WASTE PICKERS AND THE NATIONAL SOLID WASTE POLICY (PNRS) IN THE STATE OF RIO GRANDE DO SUL[1]

CATADORES DE MATERIAIS RECICLÁVEIS E A POLÍTICA NACIONAL DE RESÍDUOS SÓLIDOS (PNRS) NO ESTADO DO RIO GRANDE DO SUL

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ABSTRACT

Waste pickers play a fundamental role in the recycling chain, working in the organization, collection, and recovery of reusable waste, and contributing to the mitigation of environmental impacts. This study aimed to analyze the evolution of the participation of associations, cooperatives, and waste pickers in solid waste management in the municipalities of the state of Rio Grande do Sul (RS), before and after the implementation of the National Solid Waste Policy (PNRS) in 2010. The research was predominantly based on data available from the National Sanitation Information System (SNIS). The results indicated that, in 2021, only 15.90% of the municipalities in Rio Grande do Sul reported having waste picker associations. The correlation analysis between the total population of the municipalities and the volume of collected solid waste revealed a strong association (Pearson's correlation coefficient = 0.9666; r^2 = 93.43%). The study also identified 14 relevant indicators that may support the development of public policies and future research on the inclusion of waste pickers and the effectiveness of solid waste management in the state.

Keywords: waste pickers, recycling, waste, PNRS, SNIS.

RESUMO

Os catadores de materiais recicláveis desempenham um papel fundamental na cadeia da reciclagem, atuando na organização, coleta e recuperação de resíduos com potencial de reaproveitamento, contribuindo para a mitigação de impactos ambientais. Esta pesquisa teve como objetivo analisar a evolução da

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participação de associações, cooperativas e catadores de materiais recicláveis na gestão de resíduos sólidos nos municípios do estado do Rio Grande do Sul (RS), antes e depois da implementação da Política Nacional de Resíduos Sólidos (PNRS), em 2010. A investigação baseou-se predominantemente em dados disponíveis no Sistema Nacional de Informações sobre Saneamento (SNIS). Os resultados indicaram que, em 2021, apenas 15,90% dos municípios gaúchos relataram a existência de entidades associativas de catadores. A análise de correlação entre a população dos municípios e o volume de resíduos sólidos coletados revelou uma forte associação (coeficiente de Pearson de 0,9666 e r^2 de 93,43%). A pesquisa também identificou 14 indicadores relevantes que podem subsidiar políticas públicas e pesquisas futuras sobre a inclusão dos catadores e a eficiência da gestão de resíduos sólidos no estado.

Palavras-chave: catadores, reciclagem, resíduos, PNRS, SNIS.

INTRODUCTION

The substantial increase in consumption in recent years has resulted in a growing amount of discarded materials, turning the generation and management of solid waste into a major public issue. This is particularly evident in urban areas and industrialized regions. Waste production is intrinsically related to a country's level of development of productive capacities, affecting not only the quantity but also the variety of discarded materials and their geographic concentration, especially in cities and metropolitan areas (Aliu; Adeyemi; Adebayo, 2014; Martins; Silva, 2018; Silva; Fugii; Santoyo, 2017; Welivita; Wattage; Gunawardena, 2015).

Industry plays a significant role in generating most solid waste and can be considered one of the sources of environmental damage due to the presence of industrial waste that often includes chemicals, heavy metals, and toxic substances (Gomes; Caminha; Memoria, 2019).

Solid waste is a visible outcome of growth- and consumption-oriented production and represents an urban challenge worldwide, creating major impacts on the environment, oceans, climate, public health, the economy, and local communities. There is increasing recognition that current forms of continuous

growth cannot be reconciled with environmental protection and that existing economic and productive relations, as well as societal practices, need to be redefined (Gutberlet, 2021). The disposal of solid waste has been a problem since humanity began organizing into communities, and in recent years solid waste management has been presented as one of the main challenges in urban areas (Nolasco et al., 2021).

In recent decades, solid waste management has been a concern for federal, state, and municipal governments in Brazil. With the creation of the National Solid Waste Policy (Política Nacional de Resíduos Sólidos – Law No. 12,305/2010), municipal actions gained new foundations and guidelines within a set of responsibilities that make it possible to change the waste management landscape in Brazil. The law requires the eradication of open dumps, the implementation of selective collection programs, the forwarding of recyclable materials to waste picker cooperatives, and the establishment of composting programs as an alternative for the destination of the organic fraction (Fattor; Vieira, 2019).

The National Solid Waste Policy (PNRS) defines guidelines for the provision of services and the management of solid waste in the country, emphasizing the importance of reuse and recycling. Supported by the PNRS, Brazil has the opportunity to raise its environmental performance to a level similar to that of other nations, where government regulations play a fundamental role in advancing environmental sustainability (Maiello; Britto; Valle, 2018; Sarkis; Helms; Hervani, 2010; Sellitto; de Almeida, 2019).

