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Selective collection in the municipality of Narandiba – São Paulo – Brazil

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A coleta seletiva no município de Narandiba – São Paulo – Brasil

RESUMO

Objetivo – O presente trabalho teve como objetivo avaliar a coleta seletiva no município de Narandiba – São Paulo, desde a sua implantação até os dias atuais, por meio da análise das ações desenvolvidas no município como: logística, educação ambiental, infraestrutura e políticas públicas.

Metodologia – O estudo se baseou no acompanhamento da coleta seletiva porta a porta em diversos bairros da zona urbana do município, bem como no acompanhamento das atividades desenvolvidas pela Associação dos Protetores da Natureza (APRONAT), incluindo a coleta, triagem, estocagem e comercialização dos recicláveis. Também foram analisados documentos administrativos relacionados à gestão dos materiais recicláveis. A partir da análise dos dados primários levantados em campo e dos dados secundários coletados, foram propostas ações para aprimorar a coleta seletiva no município.

Originalidade/relevância – O estudo trata de uma pesquisa aplicada sobre coleta seletiva em um município de pequeno porte, perspectiva pouco explorada na literatura sobre a gestão de resíduos sólidos urbanos. A relevância do trabalho consiste na análise de aspectos logísticos, educacionais, financeiros, estruturais e políticos e sua influência no desempenho da coleta seletiva em municípios de pequeno porte.

Resultados – Em 2015 foram comercializadas 43 toneladas de materiais recicláveis, coletados pela APRONAT, e em 2023 a comercialização foi de 138 toneladas, indicando um aumento na capacidade de coleta, triagem e comercialização dos materiais recicláveis. As ações de educações ambiental desenvolvidas pelas escolas e pela própria APRONAT melhoraram o descarte correto dos resíduos, juntamente com o apoio financeiro aos catadores e demais incentivos por parte do poder público, que auxiliaram na melhoria da coleta seletiva e do processo operacional da APRONAT. Entretanto, ainda há necessidades de melhorias da infraestrutura operacional da coleta seletiva, capacitação e formação dos catadores de materiais recicláveis e apoio por parte da população na separação e descarte dos materiais recicláveis.

Contribuições teóricas/metodológicas – As contribuições teóricas/metodológicas ressaltam a importância da economia circular e da reciclagem, evidenciando a necessidade de políticas públicas adaptadas às realidades locais. A metodologia utilizou uma abordagem que integrou análises quantitativas e qualitativas para a gestão integrada de resíduos sólidos.

Contribuições sociais e ambientais – O estudo gerou contribuições sociais e ambientais. No aspecto social, destacou a importância da inclusão social por meio da valorização de associações de catadores de materiais recicláveis e da geração de empregos e renda na cadeia da reciclagem. No aspecto ambiental, destacou a importância da coleta seletiva para a redução de impactos negativos ao meio ambiente, promovendo o uso mais eficiente de recursos naturais e a diminuição do volume de resíduos destinados a aterros e o descarte irregular de resíduos sólidos.

PALAVRAS-CHAVE: Coleta seletiva. Catadores de materiais recicláveis. Gestão de Resíduos Sólidos.

Selective collection in the municipality of Narandiba – São Paulo – Brazil

ABSTRACT

Objective – The present work aimed to evaluate selective collection in the municipality of Narandiba – São Paulo, from its implementation to the present day, through the analysis of actions developed in the municipality such as: logistics, environmental education, infrastructure and public policies.

Methodology – The study was based on monitoring door-to-door selective collection in several neighborhoods in the urban area of the municipality, as well as monitoring the activities developed by the Association of Nature Protectors (APRONAT), including the collection, sorting, storage and marketing of recyclable materials. Administrative documents related to the management of recyclable materials were also analyzed. Based on the analysis of primary data collected in the field and secondary data collected, actions were proposed to improve selective collection in the municipality.

Originality/Relevance – The study deals with an applied research on selective collection in a small municipality, a perspective little explored in the literature on urban solid waste management. The relevance of the work consists in the analysis of logistical, educational, financial, structural and political aspects and their influence on the performance of selective collection in small municipalities.

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Results – In 2015, 43 tons of recyclable materials collected by APRONAT were sold, and in 2023, 138 tons were sold, indicating an increase in the collection, sorting and marketing capacity of recyclable materials. Environmental education actions developed by schools and by APRONAT itself improved the correct disposal of waste, together with financial support for collectors and other incentives from the government, which helped improve selective collection and APRONAT's operational process. However, there is still a need to improve the operational infrastructure of selective collection, training and education of recyclable material collectors and support from the population in the separation and disposal of recyclable materials.

Theoretical/Methodological Contributions – The theoretical/methodological contributions highlight the importance of the circular economy and recycling, highlighting the need for public policies adapted to local realities. The methodology used an approach that integrated quantitative and qualitative analyses for the integrated management of solid waste.

Social and Environmental Contributions – The study generated social and environmental contributions. From a social perspective, it highlighted the importance of social inclusion through the promotion of associations of recyclable material collectors and the generation of jobs and income in the recycling chain. From an environmental perspective, it highlighted the importance of selective collection to reduce negative impacts on the environment, promoting more efficient use of natural resources and reducing the volume of waste sent to landfills and irregular disposal of solid waste.

