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*RECYCLING OF PLASTIC PACKAGING: CHALLENGES AND  
OPPORTUNITIES FROM A WASTE PICKERS' ASSOCIATION*

**RECICLAGEM DE EMBALAGENS PLÁSTICAS: DESAFIOS E  
OPORTUNIDADES A PARTIR DE UMA ASSOCIAÇÃO DE CATADORES<sup>1</sup>**

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**ABSTRACT**

The awakening of society to the importance of environmentally correct disposal encompasses all segments of the population. Although plastic is a material widely used in everyday life, it represents one of the main contemporary environmental problems. Recycling, in contrast to simple disposal, emerges as a fundamental practice for environmental preservation. This article aims to identify how waste pickers, organized in an association, can contribute to minimizing the socio-environmental impacts caused by plastic packaging and, at the same time, be relevant agents in generating income for these workers. To this end, it is essential to analyze the characteristics of plastic packaging and its production process in order to understand its socio-environmental impacts, in addition to investigating the National Solid Waste Policy and its implications for the recycling scenario in Brazil. Methodologically, it is characterized as qualitative research, conducted through a case study with the Pinhais Recyclers Association (AREPI). Data collection was carried out through interviews using a semi-structured questionnaire applied to the members. The results indicate that the work of collectors is essential to reducing the amount of waste deposited in landfills, since they are part of a circular and sustainable economy, promoting the recycling of plastic packaging and simultaneously contributing to the creation of job opportunities and income generation.

**Keywords:** recycling, plastic packaging, association, recyclers, sustainable development objectives 6, 8 and 12.

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## RESUMO

O despertar da sociedade para a importância do descarte ambientalmente correto abrange todos os segmentos da população. Embora o plástico seja um material amplamente utilizado no cotidiano, ele representa um dos principais problemas ambientais contemporâneos. A reciclagem, em contraste com o simples descarte, surge como uma prática fundamental para a preservação ambiental. Este artigo tem como objetivo identificar de que forma os catadores, organizados em uma associação, podem contribuir para a minimização dos impactos socioambientais causados por embalagens plásticas e, ao mesmo tempo, serem agentes relevantes na geração de renda para esses trabalhadores. Para tanto, é essencial analisar as características das embalagens plásticas e seu processo de produção, a fim de compreender seus impactos socioambientais, além de investigar a Política Nacional de Resíduos Sólidos e suas implicações para o cenário de reciclagem no Brasil. Metodologicamente, se caracteriza como uma pesquisa qualitativa, conduzida por meio de um estudo de caso junto à Associação dos Recicladores de Pinhais (AREPI). A coleta de dados foi realizada por meio de entrevistas com o uso de um questionário semiestruturado aplicado aos associados. Os resultados indicam que a atuação dos catadores é imprescindível para a redução da quantidade de resíduos depositados em aterros sanitários, uma vez que eles estão inseridos em uma economia circular e sustentável, promovendo a reciclagem de embalagens plásticas e contribuindo, simultaneamente, para a criação de oportunidades de trabalho e geração de renda.

**Palavras-chave:** reciclagem, embalagens plásticas, associação, catadores, objetivos de desenvolvimento sustentável 6, 8 e 12.



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## INTRODUCTION

The lifestyle of contemporary society is driven by the excessive consumption of products with short life cycles, leading to higher levels of disposal of obsolete products as well as packaging, thus generating unsustainable amounts of municipal solid waste. Solving this problem requires appropriate technologies for waste treatment.

Recycling is the process of transforming a finished material that is no longer useful into a new product or a new raw material, thereby processing discarded waste and providing a solution and a new function for these materials. Recycling is a strategy applied to waste treatment, making it possible to reinsert raw materials into the productive cycle. The main advantages of recycling include the preservation of natural resources, energy savings, the generation of employment and income, and the extension of landfill lifespan (IBAM, 2001).

In Brazil, recycling is still very low. In 2023, the country reached 8% of total urban solid waste recycled through the work of informal waste pickers (ABREMA, 2024). To achieve more significant rates in this process, greater public awareness is needed to separate items that have recycling potential. The production of plastic packaging in Brazil, especially flexible packaging, is growing. In 2023, 2.224 million tons of packaging were produced, raising the sector's operational level for the year to 64% (Brazilian Packaging Association, ABRE, 2024).