Among its various responsibilities, the PNRS establishes that municipalities must eliminate open dumps and establish sanitary landfills designated exclusively for non-recoverable waste, while also preparing their solid waste management plans in order to maintain access to federal resources. Additionally, municipalities are tasked with implementing selective collection

programs in collaboration with cooperatives or other associations of reusable and recyclable material waste pickers, composed of low-income citizens (Baptista, 2015; Brazil, 2010).

The National Solid Waste Policy (PNRS) emerged as an opportunity to achieve progress for waste picker organizations, as it incorporates modern principles and concepts of waste management, establishing a hierarchy: reduction of waste generation, reuse, recycling, and the disposal of rejects in environmentally appropriate sanitary landfills. After a long period since the implementation and entry into force of the PNRS, the planned goal of sending only rejects to environmentally appropriate sanitary landfills by August 2014 was not achieved. The expansion of selective collection, through the inclusion of waste picker organizations as service providers for municipalities and companies within the implementation of sectoral agreements for reverse logistics, as well as the increased qualification of these organizations, progressed less than expected (Pisano; Demajorovic; Besen, 2022).

The long-standing Brazilian experience of strengthening and formalizing waste picker cooperatives neither guarantees nor ensures the transition from a situation of vulnerability to a context in which decent work and socio-productive inclusion prevail for this professional category (Gutberlet; Rizpah Besen; Morais, 2020; Pisano; Demajorovic; Besen, 2022). Involving organized waste pickers in discussions on the planning and execution of local waste management is a fundamental prerequisite for more participatory governance in combating waste and promoting environmental preservation. This implies recognizing that the skills and experiences acquired by waste pickers in activities related to resource recovery, reuse, and recycling represent crucial elements for advancing recycling in Brazil (Gutberlet, 2012; Tremblay; Peredo, 2014).

Recycling plays a relevant role in the National Solid Waste Policy and is considered a stage in waste management and handling. The PNRS granted

waste pickers a place in Article 7, item XII, by establishing among its objectives the “[...] integration of waste pickers of reusable and recyclable materials into actions involving shared responsibility for the product life cycle.” The PNRS advocates that selective collection should be carried out primarily by waste picker cooperatives, generating sustainable business opportunities, increased income and employment for waste pickers, and profits for entrepreneurs through the reintegration of waste into the value chain of the production process (Brazil, 2010; Gomes; Caminha; Memoria, 2019).

The PNRS emphasizes integrated management and, in this sense, the protagonism of recyclable material waste pickers in selective collection, highlighting the need to protect this category of workers and improve their working conditions in line with the principles of sustainability. The inclusion of waste pickers is present in the fundamental objectives and targets of the PNRS, which also encourages the participation of recyclable material waste pickers in reverse logistics and selective collection processes (Maiello; Britto; Valle, 2018).

Within this context, the present study had the general objective of analyzing the evolution of waste collection and treatment by associations, cooperatives, and recyclable material waste pickers located in municipalities of the state of Rio Grande do Sul (RS), in the periods before and after the creation of the PNRS. To this end, data and information available in the National Sanitation Information System (SNIS) database were predominantly used. The study comprised an analysis of data from the periods before and after the creation of the PNRS. As a contribution of this comprehensive research, a set of 14 pieces of information and indicators was identified that can contribute to an analysis of the waste treatment scenario in the state of Rio Grande do Sul.

This paper is organized into four sections. The first section presents the contextualization of the topic and the objective of the study. The research methodology and the stages of the study are described in the second section.

The third section presents the main findings and results of the research. Finally, the fourth section presents the final considerations and suggestions for future research.

RESEARCH METHODOLOGY

This research adopts both qualitative and quantitative approaches. With regard to its objective, it is categorized as exploratory and descriptive research, as it seeks to gain a deeper understanding of the problem and make it more evident.

The selected unit of analysis was the municipalities that make up the state of Rio Grande do Sul, and this choice can be characterized as probabilistic and systematic. The decision to use this setting was influenced by the availability of data from a highly credible national source, the National Sanitation Information System (SNIS), as well as by the presence of an appropriate institutional structure for conducting the research, located in the state capital of Rio Grande do Sul.

As a technical procedure, a bibliographic and documentary study was conducted, based on secondary data obtained through consultations with the SNIS during the period from March 2024 to July 2024.

The National Sanitation Information System (SNIS) is the largest and most relevant data collection system in the sanitation sector in Brazil. It is based on a database that encompasses institutional, administrative, operational, managerial, economic-financial, accounting, and quality information related to the provision of water supply services, wastewater treatment, and urban solid waste management. Since 1995, the SNIS has been consolidated, and its indicators have been used as benchmarks for comparisons and for evaluating service performance (Brazil, 2023).