KEYWORDS: Selective collection. Recyclable material collectors. Solid Waste Management.

Recolección selectiva en el municipio de Narandiba – São Paulo – Brasil

RESUMEN

Objetivo – El presente trabajo tuvo como objetivo evaluar la recogida selectiva en el municipio de Narandiba – São Paulo, desde su implementación hasta la actualidad, a través del análisis de acciones desarrolladas en el municipio como: logística, educación ambiental, infraestructura y políticas públicas.

Metodología – El estudio se basó en el seguimiento de la recogida selectiva puerta a puerta en varios barrios del casco urbano del municipio, así como en el seguimiento de las actividades desarrolladas por la Asociación de Protectores de la Naturaleza (APRONAT), incluyendo la recogida, clasificación, almacenamiento y venta de reciclables. También se analizaron documentos administrativos relacionados con la gestión de materiales reciclables. Con base en el análisis de datos primarios recolectados en campo y datos secundarios recolectados, se propusieron acciones para mejorar la recolección selectiva en el municipio.

Originalidad/Relevancia – El estudio aborda la investigación aplicada a la recolección selectiva en un pequeño municipio, una perspectiva poco explorada en la literatura sobre gestión de residuos sólidos urbanos. La relevancia del trabajo consiste en el análisis de aspectos logísticos, educativos, financieros, estructurales y políticos y su influencia en el desempeño de la recolección selectiva en pequeños municipios.

Resultados – En 2015 se vendieron 43 toneladas de materiales reciclables recolectados por APRONAT y en 2023 se vendieron 138 toneladas, lo que indica un aumento en la capacidad de recolección, clasificación y venta de materiales reciclables. Las acciones de educación ambiental desarrolladas por las escuelas y por la propia APRONAT mejoraron la correcta disposición final de los residuos, sumado al apoyo financiero a los recolectores y otros incentivos del gobierno, ayudaron a mejorar la recolección selectiva y el proceso operativo de APRONAT. Sin embargo, aún es necesario realizar mejoras en la infraestructura operativa de recolección selectiva, capacitación y educación de recolectores de material reciclable y apoyo de la población en la separación y disposición final de materiales reciclables.

Contribuciones Teóricas/Metodológicas – Los aportes teóricos/metodológicos resaltan la importancia de la economía circular y el reciclaje, evidenciando la necesidad de políticas públicas adaptadas a las realidades locales. La metodología utilizó un enfoque que integró análisis cuantitativos y cualitativos para la gestión integral de residuos sólidos.

Contribuciones Sociales y Ambientales – El estudio generó aportes sociales y ambientales. En el aspecto social, destacó la importancia de la inclusión social a través de la promoción de asociaciones de recolectores de material reciclable y la generación de empleos e ingresos en la cadena de reciclaje. En materia de medio ambiente, destacó la importancia de la recolección selectiva para reducir los impactos negativos al medio ambiente, promoviendo un uso

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más eficiente de los recursos naturales y reduciendo el volumen de residuos enviados a vertederos y la disposición irregular de residuos sólidos.

PALABRAS CLAVE: Colección selectiva. Recolectores de materiales reciclables. Manejo de Residuos Sólidos.

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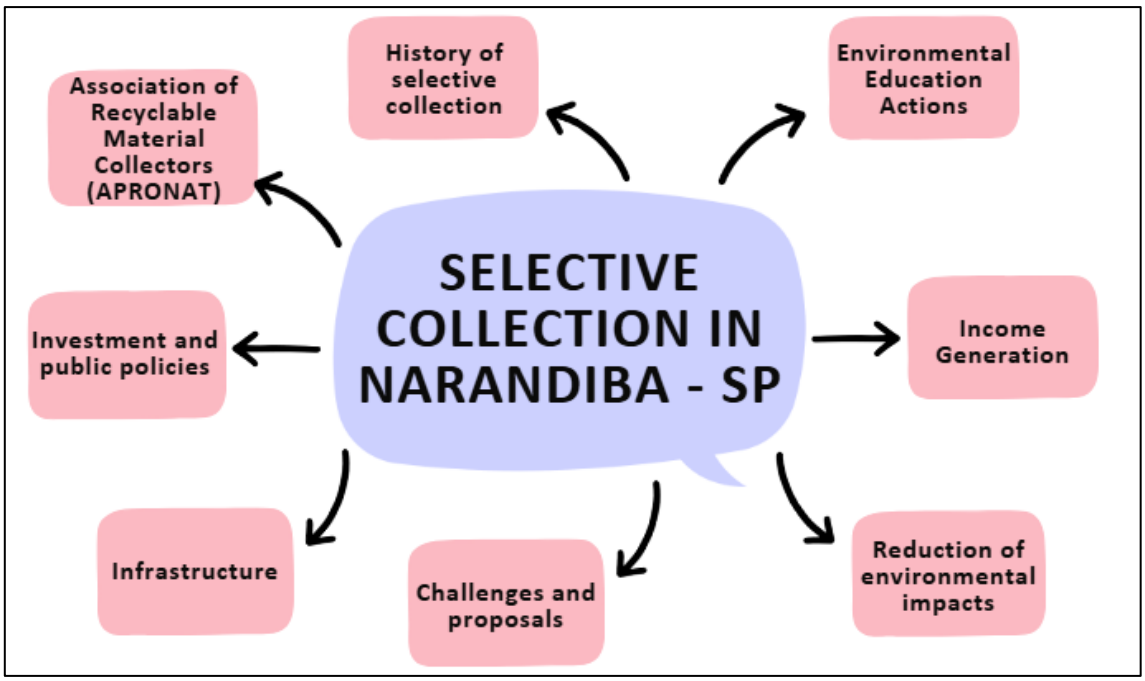
GRAPHIC SUMMARY