The National Solid Waste Policy (PNRS), implemented on August 2, 2010, through Law No. 12,305, provides the legal basis, among other measures, for integrated solid waste management and handling (BRAZIL, 2010). Item IV of Article 8, Chapter III of the PNRS, which addresses its instruments, provides for the formation of waste pickers' associations, encouraging "the creation and development of cooperatives or other forms of association of collectors of reusable and recyclable materials" (BRAZIL, 2010).



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Waste pickers' associations are fundamental to the recycled materials production chain, contributing to the environment through the application of labor by carrying out the sorting and selection of recyclable waste for commercialization, thus generating work, income, and development for their members. An association can be defined as a collective of people, of a civil nature, not subject to receivership or bankruptcy, established to provide services to its members (CAZUMBÁ, 2016).

These associations constitute the link between the disposal of unusable materials and the recycling industry, being responsible for sorting waste by type, shape, color, material, among other characteristics, and thus enabling the commercialization of these items with companies in the sector in order to generate income for their workers.

The Association of Recyclers of Pinhais (AREPI) operates within this context, receiving materials collected in the city of Pinhais, in the state of Paraná, and sorting them for recycling so that they can be reintroduced into the economy, generating income for the people who work within the associative system.

Plastic packaging is diverse and represents a significant volume within the recyclable waste chain. It is of considerable value and is therefore very important for waste pickers' associations. At AREPI, for example, plastics rank second in volume, behind only paper and cardboard in terms of selected waste; however, when it comes to revenue, plastic waste ranks first, precisely because its market value is higher compared to waste derived from paper and cardboard.

Several factors contribute to environmental problems related to excessive consumption and improper disposal of plastic products. It is known that plastics take about 400 years to decompose naturally in the environment. In addition, more than 300 million tons of plastics are produced annually, and more than 13 million tons end up in the oceans, significantly harming marine life (MIRANDA, BRAND and COSTA, 2020).



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This article aims to identify how waste pickers, organized in an association, can contribute to minimizing the socio-environmental impacts caused by plastic packaging while simultaneously acting as relevant agents in income generation for these workers. From this perspective, it is evident that waste pickers' associations play a fundamental role in contemporary society, contributing to the development of associated workers and to the reduction of environmental impacts. Without the existence of these organizations, recycling rates in Brazil would be even lower.

## **THEORETICAL FRAMEWORK**

### *Waste management*

In the context of the disposal, collection, sorting, and recycling of plastic packaging, it is necessary to understand what Urban Solid Waste is. While a package fulfills its primary function of protecting a product, it is performing its duty; however, this package will not have a long lifespan in this primary function and will soon be destined to become waste - a good that has already fulfilled its purpose. At this post-consumption stage, if not reused, it will be considered waste.

The National Solid Waste Policy (2010) presents, in Article 3, item XVI, the following definition of Urban Solid Waste:

Material, substance, object, or good discarded as a result of human activities in society, for which final disposal is carried out, proposed, or required, in solid or semi-solid states, as well as gases contained in containers and liquids whose particularities make their discharge into the public sewage system or water bodies unfeasible, or require technically or economically unviable solutions in light of the best available technology.



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Waste consists of leftovers, scraps, trimmings, and residues generated from industrial processes, agricultural, commercial, hospital, urban cleaning, and household activities.

According to the e-Cycle portal, waste is “everything that remains from a given product, whether packaging, peel, or another part of the process, which can be reused or recycled.” These are materials that need to be sorted according to their composition and can still offer economic value, as they may be reused in some industrial activity or in a recycling process.

Law No. 12,305 of August 2, 2010, establishes the National Solid Waste Policy; amends Law No. 9,605 of February 12, 1998; and provides other measures (BRAZIL, 2010). According to Article 1 of Law No. 12,305:

[...] it establishes the National Solid Waste Policy, setting forth its principles, objectives, and instruments, as well as guidelines related to integrated solid waste management and handling, including hazardous waste, the responsibilities of generators and public authorities, and applicable economic instruments.

In Brazil, despite the existence of specific state and municipal laws, the National Solid Waste Policy represents progress and serves as a guide to determine and enable the implementation of the guidelines and rules it contains regarding waste management. According to Santaella et al. (2014, p. 88), the National Solid Waste Policy presents itself “as a guiding framework for States, the Federal District, and Municipalities, indicating paths toward environmental balance and a healthy quality of life with regard to solid waste.”