Information on urban solid waste provided to the SNIS is the responsibility of municipal government managers. Currently, investment

programs of the Ministry of Regional Development require the regular submission of data to the SNIS as a criterion for the selection, prioritization, and release of financial resources for each type of service provided (Brazil, 2023).

To obtain the data, a query was carried out in the SNIS database covering the period from 2010 to the most recent year for which information was available in the system; SNIS data were available up to the year 2021. The SNIS has been in operation in Brazil since 1995, which demonstrates the maturity of the system. The analysis, description, and presentation of the collected data were conducted through the application of descriptive statistics. This statistical approach is used to illustrate the characteristics of a set of observations and information, providing an informative summary of the sample under study (Ferreira, 2020; Kaliyadan; Kulkarni, 2019; Marshall; Jonker, 2010).

PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

Initially, the main aspects set out in the National Solid Waste Policy (PNRS) that are related to recyclable material waste pickers were examined, serving as the basis and context for guiding the research, as outlined in the introductory section of this study. In order to verify participation and changes in the volumes of waste handled by recyclable material waste pickers in the municipalities of the state of Rio Grande do Sul, Brazil, in the periods before and after the PNRS, data and information were collected from the SNIS. The results and main findings of the research are presented in the following section.

Information regarding waste pickers in the state of RS in the SNIS

According to Brazil (2022), through Law No. 12,305/2010 and Decree No. 10,936/2022, the National Solid Waste Policy (PNRS) establishes guidelines, responsibilities, principles, and objectives that guide the various actors involved in the management and administration of solid waste. This has become one of

the main challenges in urban environmental management for Brazilian municipalities today.

Proper solid waste management begins with what is defined in Article 9 of the Law, which describes the order of priority to be followed: prevention, reduction, reuse, recycling, treatment of solid waste, and environmentally sound final disposal of rejects. In addition, this approach allows for the adoption of technologies aimed at energy recovery from urban solid waste.

The National Solid Waste Policy (PNRS) not only prohibits the improper disposal of solid waste, but also promotes the adoption of reverse logistics systems, the integration of waste pickers into strategic planning, and, indirectly, contributes to the expansion of selective collection (Lima et al., 2022).

According to MIDR (2021), the total number of associative entities of recyclable material waste pickers present in 79 municipalities in the state of Rio Grande do Sul was 125 (Table 1). This number corresponds to the information provided by the municipalities; that is, only 15.90% reported data to the National Sanitation Information System (SNIS).

Table 1: Total number of municipalities with waste picker associations in RS

Municipality	Number of associations of recyclable material collectors in the municipality	Total number of members	Average number of members per association
Alegrete	2	11	5,5
Alvorada	1	7	7
Arroio Grande	1	12	12
Bento Gonçalves	9	81	9
Caçapava do Sul	1	8	8
Cachoeira do Sul	1	40	40
Camaquã	1	20	20
Campo Bom	1	38	38
Canguçu	1	12	12
Canoas	4	138	34,5
Capão da Canoa	1	111	111
Carazinho	1	25	25
Cerro Largo	1	22	22
Cruz Alta	4	52	13
Dois Irmãos	1	35	35
Eldorado do Sul	1	12	12

Municipality	Number of associations of recyclable material collectors in the municipality	Total number of members	Average number of members per association
Encruzilhada do Sul	1	26	26
Erechim	5	94	18,8
Estância Velha	1	10	10
Flores da Cunha	1	18	18
Garibaldi	1	15	15
Glorinha	1	8	8
Gravataí	2	73	36,5
Ibirubá	1	14	14
Igrejinha	1	18	18
Ijuí	2	28	14
Imbé	1	20	20
Jaguarão	1	25	25
Jaguari	1	7	7
Jari	1	5	5
Lajeado	1	40	40
Lindolfo Collor	1	20	20
Marau	1	10	10
Minas do Leão	1	10	10
Morro Redondo	1	12	12
Morro Reuter	1	9	9
Nova Santa Rita	1	7	7
Novo Hamburgo	3	114	38
Passo do Sobrado	1	8	8
Passo Fundo	4	73	18,25
Pelotas	6	90	15
Pinheiro Machado	1	27	27
Piratini	1	15	15
Portão	1	15	15
Restinga Sêca	1	12	12
Rio Grande	4	46	11,5
Rio Pardo	1	18	18
Rosário do Sul	1	8	8
Salto do Jacuí	1	7	7
Santa Cruz do Sul	1	52	52
Santa Maria	2	50	25
Santa Rosa	1	15	15
Santana do Livramento	1	12	12
Santiago	1	35	35
Santo Ângelo	1	42	42
São Borja	1	12	12
São Francisco de Assis	1	17	17
São José do Norte	1	11	11
São Leopoldo	8	96	12
São Lourenço do Sul	1	20	20
São Marcos	2	18	9