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1 INTRODUÇÃO

The generation of municipal solid waste (MSW) in Brazil differs in terms of geographic region, income and size of municipalities. The South and Southeast regions of the country, considered more economically developed and with a higher population concentration, have the lowest waste generation per inhabitant and the highest recycling rates (Rebehy et al., 2023).

Global environmental challenges associated with municipal solid waste continue to increase, especially in developing countries. Therefore, engagement in municipal solid waste management practices that promote environmental sustainability through waste recovery should be encouraged at all levels. The identification and segregation at the source of the waste generated are necessary actions for sustainable integrated management of solid waste, based on the circular economy model (Onungwe; Hunt; Jefferson, 2024).

In most cities in developing countries, thousands of people depend on the collection of recyclable materials for their livelihood, with up to 2% of the population in Asian and Latin American cities living off the income from collecting recyclable materials (Khatib; Al-Sari; Kontogianni, 2020).

Recyclable material collector organizations play a fundamental role in the circular economy and assist in the integrated management of solid waste. However, institutional, financial, political and social issues still hinder the development of these activities (Siman et al., 2020).

A fundamental pillar of solid waste sustainability through recycling is selective collection. To this end, there must be measures to cover the largest number of routes, vehicles, containers, workers, among others (Campos-Alba et al. 2021), thus ensuring the success of selective collection and the subsequent sorting, separation, marketing and recycling of various types of solid waste, such as paper, plastic, metal and glass.

The Decree n. 10,936 of January 12, 2022, regulates the Law n. 12,305 of August 2, 2010, which establishes the Brazilian National Solid Waste Policy. The Article 36 of Decree n. 10,936 of 2022 states that:

> The selective solid waste collection system will prioritize the participation of cooperatives or other forms of association of collectors of reusable and recyclable materials, formed by low-income individuals, with a view to:
> I - formalizing hiring;
> II - entrepreneurship;
> III - social inclusion; and
> IV - economic emancipation (Brasil, 2022).

Ciclosoft 2023's research, considering the total universe of Brazilian municipalities and their districts (5,570), indicated that 35.9% of the Brazilian population is served by door-to-door selective collection. At least 21.7% of Brazilian municipalities serve 50% or more of their population with door-to-door selective collection (CICLOSOFT 2023, p. 22-23).

The North, Northeast and Southeast regions presented as the main agent executing of the selective collection the waste picker organizations with some type of link with the city hall; the Central-West region, the city hall, and the South region, the companies contracted out (CICLOSOFT 2023, p. 25).

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According to Duarte (2023, p. 71), the regionalization of sectoral public policies is a necessity, since of the 5,5688 Brazilian municipalities, almost 88% are considered small (up to 50 thousand inhabitants) and most small and medium-sized municipalities have a technical and financial resource deficit to implement policies in isolation, especially those that have been neglected for decades, such as urban solid waste.

The recovery rates of recyclable materials in Brazil are influenced by a set of factors, including the seasonality of the market, the country's economic situation, the geographic distribution of the industry and the existence of a consumer market. Waste picker organizations normally work with materials from municipal selective collection, from their own selective household collection routes, from large generators and voluntary drop-off points. The importance of the environmental work of waste picker organizations lies in the fact that the cooperatives receive and sort various recyclable materials, in order to enable them to be absorbed by the industry (Brasil, 2020).

In this context, understanding the challenges of selective collection in small Brazilian municipalities is of utmost importance for advancing solutions to local problems in relation to urban solid waste.

The municipality of Narandiba belongs to the 10th Administrative Region of the State of São Paulo and is part of the Territory of Citizenship of Pontal do Paranapanema. It is located in the west of the State of São Paulo, bordering the State of Paraná, 600 km from the capital São Paulo. According to the IBGE Demographic Census, in 2022, the municipality of Narandiba had a population of 5,713 inhabitants, called “Narandibenses”.

The municipality of Narandiba, SP, is part of the Pontal do Paranapanema Intermunicipal Consortium (CIPP), together with the municipalities of Sandovalina, Tarabai, and Pirapozinho. The CIPP was created in 2013, based on the need for management and final disposal of solid waste from the municipalities involved, with the purpose of building and managing a sanitary landfill that would accommodate the waste from the municipalities of Narandiba, Pirapozinho, Tarabai, Sandovalina, and Estrela do Norte. In 2018, the municipality of Estrela do Norte ended up giving up being part of the Consortium, with the municipalities of Narandiba, Pirapozinho, Tarabai, and Sandovalina remaining in the CIPP. The statute that governs the CIPP establishes that it is mandatory for the consortium municipalities to have selective collection.