The National Solid Waste Policy presents a series of definitions, principles, objectives, and instruments that demonstrate and allow society to fully understand how essential and fundamental this law is in the management of solid waste, clearly identifying those responsible and involved in the entire solid waste management mechanism. As emphasized by Santaella et al. (2014):



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[...] the PNRS law defines the foundations for the creation of efficient public policies by the various spheres of government, as well as initiatives by Non-Governmental Organizations (NGOs) and companies, which are detailed in this Law.

Among the fifteen objectives listed in Law No. 12,305, Article 7, item VI stands out, which addresses the “promotion of the recycling industry, with a view to encouraging the use of raw materials and inputs derived from recyclable and recycled materials” (BRAZIL, 2010). Based on this objective, it can be considered that recycling has taken new directions, bringing greater economic opportunities and fostering a circular economy.

In this sense, the National Solid Waste Policy represents a significant advance in the management of urban solid waste, increasing the responsibility of companies and public authorities, and reducing the gap between product disposal and its collection after discard.

### *Plastics and packaging*

Plastic is a very useful material in modern life and is embedded in everyday society, being found in packaging, electronic devices, household appliances, toys, automotive parts, among many other objects. Its use in a wide variety of products is due to factors such as durability, ease of processing, and low energy consumption (ECYCLE, 2021). In 2021 alone, 373 million tons of plastics were produced worldwide (PERFIL, 2021).

In 2021 alone, 373 million tons of plastic were produced worldwide (PERFIL, 2021). By 2024, total global plastic production will reach 413.8 million tons. According to the United Nations Environment Programme (UNEP), this number could triple by 2060. Globally, 1 million plastic bottles are purchased every minute and up to 5 billion plastic bags are used annually. Another alarming statistic is that 36% of all manufactured plastic is destined for packaging



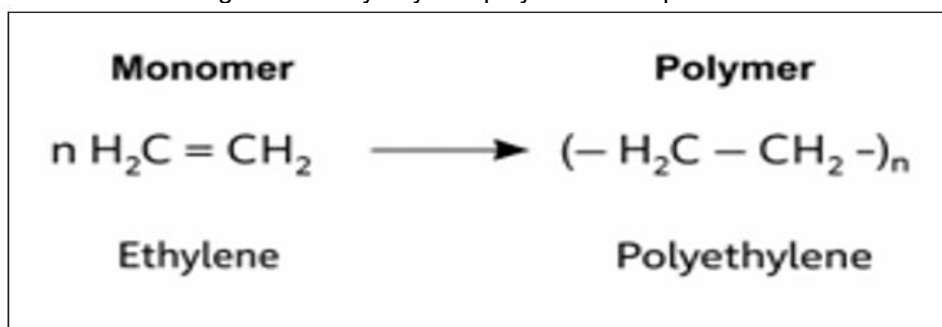
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production, and of that total, approximately 85% ends up discarded in landfills or as unregulated waste.

Plastic raw materials began to be conceived as early as the 19th century with the vulcanization of rubber and the creation of resin from cellulose, which was flexible and permeable to water. Between 1930 and 1950, polymerization was achieved - the polymer process derived from petroleum - and from then on plastic began to be industrially produced and consumed on a larger scale (PIATTI, RODRIGUES, 2005).

Polymers are macromolecules resulting from the joining of small molecules, known as monomers. "Polymerization is a chemical transformation in which small molecules, called monomers, join together to form giant molecules, macromolecules" (PIATTI, RODRIGUES, 2005). Monomers, in turn, are obtained from naphtha (a petroleum byproduct), which is subjected to a process called thermal cracking (heating in the presence of catalysts). This process gives rise to various monomers - substances that will form plastics - such as ethylene, propylene, butadiene, butene, and isobutylene, known as basic petrochemicals (PIATTI, RODRIGUES, 2005). The combination of many monomers forms polymers. Figure 1 represents a chemical polymerization process, in which several ethylene monomers are joined to form the polymer known as polyethylene.

Figure 1 – Polyethylene polymerization process.



Source: Adapted from Manual da Química: O que são polímeros? (2020).





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The transformation of polymers into plastic products occurs through mechanical processes that use specific equipment. The most common processes in these transformations are extrusion, blow molding, and injection molding; essentially, all of them require overheating so that the resin reaches fusion (softening) and can thus be transformed into the desired product (COLTRO; GARCIA, 2004).