Municipality	Number of associations of recyclable material collectors in the municipality	Total number of members	Average number of members per association
São Vicente do Sul	1	10	10
Sapucaia do Sul	1	38	38
Tapes	1	34	34
Taquara	1	30	30
Teutônia	1	22	22
Torres	1	10	10
Três Cachoeiras	1	6	6
Três de Maio	1	6	6
Triunfo	1	26	26
Tupanciretã	1	7	7
Turuçu	1	6	6
Uruguaiana	2	70	35
Vacaria	1	9	9
Venâncio Aires	1	25	25
Vera Cruz	1	16	16
Veranópolis	3	18	6
Viamão	1	60	60
Xangri-lá	1	80	80
79	**125**	**2379**	**-**

Source: Adapted from SNIS (2021)

In the database of the National Sanitation Information System (SNIS), information related to recyclable material waste pickers was examined, as the research sought to verify the inclusion and the situation of these professionals before and after the implementation of the PNRS. The information analyzed refers to the SNIS codes (Table 2): CA001 – Presence of waste pickers at open dumps or landfills; CA004 – Are there recyclable material waste pickers working informally throughout the city?; CA005 – Are there waste pickers organized in cooperatives or associations?; CA006 – Number of associative entities; CA007 – Number of members; and CA008 – Is there any social work carried out by the municipality aimed at waste pickers?

Table 2: Information about waste pickers at the base of SNIS

COD. SNIS	CA001	CA004	CA005	CA006	CA007	CA008
2002	9	10	5	5	0	7
2003	9	8	6	21	955	6
2004	13	12	10	38	1007	8
2005	15	15	11	39	1239	8
2006	23	21	14	37	1378	13

COD. SNIS	CA001	CA004	CA005	CA006	CA007	CA008
2007	26	21	15	46	1365	13
2008	-	30	17	47	1199	13
2009	-	153	56	100	2449	52
2010	-	175	51	106	2428	54
2011	-	110	37	89	2590	29
2012	-	134	44	93	2375	28
2013	-	134	49	103	2264	34
2014	-	124	41	70	1608	28
2015	-	132	40	60	1537	23
2016	-	217	63	100	2087	20
2017	-	222	66	94	1986	27
2018	-	230	61	91	1879	20
2019	-	235	66	117	2701	21
2020	-	269	79	125	2379	22
2021	-	305	79	142	2976	24
Total Geral	**95**	**2557**	**810**	**1523**	**36402**	**450**

Source: Elaborated by authors (2024)

With regard to code CA001, which refers to the presence of waste pickers at open dumps or landfills, it is observed that, in the period from 2002 to 2007, there were records indicating the presence of waste pickers in these environments; after this period, no further records were reported.

When analyzing code CA004 (Are there recyclable material waste pickers working dispersed throughout the city?), it was observed that from 2002 to 2010 - the year in which the PNRS was established - there was growth in the number of cities reporting the presence of dispersed waste pickers: 10 cities in 2002 and 175 in 2010. When comparing the period from 2010 to 2020, a growth of 74% is identified, increasing from 175 in 2010 to 305 in 2020. Considering the total number of municipalities in the state, which is 497, it was found that 61.37% declared, in 2020, the presence of dispersed waste pickers.

With respect to the existence of waste pickers organized in cooperatives or associations (CA005), an increase over the years was observed. In 2002, a total of 5 municipalities reported the existence of waste picker entities, and in 2010 there were 51 reporting municipalities. Between 2010 (51 municipalities) and 2021 (79 municipalities), growth reached 55%. When considering the total

number of municipalities in the state, the number of reporting municipalities remains low, representing only 15.90% of the total. The lack of information is detrimental, including for the definition of future actions and programs by state and federal governments.

The organization of recyclable material waste pickers promotes collective cooperation, with the potential to overcome structural challenges that limit their ability to add value to their work. When organized, recyclable material waste pickers gain greater influence, enabling them to establish more favorable market relations and even advance through different stages of the recycling value chain. Although waste picker cooperatives play a crucial role in the recycling chain, they are positioned at the base of the structure and often face difficulties in adding value to recyclable materials. This occurs mainly due to a lack of investment in physical and technological infrastructure, as well as the absence of public policies that support selective collection with the inclusion and active participation of waste pickers (Gutberlet, 2015; Gutberlet; Uddin, 2017; Tirado-Soto; Zamberlan, 2013).

