010	MM	A	QlQt	ID; C/S	WEEE	RL; WR; PD	EC
41	Brazil	2016	SLR; CS; I; DD	B	Ql	ID; C/S; G	WEEE	NA	SL
42	Brazil	2014	LB; DD	B	Ql	ID; G; C/S	WEEE	NA	NA
43	England	2022	LB; DD; SLR; I	B	Ql	ID; C/S; G	WEEE; P	RL; WR; PD	NI
44	India	2018	S; MM	B	QlQt	ID; C/S; G	WEEE	WR	ST
45	Russia	2020	DD	B	Ql	ID; C/S; G	SW	RL; WR; PD	SL; EC

S - Survey; SLR - Systematic Literature Review; CS - Case Study; I - Interview; MM - Mathematical Modeling; DD - Documentary Research; LB - Literature-Based Research; A - Applied; B - Basic; Ql - Qualitative; Qt - Quantitative; QlQt - Mixed-Methods; AG - Agriculture; ID - Industry; C/S - Commerce/Services; NGO - Non-Governmental Organization; SC - Society; G - Government; CDW - Construction and Demolition Waste; SW - Solid ; WEEE - Waste Electrical and Electronic Equipment; P - Packaging; RL - Reverse Logistics; WR - Waste Recovery; PD - Proper Disposal; EC - Economic; EN - Environmental; SL - Social; ST - Sustainable; NI - Not identified; NA - Not applicable.

Source: Authors (2023).

Next, an analysis and discussions of the answers was carried out for each RQ, aiming to achieve the proposed objectives for each of them.

3.2. Analysis and discussions of answers from the RQ

In this section, data from the answers to the RQ were analyzed in order to characterize the current context of research on stakeholders and responsibilities in RSC and also to identify possible gaps or opportunities for the development of new related research. These analyses are presented as follows.

- RQ 1 - What is the country of origin of the article?

Table 4 shows the countries that have records of publications in journals. From this table, it can be concluded that the theme “stakeholders and responsibilities in RSC” is gaining prominence, especially in Brazil and India. These countries have large populations in common, with the majority being poorly educated/aware of environmental issues, a situation possibly influenced by economic fragilities and social vulnerabilities. Additionally, there is a lack of appropriate facilities for waste disposal, causing environmental problems. Another prominent country was China, also populous and developing, with a circular economy still in its early stages and in need of environmental regulations to promote sustainable development of society. Therefore, it is evident the lack of research involving solutions implemented in other countries and capable of becoming references for proposing innovative and adaptable solutions for countries that still demand such solutions.

- RQ 2 - What is the year of the paper?

According to Table 4, there has been a gradual increase in the number of articles published, with a focus on the last 4 years (2019 - 2022), indicating that discussions on the topic are still evolving over time. It is worth noting the first related paper was identified only in 2010, indicating this is a relatively new topic. The year 2022 stood out with 22.22% of the papers, followed by the years 2021, 2020, and 2019, with 20%, 15.56%, and 13.33%. It can also be inferred, specifically from 2020, this increase may have been triggered by the COVID-19 pandemic, which intensified concerns about waste generation, as there was a hypothesis of a relationship between accelerated environmental degradation and the emergence of new pandemics. The

growing concern in recent years regarding waste generation stems from the numerous negative consequences associated with improper disposal conditions. Examples of these can be observed through soil, air, and water resource pollution, as well as the emergence of diseases that affect society.

- RQ 3 - Which research methods have been used?

As shown in Table 4, the most frequent methods were Documentary Research (18), Bibliographic Research (17), Mathematical Modeling (15), Case Study (14), Interviews (13), Systematic Literature Review - SLR (9), and Survey (5). Based on this table, there is a certain balance between the options "Documentary Research", "Bibliographic Research" and "Mathematical Modeling", indicating that this research theme is being explored from different perspectives, with the aim of promoting greater depth and, consequently, a better understanding. In addition, the results related to SLR (9) and Survey (5) demonstrate a possible search for further theoretical development and expansion of debates and discussions on possible variables associated with the theme. Therefore, such research should be strengthened, especially in areas such as identifying, defining, and assigning responsibilities for both the RL and other activities involved in the implementation of RSC.