According to Ventura et al. (2020), intermunicipal consortia are one of the alternatives for the decentralized management of public services, and among basic sanitation services, solid waste consortia are the most predominant in Brazil. The authors also highlighted that the viability of intermunicipal arrangements mainly considers the need to reduce financial resources, improve collective infrastructure, and dispose of waste in landfills.

2 OBJECTIVES

The objective of this study was to analyze selective collection data in the municipality of Narandiba - SP, since its implementation in 2015 until 2023, pointing out difficulties and improvements in the process, as well as possible solutions to face the main challenges.

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3 METHODOLOGY

This study is characterized as qualitative research of a descriptive nature, with an exploratory approach, whose purpose was to construct a historical and operational panorama of selective collection in the municipality of Narandiba – SP, from its implementation to the present day. The investigation was based on the analysis of documentary sources, direct observation and analysis of secondary data, allowing an understanding of the evolution and challenges faced in selective collection.

Documentary analyses were conducted of official records linked to the management of selective waste collection, made available by the city government and the Association of Nature Protectors (APRONAT). The following stand out among the documents analyzed: association bylaws, meeting minutes, spreadsheets for controlling the entry and exit of recyclable materials, sales invoices for sorted waste, activity reports, contracts signed with the government, and various administrative records.

The door-to-door selective collection was monitored throughout the urban area of the municipality, in the neighborhoods: Ingá I, Ingá II, Ipê, Arruda, Santo Antônio, CDHU, Concordia, Centro, 21 de Março, Melen, Vila Rica and São Francisco Vila.

Additionally, monitoring was carried out at the sorting shed of the Association of Nature Protectors, with the aim of understanding the dynamics of separation, classification, storage and marketing of recyclable materials. This stage involved technical visits, allowing the collection of data on the flow of materials, the available infrastructure, the working conditions of the collectors, and the challenges faced by the Association.

After analyzing the situation of selective collection in the municipality, we sought to propose actions to improve selective collection, based on the diagnosis of selective collection in the municipality and the identification of the main advances, weaknesses and opportunities.

4 RESULTS

4.1 History of selective collection in Narandiba

The collection of recyclable materials in Narandiba began in mid-2005, on the initiative of two residents of the municipality. The materials were collected door-to-door, using one of their own vehicles, which was in poor condition. They only collected recyclable materials that had greater added value and were easy to sell, such as aluminum, iron and cardboard. They did not use any personal protective equipment (PPE) and separated the waste in their own homes.

In 2006, the City Hall, through community health agents, carried out Environmental Education campaigns, distributing pamphlets informing about the importance of separating recyclable materials and providing a tractor with a trailer so that the two collectors could collect these materials.

The tractor was also used to clean the streets, remove pruning, branches and debris in the city and was constantly being used for other services or it was in maintenance. As a result, the collection was not carried out as had been established. With the accumulation of waste in

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the residents' homes, the population stopped separating the recyclables and the materials ended up going to the landfill.

Thus, the two collectors started going to the landfill to carry out the collection, abandoning the door-to-door collection in the city.

Residents show solidarity with the collectors and have started to separate recyclable material and contact them to donate the waste.

After a few years, on December 12, 2008, the Association of Nature Protectors (APRONAT) was founded, a non-profit organization, made up of members of civil society and including the two recyclable material collectors mentioned.

In 2012, one of these collectors left the Association, leaving only one collector, who, with great difficulty, continued to carry out selective collection until 2014, when this collector handed its letter of resignation from APRONAT. For a few months, the municipality was without selective collection.

At the beginning of 2015, selective collection was formalized again in the municipality of Narandiba. Two new recyclable material collectors (one male and one female) began to carry out door-to-door collection twice a week, using a regular truck, without adaptations, provided by the city government.

The collectors collected recyclables in all neighborhoods of the municipality, carrying out 100% of the collection in the urban area. To better package the waste, green plastic bags were distributed to each residence, as well as an information booklet with instructions on the collection days and which waste should be separated for recycling.

After door-to-door collection, the collectors sorted the waste in a 1,000 m² area surrounded by wire mesh and with a 15 m² roof. The area was close to the urban area and had no water, electricity or bathrooms. Recyclables were separated directly on the ground and stored in bags. Even with the wire mesh, many recyclables ended up being stolen before being sold.

On February 5, 2015, the Municipal Law n. 1,436 was approved to include cooperatives and associations of selective waste collectors in the city's Urban Cleaning System, authorizing the payment of collectors and creating the Management Council, which made a transfer to the Association in the amount of R$2,000.00 per month. With this, the two collectors of recyclable materials began to earn a minimum wage plus the profit from the distribution of sales of recyclable materials, earning an average of about one and a half minimum wages.

Because the sorting site was located within the urban area, many residents began to complain about the recyclables that were there. In addition, thefts of materials such as cardboard, aluminum and scrap metal became frequent. Therefore, the City Hall transferred the activities to the land where the future construction of the sorting shed was planned, 4 km from the urban area. The new site had no roof for sorting/storing the materials, nor bathrooms, electricity or running water, and had a fence with two wires.