In this context, organization into cooperatives reveals significant aspects for recyclable material waste pickers, such as the importance of marketing logistics, the advantages of achieving scale, the dissemination of knowledge, and the sharing of management practices among different associations and cooperatives with varying levels of efficiency.

The number of associative entities of waste pickers (CA006) reported by municipalities increased over the years. In 2002, a total of 5 municipalities reported the existence of 5 entities; in 2010, 51 municipalities reported 106 waste picker entities; and in 2021, 79 municipalities reported 142 entities. Between 2010 - the year of the creation of the PNRS - and 2021, a growth of 34% was identified in the total number of entities in the reporting municipalities. When assessing the number of members belonging to waste picker entities (CA007), a growth of

22.57% is observed between 2010 and 2021, increasing from 2,428 to 2,976 waste pickers affiliated with these entities.

In Brazil, as in many developing countries, only a small proportion of recyclable material waste pickers are associated with cooperatives and, occasionally, with broader networks, while they carry out the collection, sorting, and sale of recyclable materials, with or without government support. Most waste pickers work under precarious, dangerous, and unhealthy conditions.

Some groups of waste pickers choose to form cooperatives, and these organizations provide a kind of safety net, helping them access more opportunities to sell materials and thus secure their livelihoods. Waste pickers operating at different stages of the recycling chain have sought to organize individually and collectively. This organization manifests itself through various forms and strategies, observed both in the political and economic spheres, as these workers mobilize as a professional category in search of social recognition and citizenship rights (Gutberlet, 2015; Gutberlet; Uddin, 2017; Lima; Mancini, 2017; Ogando; Roever; Rogan, 2017).

Code CA008 refers to the existence of any social initiatives by municipal governments directed toward waste pickers. In this regard, a reduction in the number of cities reporting such actions was observed: in 2010, the number was 54, and in 2021 it fell to 24, representing a reduction of 56%. When comparing the 2021 result - 24 municipalities - with the total number of municipalities in the state (497), the percentage is only 4.83%, indicating a very low number of municipalities with such initiatives.

When growth (demographic, economic, etc.) occurs in an urban area, there is an increase in resource flows, making waste management even more relevant. One of the strategies for such management is waste recycling, which serves as an alternative for the reuse of recoverable portions of resources, especially in times of increased consumption of goods and services. Successful

waste recycling programs generate environmental, health, social, economic, and educational benefits (Conke, 2018).

Information regarding waste generation in the state of RS according to SNIS

SNIS indicator CO119 aims to verify the total amount of household solid waste (HSW) and public solid waste (PSW) collected in the municipality by all agents. In this context, population growth and the amounts of HSW and PSW collected over the same period were examined, as presented in Table 3.

Within this context, linear regression analysis techniques, the Pearson correlation coefficient, and the coefficient of determination were applied (Devore, 2018) to verify the relationship between the total population of municipalities in the state of Rio Grande do Sul and the total amount of HSW and PSW collected by all agents during the same period. After identifying the presence of correlation between the variables, according to Callegari-Jacques (2007), the Pearson correlation coefficient ranges from −1 to 1, and the strength of the correlation is assessed as follows: none when the correlation is 0; weak when between 0 and 0.3; moderate when between 0.31 and 0.6; strong when between 0.61 and 0.9; very strong when between 0.91 and 0.99; and perfect when the correlation equals 1.

Table 3: Correlation between population and waste collection in RS

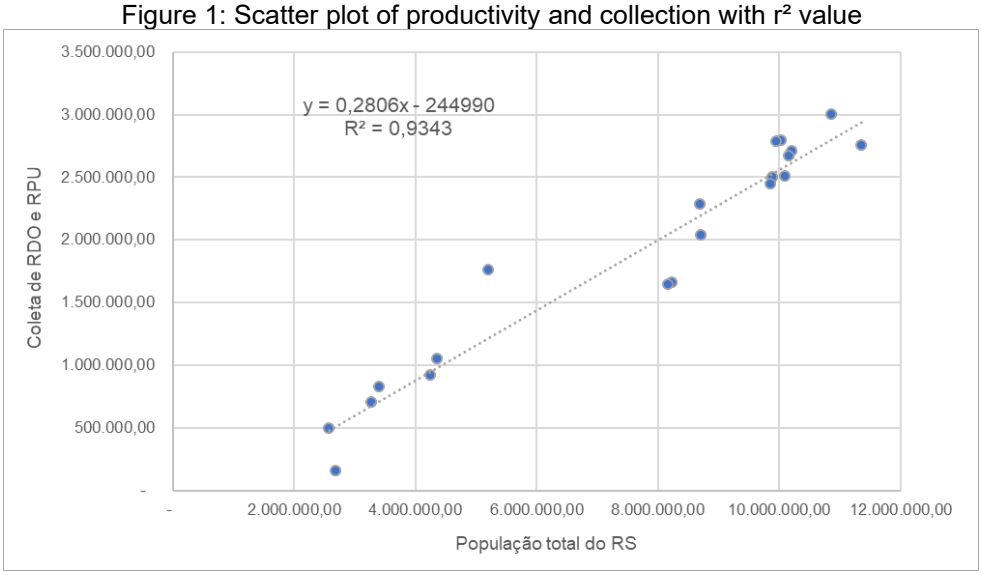
Year	Municipality total population (Source: IBGE)	COD. CO119 (collected HSW and PSW) (kg)
2002	2.680.145,00	155.279,00
2003	2.580.352,00	500.184,60
2004	3.280.337,00	703.648,60
2005	3.397.677,00	831.268,40
2006	4.250.803,00	923.968,70
2007	4.358.732,00	1.055.785,40
2008	5.203.838,00	1.758.957,80
2009	8.233.014,00	1.658.814,60
2010	8.160.376,00	1.645.623,50
2011	8.713.503,00	2.037.591,90
2012	8.692.332,00	2.286.805,70
2013	10.035.853,00	2.794.469,00