- RQ 4 - What the nature of the research has been identified?

Among the reviewed articles, the majority were identified as basic research, accounting for 75.6% (34) of the papers surveyed as shown in Table 4.

Given that the first paper on the topic was identified only in 2010 and the majority of the studies analyzed were identified as basic research, it was inferred this is a new topic, with research still focused on theoretical understanding of knowledge in the economic, social, environmental, or sustainable aspects of RSC. These results indicate the theory on the topic is still being consolidated, suggesting a low current level of maturity of research related to the topic. Thus, there may still be many opportunities for developing new papers, particularly applied research.

- RQ 5 - Which research approaches have been adopted?

It was observed that in 29 articles a qualitative approach was considered, in 14 quali-quantitative approaches were identified, and in only 2 publications, quantitative approaches were used.

Upon analyzing the results presented in Table 4, the high prevalence of qualitative approaches may indicate a high degree of subjectivity in the results

considered. This may also indicate difficulties in finding more objective variables capable of enabling the application of quantitative tools and generating results that are more consistent with the different real contexts. The current results identified for quali-quantitative approaches already demonstrate some evolution in this regard. Therefore, the search for the identification/definition of more objective variables associated with the theme seems to be the research gap identified in this RQ.

- RQ 6 - Which stakeholders have been identified?

Table 4 highlights the most frequent stakeholders are in the Industry (80%). It was observed that most of the research assigns to this sector the greater responsibility for waste recovery or disposal. Therefore, after the product reaches the consumer, there should be adequate alternatives for waste recovery or disposal, provided by the product manufacturers themselves. The second highest percentage refers to "Government" (68.89%) as a stakeholder, which should be responsible for promoting the well-being of society and acting in the proper WM.

It was also identified some studies considering multiple stakeholders, where efforts were directed towards understanding contexts closer to reality and various organizations within RSC act concurrently (multi-stakeholders). Furthermore, research oriented towards RSC management was identified, which aimed to identify stakeholders, responsibilities, and also discuss the best implementation proposals (ACHILLAS et al. 2010; KOSHTA et al. 2022). Some studies, even addressing responsibilities, did not identify stakeholders or vice versa, and therefore the option "Not applicable" was considered (4.44%).

- RQ 7 - Which types of waste have been considered?

As presented in Table 4, the higher frequency of waste was observed, specifically Waste Electronic and Electrical Equipment (WEEE), Solid Waste (SW), Packaging, and Construction and Demolition Waste (CDW). In some papers, no waste was identified, in which case the option "Not applicable" was considered.

Regarding the WEEE, a higher frequency was noticed compared to the others, probably due to technological advancements and the consequent technological obsolescence that leads to premature disposal of electronic equipment and components. Moreover, as electronic devices become increasingly prevalent and contain heavy metals and highly polluting components, improper disposal of such equipment can cause irreparable damage to the environment. Another highlight was

SW, probably due to the wide variety of waste considered and generated daily by society in large consumption centers. The packaging waste was also highlighted, as they are responsible for the storage, movement, and protection of any product from its production to consumption, where they become waste. The CDW were also mentioned, as the construction sector also generates large quantities of waste. Therefore, these results suggest exploring further alternatives to deal with the inadequate disposal of WEEE, strategies to reduce the amount of packaging used in industry and commerce, and adopting sustainable solutions in order to reduce the CDW generation.

- RQ 8 - Which stakeholders' responsibilities have been identified?