In June 2015, the male member left the Association and two new members joined, totaling three female collectors. Also in that same year, the municipality acquired, through the State Fund for Pollution Prevention and Control, its own truck for selective collection. The truck is classified as medium-sized, with its own cages for storing selective collection materials. The municipality designated a driver to transport the recyclables.

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From 2015 to 2016, APRONAT, in partnership with the municipality, distributed environmental education booklets. Green bags were replaced by raffia bags, called returnable bags, which are returned to residents after the recyclable material is transferred to the truck. In partnership with elementary schools, recycling-related activities were carried out with teachers, students and staff.

With financial resources obtained from the Public Prosecutor's Office/CESP Agreement, construction of the sorting shed began in 2016. The shed was built in the same location where the separation of selective collection materials was already carried out, 4 km from the urban area, on Highway SP 488/425. Although the location lacked an electrical or water network, the members began to sort the waste inside the shed, providing a little more comfort and protection from the weather conditions. Initially, the municipality provided a diesel generator to operate the press and gallons of drinking water for consumption. It was only in January 2020, with the implementation of the Industrial District near the Association's shed, that it was possible to install water and electricity and thus complete the work. The entire process until the completion of the warehouse and acquisition of equipment took 5 years, from 2015 to 2020. The masonry warehouse, with zinc roofing, has a bathroom, kitchen, cafeteria and a small office with a built area of 130 m², in a total area of 960 m². The warehouse has a press, weighing scale, sorting table, computer, cabinets, etc.

In 2017, a reduction in the collection of recyclable materials in the municipality began to be observed. This drop was mainly due to other informal waste pickers who began collecting waste destined for APRONAT before the collection time. The Agriculture and Environment Sector, aware of the incident, carried out awareness-raising work with the population using pamphlets, social media and meetings with informal waste pickers, who, despite being invited to join the Association, refused to do so.

The delay in the execution of works to ensure full structural working conditions for collectors affected the efficiency of selective collection in the municipality. Furthermore, the informal collection of recyclable materials, before the time scheduled by APRONAT, also affected the performance of formal selective collection in the municipality, requiring continued action to ensure effective solutions in this regard.

Another factor that contributed to the reduction in municipal selective collection was the collection of recyclable material provided by a sugarcane mill, consisting of fine plastic, with a good market price. The collection was carried out by the Association directly at the mill every two weeks and after a few months it began to be carried out weekly. Thus, the collectors, lacking structure and in small numbers, were no longer able to sort the recyclable materials from the urban area, prioritizing the waste from the mill because it had a better market value.

As a result, the Association began to relax its door-to-door collection in the municipality, losing sales of plastic, cardboard, paper and others. At the end of 2018, the sugarcane mill stopped supplying recyclable materials to the Association, which once again prioritized the collection in the municipality.

APRONAT, in partnership with the City Hall, has carried out several campaigns in schools, with elementary school students, and also with the general population. In one of these campaigns, points of receipt of recyclable materials were created in places accessible to the population, such as the Edson de Oliveira Garcia Elementary School, the Ineura Rodrigues de

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Lima Elementary School and the Cozinha Piloto. All of them received bags with capacity for 1000 kg to store recyclable materials, which are weekly collected by APRONAT. With these actions and a small improvement in the sorting location, the sale of recyclable materials grew again in 2018.

According to Beka; Meng (2021), intensive education of city residents is necessary to ensure that they fully understand the health risks arising from inadequate management of urban solid waste, which will motivate them to pay attention to solid waste management services. In addition, standards and regulations must be aligned with the city's reality.

The need for municipal governments to develop environmental education programs focused on selective collection is of utmost importance to involve the population and improve selective collection. Municipalities could even consider alternatives for discounts on fees/tariffs for solid waste management for residents who actively engage in the separation of waste and its disposal for selective collection. Additionally, environmental education campaigns should focus on the civic responsibility of residents, who generate solid waste and who must exert influence on the success of urban solid waste management (Zon et al., 2020).

At the beginning of 2019, selective collection faced some difficulties, as the vehicle for collecting and transporting recyclable materials required maintenance and spent 3 months in the workshop to have its body, bodywork and electrical parts replaced. The municipality hired a truck that was not suitable for selective collection, which did not have cages for storing the materials, and therefore there was loss of materials.

The need for specific vehicles in good condition is essential to ensure that selective collection occurs successfully, and it is necessary for the municipality to support the acquisition of these vehicles in some way and for the Association itself to also have a reserve fund set aside for possible maintenance on the vehicle, without compromising the regularity of the service provided.

In addition to the above, there was a need to replace the bags delivered in 2014, which were already damaged, furthermore to the need to deliver bags to the new neighborhoods that have been growing over the years. The purchase of new raffia bags was only possible at the beginning of 2020. While it was not possible to purchase new raffia bags, residents were asked to store recyclables in cardboard boxes and plastic bags.

In October 2019, the municipality made a training course available to Associates, taught by Capaciclage ME, lasting 360 hours, which covered the following topics: teamwork, ethics in service, administrative and economic notions.