Year	Municipality total population (Source: IBGE)	COD. CO119 (collected HSW and PSW) (kg)
2014	10.203.206,00	2.707.611,10
2015	9.943.932,00	2.786.261,60
2016	9.880.328,00	2.500.056,70
2017	9.859.558,00	2.451.218,10
2018	10.097.657,00	2.507.965,80
2019	10.150.602,00	2.672.413,80
2020	10.859.948,00	3.001.484,60
2021	11.352.833,00	2.755.604,40
Pearson Correlation		**0,966614842**
Correlation intensity (Callegari-Jacques, 2007)		**Very strong**
R^2		**93,43%**

Source: Elaborated by auhtors (2024)

Based on the results presented in Table 3, it can be observed that, when analyzing the correlation between the total population of the municipalities in the state of Rio Grande do Sul and the total amount of HSW and PSW collected by all agents during the same period, the correlation can be considered very strong. Figure 1 presents the scatter plot, considering population on the x-axis and the total amount of waste collected on the y-axis, along with the r² values.

Figure 1: Scatter plot of productivity and collection with r² value



Source: Elaborated by authors (2024)

Expenditures on waste management in Brazilian cities depend on how waste is handled and managed by the municipality, including the existence of a

selective collection service. The privatization of these services tends to create pressures that favor increased service costs when compared to provision by the public sector or through public–private partnerships (Carbonai; Baum; Camiz, 2020; Rodrigues; Magalhães Filho; Pereira, 2015).

Within this context, information related to the existence of formally established selective collection by municipal governments in the municipalities of Rio Grande do Sul was examined (Table 4), which can be obtained through code CS001 in the SNIS database. The quantities of recyclable materials recovered by type were also collected (Table 5), available in the SNIS database through the following codes: CS010 – Quantity of recyclable paper and cardboard recovered; CS011 – Quantity of recyclable plastics recovered; CS012 – Quantity of recyclable metals recovered; CS013 – Quantity of recyclable glass recovered; and CS014 – Quantity of other recyclable materials recovered (excluding tires and electronic waste).

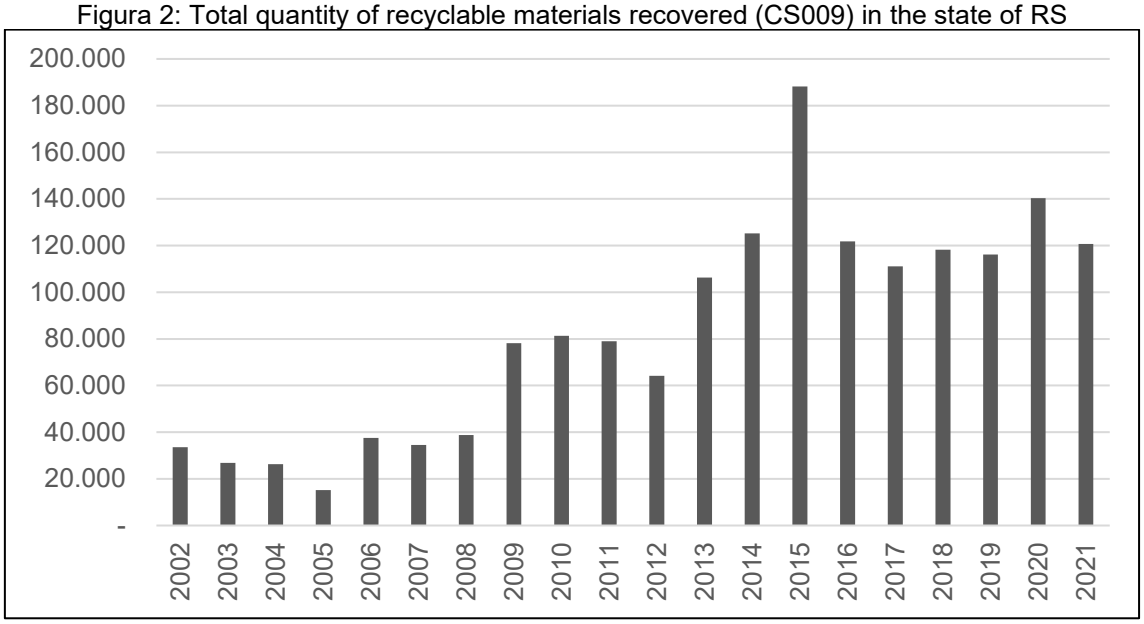
Table 4: Formalized selective waste collection implemented by the municipalities in the city of RS