In this RQ, the following results were identified: Reverse Logistics (32), Waste Recovery (30), Proper Disposal (23), and "Not Applicable" (11). The percentage distribution of the identified responsibilities is presented in Table 4. Based on the analysis of these table, the values attributed to the responsibilities of Reverse Logistics (71.11%) and Waste Recovery (66.67%) stand out, showing the concern of researchers with the reintegration of waste into production cycles for the reduction of waste. This explains the slightly lower, but still necessary, value attributed to the Proper Disposal option (51.11%). In this research, RSC responsibilities were organized into three groups. It is worth noting each of these groups still needs to be detailed to identify variables capable of define how the responsibilities should be attributed to each stakeholder, considering the processes involved in the effective functioning of RSC.

- RQ 9 - Which sustainability perspectives have been addressed?

In Tbale 4, it was found that the Economic aspect was considered in 46.67%, Sustainable in 13.13%, Social in 11.11%, and Environmental in 8.89% of the set of articles surveyed.

The economic aspect has still been the most addressed in papers on the subject, probably due to the greater challenge associated with RSC still being related to the costs of implementing and operating RL systems, recovering or proper disposing of waste. Such processes require high investments and are still considered unimportant from the perspective of poorly informed portions of society about the potential benefits of sustainable WM. The sustainable aspect, with the second highest percentage, is becoming a promising aspect associated with this research. The other

aspects of sustainability showed less significant percentages, with the Environmental aspect being the lowest when analyzed separately. There were also papers where the options "Not identified" (11.11%) and "Not applicable" (20%) were considered. Based on this analysis, more research relating the economic, environmental, and social aspects should be encouraged in order to promote more sustainable perspectives and results.

- RQ 10 - What were the main results presented?

Among the reviewed articles, extended producer responsibility (EPR) was heavily discussed. According to Kuo et al. (2021), policy instruments can be efficiently implemented with government support for the design of appropriate policies and the participation of the government as a stakeholder in RSC. This view is also supported by Pereira and Ribeiro (2021), who highlight the government participation as crucial for defining responsibilities and designing public policies.

In Portugal and Spain, EPR strategies have shown a positive impact, such as investment in new research and development of sustainable packaging, and promotion of recycling and waste recovery (RUBIO et al., 2019). Shan and Yang (2019) highlight that there are still difficulties in implementing EPR with the financial aspect being one of the most important barriers for RSC stakeholders. According to these authors, increasing financial incentives can encourage the stakeholders to assume more responsibilities in RSC. From the Brazilian perspective, the cost of RL, especially transportation, due to the continental proportions of the country, represents the main reason for resistance from the productive sectors to assume responsibility in RSC (DEMAJOROVIC et al., 2016).

Countries with larger populations or territorial extensions, such as Brazil, will face more barries in implementing and managing RSC. However, China, despite its large territorial extension, is becoming a country with high recycling rates due to legislation, financial incentives, and shared responsibility implemented in the country (MAZHANDU et al., 2020), highlighting the effectiveness of RSC.

Koshta et al. (2022) assessed the willingness of users of electronic devices to financially support the RL. According to the authors, consumers still lack knowledge about the difference between WEEE and municipal solid waste, they consider both to be household waste. However, such users are aware of the environmental issues of recycling and demonstrate a willingness to participate financially in the process.This

aspect aligns with Souza et al. (2016), who highlight the significance of community awareness in WM, as society shares responsibility for the selection and proper disposal of waste. Bhaskar and Turaga (2018) reinforce this notion, emphasizing that societal awareness is a critical driver for WEEE management.

However, additional research is needed to identify stakeholders and responsibilities within RSC. Table 5 summarizes the main findings and highlights potential avenues for further investigation based on the analysis of the addressed RQ.