After the course, an improvement in the service provided by members was observed, such as the constant use of PPE, a greater sense of leadership and greater commitment to the service.

In general, workers in the solid waste sector are vulnerable to different health risks, such as accidents caused by equipment, trucks, recyclable materials, etc.; infections caused by direct contact with waste and infections caused by insect/animal bites; chronic diseases, such as chronic respiratory diseases, resulting from exposure to dust and hazardous waste, among others (Al-Khatib; Al-Sari; Kontogianni, 2020). In this sense, the correct use of PPE seeks to protect collectors from some of these occupational risks.

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In 2020, the shed was painted and the fence was replaced. With the structure completed, the following items were purchased: an electronic scale for weighing, a computer and printer, a refrigerator, a stove, cabinets and a press with a capacity of 25 tons. This improved the sorting process, adding more economic value to the sale of recyclable materials, as the material was no longer sold loose.

In the same year, the municipality managed to acquire 3,000 (three thousand) raffia bags, to be delivered door-to-door by APRONAT.

Due to the COVID-19 pandemic, at the beginning of 2020, there was greater attention to safety precautions, in addition to the use of PPE, such as closed coveralls, masks, alcohol gel in the truck and in the sorting shed, in addition to the concern with recyclable materials, in which sodium hypochlorite was applied to the collected materials for sorting the following day. Even with all the difficulties of the pandemic, there was good sales of recyclable materials.

In the Agreement with the Public Prosecutor's Office/CESP, mentioned above, an amount of R$4,700.00 was also allocated for the implementation of a Social Technical Project, to be developed with the collectors. Thus, training was carried out from January to April 2021, covering topics such as ethics, entrepreneurship, etc. Also with this same resource, uniforms were made for the collectors. In total, the initial amount made available by the Agreement for selective collection actions in the municipality was: R$116,244.00, but its value was adjusted at the end of the work, to R$216,000.00.

In 2022, APRONAT was awarded by ARCOP – Regional Association of Recyclable Material Collectors of Western São Paulo, with the training course Promotion and Strengthening of the Solidarity Economy, held on Saturdays, with a workload of 80 hours. The topics covered were Environmental Education and its importance; the importance of individual and collective health of the Association; guidance and importance of planning for a campaign to be carried out in the municipality to improve selective collection in the urban area of the municipality of Narandiba.

Due to the increase in the collection of recyclable materials, APRONAT decided to expand its membership from 4 to 6, all female, aged between 30 and 60. Currently, they have left informality and vulnerability, living in a more dignified way, with a signed contract of service provision, guaranteed labor rights such as INSS, basic food basket and approximately two minimum wages.

In the study by Almeida et al. (2024), with 83 associated collectors from the municipality of Ponta Grossa – PR, it was identified that the majority of collectors were female (72.3%), a condition similar to that of the present study; and that the collectors performed this work out of necessity (34.0%) and because it was the only opportunity (26.0%). The study also highlighted that collectors of recyclable materials are exposed to several risks associated with waste management.

Currently, the selective collection is carried out in the municipality on Tuesdays and Thursdays, with recyclable waste being sorted on Mondays, Wednesdays and Fridays.

With the Municipal Law n. 1,588, of March 18, 2021, the municipality changed the amount of the financial transfer, which was previously R$2,000.00 per month, to R$6,600.00 per month, representing approximately one minimum wage per member.

Figure 1 shows the average income of organized waste pickers. At the national level,

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the average income of organized waste pickers rarely exceeds two minimum wages (5.5%), with the majority of them receiving between half and two minimum wages per month (87.3%) (CICLOSOFT 2023, p. 39).

Figure 1 – Average income of organized waste pickers.

Renda média mensal dos Catadores (%)	Brasil	Centro-Oeste	Nordeste	Norte	Sudeste	Sul
Mais de dois salários mínimos	**5,5%**	4,4%	-	2,4%	7,1%	8,1%
Entre um e dois salários mínimos	**50,1%**	73,3%	16,4%	42,9%	48%	64,3%
Entre meio e um salário mínimo	**37,2%**	22,2%	62,9%	35,7%	40,9%	23,8%
Menos de meio salário mínimo	**6,9%**	-	20,7%	19%	3,2%	3,8%
Não informado	**0,3%**	-	-	-	0,8%	-

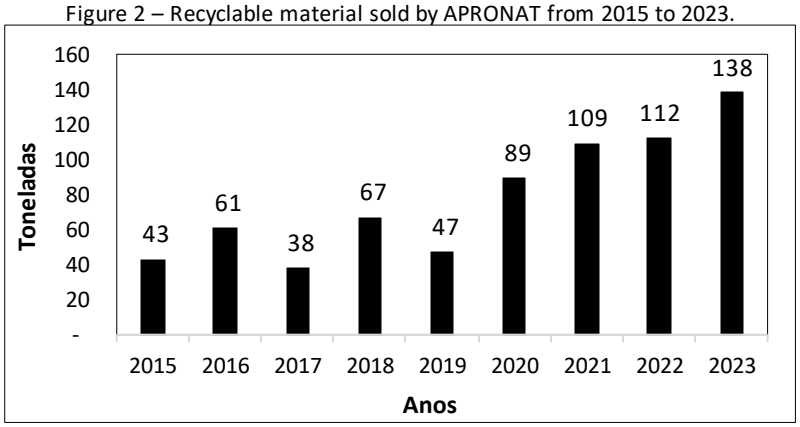
Source: CICLOSOFT (2023, p. 39).