Ano	COD. CS001	Number code CS001/Total of Municípalities in RS
2002	8	1,61%
2003	9	1,81%
2004	11	2,21%
2005	12	2,41%
2006	19	3,82%
2007	19	3,82%
2008	24	4,83%
2009	109	21,93%
2010	126	25,35%
2011	123	24,75%
2012	168	33,80%
2013	175	35,21%
2014	191	38,43%
2015	177	35,61%
2016	178	35,81%
2017	189	38,03%
2018	217	43,66%
2019	203	40,85%
2020	226	45,47%
2021	217	43,66%

Source: Elaborated by authors (2024)

With regard to the existence of formally established selective collection by municipal governments in the municipalities of Rio Grande do Sul, Table 4 shows that, between 2002 and 2021, there was an increase over the years in the number of municipalities reporting the availability of selective collection services. Recycling rates of the main materials in Brazil remain at considerably low levels, despite the various actions and initiatives implemented to achieve greater use and recovery of these resources. One of the reasons for this situation is the low level of public adherence to selective collection systems (Brazil, 2022). Figure 2 illustrates the evolution of code CS009, which refers to the total quantity of recyclable materials recovered in the state of Rio Grande do Sul.

Figura 2: Total quantity of recyclable materials recovered (CS009) in the state of RS



Source: Elaborated by authors (2024)

Considering the implementation of the PNRS in 2010 and analyzing the volumes of waste recovered between 2010 and 2021, an increase of 48.49% in recovered volumes was observed. With regard to the quantities of recyclable materials recovered by type, code CS010 accounted for 35.09%, CS011 for 25.79%, CS012 for 17.71%, CS013 for 14.60%, and CS014 for 6.81%, as shown

in Table 5.

Table 5: Total waste recovered per year in Rio Grande do Sul based on SNIS

Year	CS010	CS011	CS012	CS013	CS014	Recovered total
	(ton/year)					
2002	11562,40	9170,20	2554,00	2546,40	5236,50	31069,50
2003	10040,70	7818,00	2184,50	940,60	5229,60	26213,40
2004	12394,20	6095,30	3734,50	2829,80	1278,60	26332,40
2005	6278,50	3905,70	11883,60	2728,20	115,80	24911,80
2006	14504,40	12114,80	4668,60	4124,00	2242,50	37654,30
2007	10730,60	8096,40	6099,80	4256,10	2799,20	31982,10
2008	9955,10	7013,80	1361,60	1287,10	1083,10	20700,70
2009	20212,00	14030,00	4939,10	4523,70	5226,70	48931,50
2010	29054,00	23138,40	67385,80	45445,80	4094,50	169118,50
2011	28601,00	22887,40	10183,70	6574,70	6227,20	74474,00
2012	17220,60	16745,90	10391,80	6324,80	6598,90	57282,00
2013	28254,30	22396,50	15896,90	11237,90	9235,40	87021,00
2014	37420,60	26846,50	15387,90	12676,40	9353,40	101684,80
2015	43719,10	32194,60	15598,60	15024,90	5125,90	111663,10
2016	39857,70	24020,50	9489,00	11656,70	3801,60	88825,50
2017	33388,00	22884,30	10647,20	10075,90	5871,20	82866,60
2018	21697,80	15054,60	6806,50	8749,50	2243,50	54551,90
2019	23001,10	16227,00	7142,20	10315,50	2474,20	59160,00
2020	33178,50	21367,80	15731,30	15477,60	6672,10	92427,30
2021	28214,00	25579,80	9744,80	14279,00	4190,10	82007,70
Total	**459.284,60**	**337.587,50**	**231.831,40**	**191.074,60**	**89.100,00**	**1.308.878,10**
%	**35,09%**	**25,79%**	**17,71%**	**14,60%**	**6,81%**	**100%**

Source: Elaborated by authros (2024)

Several factors affect the rates of recovery of recyclable materials in Brazil, including market seasonality, the country's economic situation, the geographic distribution of industry, and the presence of consumer markets. Waste picker organizations generally handle materials originating from municipal selective collection, household selective collection along specific routes, materials from large generators, and voluntary drop-off points (VDPs). The environmental work carried out by these organizations is of great importance, as cooperatives sort a wide variety of recyclable materials, enabling their absorption by industry.