Table 5 - Results and opportunities for further research in each RQ

RQ	Main Results	Research Opportunities
1	India (9), Brazil (6) and China (5) were highlights, followed by Canada and Indonesia (3); Australia, Netherlands, Portugal, Botswana, Belgium and England (3); and others (1).	The larger, more populous, and developing countries are the ones that have published the most on the subject. However, there is still much to be developed on the topic, especially for such countries.
2	The year 2022 was the main highlight with 22.22% of publications, followed by 2021 (20%), 2020 (15.56%) and 2019 (13.33%).	Research has been growing in recent years, indicating ongoing evolution of discussions on the topic. However, the recent concern with waste generation and the negative consequences of inadequate disposal conditions pose a challenge to be overcome.
3	Documentary Research (18), Bibliographic Research (17), Mathematical Modeling (15), Case Study (14), Interviews (13), Systematic Literature Review (9) and Survey (5) were identified.	Research on this topic should be strengthened, specially regarding identifying, defining, and assigning responsibilities in RSC.
4	More Basic research (75.6%) than Applied research was identified.	There may be opportunities to develop applied research on this topic.
5	Qualitative approaches (29) were the most frequent, followed by Quali-quantitative (14) and Quantitative (2).	The search for more objective variables associated with the central theme of this research seems to be the gap identified in this study.
6	The highlights of the research were: Industry (80%) and Government (68.89%). In 4.44% of the research, none of the standardized aspects were addressed.	Suitable alternatives for reuse or disposal of waste must be developed, especially incentivized or made available by the product manufacturers themselves.
7	WEEE (51.11%), SW (26.67%), Packaging (17.78%) were highlighted, and CDW (4.44%).	Exploring alternatives to address the problem of WEEE, strategies to reduce the amount of packaging used in industry and commerce; and adopting sustainable solutions to reduce the large quantities of CDW are suggested.
8	The main responsibilities associated with LR or CSR structuring were highlighted as reverse logistics (71.11%), recovery of waste value (66.67%).	Each of the three groups of responsibilities considered still needs to be analyzed in detail for a better understanding of the exact responsibilities of each stakeholder in RSC.

9	The main responsibilities highlighted were on the economic aspect (46.67%) and approximately 30% did not correspond to any of the standardized aspects.	Further research to simultaneously relates economic, environmental, and social aspects to generate more sustainable perspectives and outcomes on the topic.
10	The EPR as a public policy and community awareness were highlighted as the crucial factors regarding stakeholders' responsibility in RSC.	It is necessary to identify in detail the responsibilities and stakeholders responsible for activities carried out in RSC.

Source: Authors (2023).

The information gathered in this research enabled an initial characterization of the current literature context regarding stakeholders and responsibilities in RSC. These findings identified gaps and will enhance opportunities for the development of new research on the subject. Additionally, they will contribute to a better understanding of the structuring and organization of RSC, generating knowledge to guide more sustainable public policies and business models both tailored to the specificities of each context, considering economic, environmental, social, cultural, political, regulatory aspects, among others.

4 CONCLUSION

In some developing countries with vast territories and large populations, such as Brazil, China, India, etc., the concerning indicators of increasing waste generation are related to the evident incapacity for recovery and proper disposal, which has been aggravated by the government's inefficient management of these materials. In light of the urgent search for sustainable solutions and with the purpose of mitigating the harmful effects generated by such inefficiency, it becomes imperative to propose sustainable measures to develop and encourage the structuring and consolidation of Reverse Supply Chains (RSC). Such measures would enable the reuse or the proper disposal of waste, and therefore, the reduction of the environmental and social impacts caused by increasing generation.

The aim of this research was to characterize the literature related to the stakeholders and responsibilities in Reverse Supply Chains (RSC). To this, a systematic literature review was conducted, considering papers available in Scopus, ScienceDirect, and Web of Science databases. Once the articles were selected,

research questions (RQ) were applied to achieve specific objectives. After presenting the results of the RQ application and their respective conclusions, identified in Table 5, it was possible to verify that research on the central theme is still in its early stages of development on a global scale. However, some emerging countries are identified as leaders in the publication of related scientific research. It was also noted that the majority of articles discussed electronic waste, while only two publications addressed construction and demolition waste, which was initially proposed as the waste stream for the research. Finally, aspects related to sustainability (economic, environmental, and social) have already been considered in these papers. However, there are still opportunities for further research in RSC. These include developing applied research, defining stakeholders and responsibilities in detail, and exploring objective variables for responsibility assignment.

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