Furthermore, 30.1% of waste picker organizations receive a fixed monthly amount from city governments; 62.7% of organizations that receive non-financial assistance have, as a municipal benefit, the provision of workspaces (CICLOSOFT 2023, p. 40).

From 2015 to 2023, there was an increase in the municipality's selective collection, from 43 tons (2015) per year to 138 tons per year (2023).

Figure 2 shows the total amount of materials collected and sold between 2015 and 2023 by APRONAT, showing fluctuations between the first years of its implementation, with 2017 being the most critical year, due to the lack of infrastructure at the sorting site and the relaxation of municipal selective collection by collectors.

Figure 2 – Recyclable material sold by APRONAT from 2015 to 2023.



Source: Prepared by the authors (2024) based on APRONAT data.

The predominant recyclable materials are PET, HDPE, cardboard and mixed papers. The products with the least predominance are PVC and PS, often discarded together with construction waste. Another product with low predominance is aluminum, because it has a satisfactory market value, it is not discarded directly in selective collection but is instead sold directly by some residents.

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4.2 Challenges and proposals for selective collection

Many organizations of recyclable material collectors operate in scenarios of very low economic efficiency. The participation of these organizations in integrated solid waste management generally relies on subsidies and assistance programs. In some cases, the government provides machinery, sorting warehouses, water and electricity, trucks (including fuel), as well as training and investment in extension and environmental education for the development of activities (Siman et al., 2020).

Before implementing an association or cooperative of recyclable material collectors, an analysis of the logistics structure, environmental education actions and dissemination to all citizens about what selective collection is, its importance and how it can be carried out in the municipality must be carried out.

Household waste segregation at source is an integral component of sustainable solid waste management, which represents a critical public health issue. The need for adequate waste segregation and sorting can reduce the volume of waste sent to landfill or other forms of final disposal and allows for resource recovery (Trushna et al., 2024).

At the same time, studies must be developed regarding the amount of MSW generated, collection days, and percentage of recyclables within the MSW. This will provide parameters to quantify the recyclables that can be collected and sorted and to determine the physical and operational structure of selective collection. These parameters will make it possible to choose the model of truck for selective collection, determine the size of the warehouse area, the models of equipment to be purchased, the operational sorting process, among others.

The structural part is one of the most important parts of the process of implementing selective collection. One should not only think about the physical space for storing the material that will arrive, as if it were a kind of dump, but also a space with infrastructure: the place must be ventilated, have running water and electricity, which are essential for the use of the equipment on site, bathrooms with showers and changing rooms, a kitchen and cafeteria so that members can have their meals, and an office equipped with a computer, printer, internet, desk and cabinets so that the administrative process can be carried out.

The warehouse must have sufficient external space for possible storage of already pressed materials, and also for maneuvering of large vehicles that will enter there to load and unload materials. The location must have a masonry protection (wall) or wire fence, preventing entry by unauthorized persons. One option to prevent theft and other aggravations would be to use cameras at strategic points.

> The structuring of waste pickers' cooperatives and associations is crucial to improving the safety, working and productivity conditions of these groups. The presence of equipment such as conveyor belts, scales and presses facilitate and improve the entire process of separating, storing and destination of waste for recycling (CICLOSOFT 2023, p. 36).

Figures 3 and 4 show the existence of equipment for collection and sorting and the existence of equipment for processing recyclable materials in the organizations analyzed.

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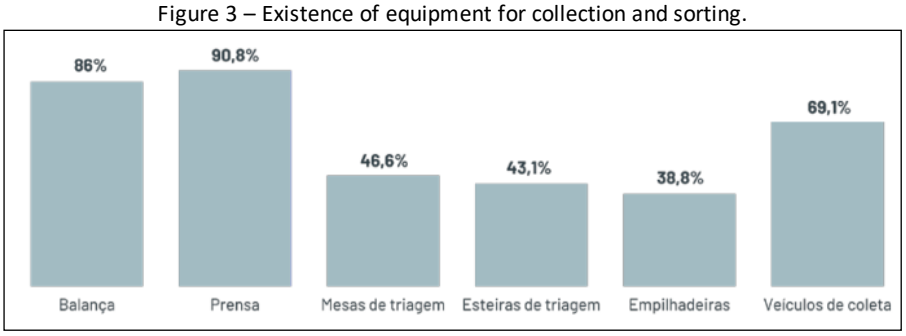
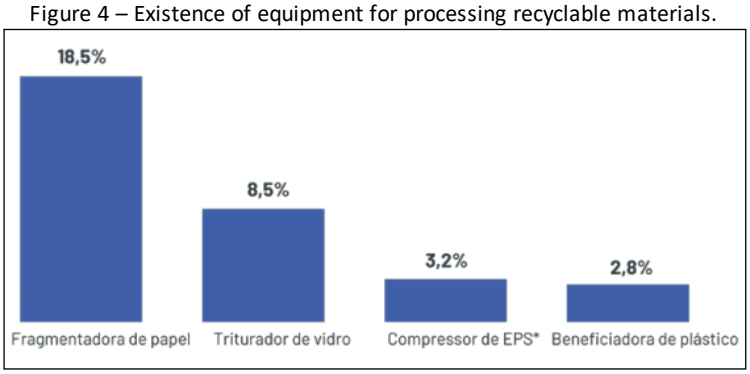
Figure 3 – Existence of equipment for collection and sorting.