However, there is a series of interconnected factors that affect the economic viability of this activity and, consequently, recycling rates in the country.

Among these factors, the geographic dispersion of waste picker organizations and the territorial distribution of the recycling industry stand out (Brazil, 2022).

The collection of recyclable waste is typically an activity embedded in the informal sector, involving the sorting of waste to identify valuable materials that can later be sold for profit. There are millions of waste pickers worldwide, mainly in low-income countries. Waste pickers who perform waste sorting often carry out this activity in inadequate and unhealthy environments, being exposed to social, psychological, biological, and environmental risks, which can generate adverse health effects associated with various forms of exposure (Cruvinel et al., 2019; Thakur; Ganguly; Dhulia, 2018; Ziraba; Haregu; Mberu, 2016).

CONCLUSIONS

The increase in waste generation, inadequate management of these materials, and the significant presence of people living in poverty highlight the growing importance of recyclable material waste pickers in contemporary society. Historically, these workers began collecting discarded materials on the streets and in disposal areas in order to gather items that could be sold to the recycling industry to secure their livelihoods (Gouveia et al., 2019).

Waste pickers collect, sort, and sell recyclable materials, operating on streets, open dumps, sanitary landfills, and in sorting facilities or cooperatives, and are mostly embedded in the informal labor market. Their activity essentially consists of identifying and separating waste with reuse potential - such as plastic bottles, glass, iron, paper, and cardboard - until a sufficient quantity is accumulated for sale. This work enables materials to return to the productive cycle as raw materials, preventing improper disposal (Filipak et al., 2020).

Within this context, the present study had the general objective of analyzing the evolution of waste collection and treatment carried out by associations, cooperatives, and recyclable material waste pickers in the

municipalities of the state of Rio Grande do Sul (RS), in the periods before and after the creation of the National Solid Waste Policy (PNRS). It is considered that this objective was achieved. To this end, data from the National Sanitation Information System (SNIS) database were predominantly used.

Initially, a bibliographic review was conducted to identify the elements and guidelines that make up the PNRS and that could guide the development of the investigation. The PNRS established the allocation of federal and state resources to support municipalities in the integration and training of waste pickers, encouraging the formation and strengthening of cooperatives and other associative forms (Brazil, 2010; Pisano; Demajorovic; Besen, 2022).

The policy also prioritizes the implementation of selective collection through waste picker cooperatives, promoting sustainable business opportunities. This guideline contributes both to increased income and formal employment for waste pickers and to profit generation for entrepreneurs through the reintegration of waste into the value chain of the production process.

Based on the results, it was found that in 2021 only 15.90% of municipalities in Rio Grande do Sul reported having associative entities of waste pickers, which demonstrates the need to expand the presence and institutional recognition of these organizations at the municipal level.

The efficiency of waste picker organizations and the achievement of gains in scale and quality can be enhanced through the inclusion of these organizations in integrated solid waste management and reverse logistics; through training for self-management; production standardization; the appropriate use of spaces for storing recyclable materials; and the consolidation of commercial networks (Fidelis; Ferreira; Colmenero, 2015; Ribeiro et al., 2014; Siman et al., 2020).

Within the scope of practices aimed at environmental sustainability, recycling involves both collective actors, such as cooperatives or associations,

and individual actors, namely the waste pickers themselves. Collective organizations, in particular, provide better working conditions, facilitate value addition to recyclable materials, and enable more advantageous negotiations with industry, which may even ease the transition of these workers to other professional opportunities (Cardoso et al., 2020).

Brazil, as a developing country, faces significant challenges in solid waste treatment and in promoting recycling. These challenges become even more complex given the country's vast territorial extent, the high number of municipalities, and the economic and social diversity of its regions. In this scenario, public policies such as the PNRS are crucial for enabling appropriate practices for waste disposal and recovery.

Considering that recycling cooperatives play an essential role in the collection, sorting, and destination of waste, it is timely to assess the impact of public policies on the structuring and operation of these enterprises. Moreover, the results of this research may provide a basis for further investigations into the inclusion of waste pickers within the context of the PNRS and the factors that contribute to more efficient, equitable, and sustainable environmental management.

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