Source: CICLOSOFT (2023, p. 36).

Figure 4 – Existence of equipment for processing recyclable materials.



Source: CICLOSOFT (2023, p. 36).

It is observed that 64.2% of organizations have equipment that allows for adequate operating conditions (equipped with a sorting table or conveyor belt, scale and press). However, only 31.2% of organizations have a complete infrastructure that allows for ideal operating conditions (roofing without holes, fire extinguishers within their validity period, unobstructed emergency exits, waterproof and non-slippery floor, adequate lighting, office, bathrooms or changing rooms, kitchen and cafeteria) (CICLOSOFT 2023, p. 36-37).

Thus, it can be said that there is still a deficit in terms of infrastructure to ensure ideal working conditions, safety and operational efficiency. Basic equipment could increase productivity, improve the quality of sorted materials and add economic value to the work of collectors. Therefore, it is urgent that public policies to support cooperatives and associations of recyclable material collectors advance not only in the donation of equipment, but also in promoting the improvement of the physical and structural conditions of warehouses and sorting centers.

Another difficulty is that members are often not qualified to perform administrative tasks. Most members do not finish high school, many do not even finish elementary school, and do not have computer skills, which are essential for administrative routines today. Therefore, the association or cooperative must have someone capable of performing administrative routines, issuing sales or purchase invoices, checking, researching and negotiating sales prices of goods, monitoring inventory, scheduling work shifts and monitoring the number of days worked. Municipalities can provide an employee to help perform these functions and at the same time train and encourage members to return to complete their studies.

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In Narandiba, even with the existence of some educational actions, it would be important to develop more training actions for collectors and investments to improve the level of education of those involved in selective collection, as the lack of administrative skills and the lack of access to professional training opportunities are limiting factors that compromise not only selective collection, but also the quality of life of collectors.

Therefore, it can be said that, in general, the lack of education and administrative training of collectors compromises the efficiency of cooperatives and the quality of life of those involved. Therefore, it is essential to invest in professional training and technical support, with possible involvement of municipalities.

5 CONCLUSION

In the municipality of Narandiba, the creation of APRONAT and its promotion was essential for the development not only of selective collection in the municipality, but also for the preservation of the environment, generation of income and restoration of the dignity of the Associates.

There has been an increase in environmental awareness in the municipality among urban area residents, many of whom understand and are concerned about separating and storing recyclables and, thus, contribute not only to the correct disposal of recyclables, but also to municipal cleanliness and health.

There is great difficulty in teaching literacy to APRONAT members, so it must be encouraged through public literacy programs. The creation of a literacy room within the Pontal of Paranapanema Intermunicipal Consortium, to teach adults in the process of learning to read and write, would simultaneously teach them to read and write and restore their self-esteem.

Developing a support network for the storage and direct sale of recyclables to companies can provide a better price for the product sold. The Cooperatives and Associations from the Pontal of Paranapanema Intermunicipal Consortium sell to a single buyer, who is in fact an intermediary, who ends up monopolizing the purchase, paying prices below the real value. With the help of the Pontal of Paranapanema Intermunicipal Consortium, the Cooperatives and Associations would start to sell directly to the final recipient, without the interference of the intermediary, transferring the monthly load from the 4 municipalities, thus providing a better price for the product.

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DECLARAÇÕES

CONTRIBUIÇÃO DE CADA AUTOR

Ao descrever a participação de cada autor no manuscrito, utilize os seguintes critérios:

- **Concepção e Design do Estudo**: Informe quem teve a ideia central do estudo e ajudou a definir os objetivos e a metodologia: Cláudio Domingues Branco; Maria Cristina Rizk.
- **Curadoria de Dados**: Especifique quem organizou e verificou os dados para garantir sua qualidade: Cláudio Domingues Branco.
- **Análise Formal**: Indique quem realizou as análises dos dados, aplicando métodos específicos: Cláudio Domingues Branco.
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DECLARAÇÃO DE CONFLITOS DE INTERESSE

Nós, **Cláudio Domingues Branco; Maria Cristina Rizk e Renata Ribeiro de Araújo**, declaramos que o manuscrito intitulado " **A coleta seletiva no município de Narandiba – São Paulo – Brasil**":

1. **Vínculos Financeiros**: Não possui vínculos financeiros que possam influenciar os resultados ou interpretação do trabalho. Nenhuma instituição ou entidade financiadora esteve envolvida no desenvolvimento deste estudo.
2. **Relações Profissionais**: Nenhuma relação profissional relevante ao conteúdo deste manuscrito foi estabelecida.
3. **Conflitos Pessoais**: Nenhum conflito pessoal relacionado ao conteúdo foi identificado.