Packaging is produced from various raw materials such as plastic, metal, paper and cardboard, glass, wood, and textiles; however, the most widely used raw material for packaging production is plastic resins (polymers), whether recycled or virgin. Plastic leads the packaging production sector.

Packaging produced from plastic resins is divided into rigid packaging, used to manufacture a wide variety of products such as containers, bottles, caps, jars, disposable utensils, and flexible packaging, which is commonly used to manufacture plastic bags, labels, plastic sacks, seals, adhesive labels, wrappers, sachets, and tubes (YUGUE, 2020).

Flexible packaging consists of plastics that can easily bend or fold and are widely used. They offer advantages precisely because they are moldable, adapting to the shape of the object they are meant to protect without losing their integrity, in addition to having low production costs.

Because they use a small amount of raw material and are easy to transport, flexible packaging can be found in cleaning and hygiene products, pharmaceuticals, construction materials, e-commerce, among others. However, the food industry is the largest user of flexible packaging, precisely because it offers food preservation properties, maintains freshness, facilitates storage and transportation, improves product presentation, and allows the display of nutritional information, among other benefits (YUGUE, 2020).



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Plastic has existed for just under 100 years; however, some plastic-derived materials take approximately 400 years to decompose naturally in the environment, as is the case with plastic bottles.

### *Plastic recycling*

Recycling is a term widely discussed around the world. Beginning in 1973, with the oil crisis, companies started to recognize that recycling could be strategic - something capable of triggering a positive revolution by reducing the complete dependence on new materials and making use of new sources of raw materials, in this case, recyclable ones. The economic gains were also considered significant, especially during a period of crisis. Berté and Filho (2009, p. 100) state that “countries and companies began to view recycling as a strategic initiative, gaining popularity mainly due to its economic aspect.”

Recycling gained prominence not because of environmental concerns, but for economic reasons. It was precisely during the oil crisis that the world felt the economic impact of rising oil barrel prices, and recycling became a consumption option, rather than a response to an ecological demand for environmental preservation.

Recycling represents the recovery of discarded goods and materials that may hold economic value and constitutes a process of transformation or reuse of a product - or part of it - that has been used and discarded and can be used again either in its original form or for another purpose (BERTÉ; FILHO, 2009).

According to the National Solid Waste Policy, Article 3, item XIV, recycling is defined as,

A process of transforming solid waste that involves changing its physical, physicochemical, or biological properties, with the aim of converting it into inputs or new products, in accordance with the conditions and standards established by the competent bodies of SISNAMA and, where applicable, SNVS and SUASA.



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According to the eCycle portal, recycling can be understood as “taking something that is no longer useful and transforming it back into raw material so that an item identical to or unrelated to the original can be formed.” Recycling is presented as a solution to contain, or at least reduce, the amount of materials that are discarded daily and accumulate in nature.

Plastic is one of the most widely used materials for packaging and, consequently, one of the most discarded. According to information from the Brazilian Association of the Plastic Industry (ABIPLAST), in 2024, 4.82 million tons of post-consumer plastic waste (domestic and non-domestic) were generated in Brazil. Of this total, the recycling industry consumed 1.55 million tons of plastic waste (including post-consumer and post-industrial) for reprocessing, an increase of 7.2% compared to 2023 (ABIPLAST, 2025).

Plastic waste can be recycled in several ways, as exemplified by Mano (2005): chemical recycling, energy recovery (energy recycling), mechanical recycling, and reuse. In waste pickers' associations, the selected plastic waste is sent to organizations that apply mechanical recycling, which involves washing, drying, grinding, and processing through extrusion (SANTOS et al., 2020). This process generates pellets (plastic in granular form suitable for industrial processes), which can be reused to produce new plastic products, thereby replacing virgin raw materials.

Gradually, plastic has gained prominence in debates on pollution and environmental preservation; however, the plastic industry remains highly relevant to the economy, comprising a total of 10,891 industries that employ 326,759 people. The sector also generated more jobs, reaching 20,043 direct jobs in 2024, a growth of 7.7% (Figure 1) (ABIPLAST, 2025).



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Figure 1 – Job and income generation in industry



Source: ABIPLAST, 2025.

In general, discarded plastic products mainly consist of disposable packaging such as bags, containers, cups, bottles, toys, etc., representing a significant volume. Their separation from other solid waste brings a series of benefits to society, such as extending landfill lifespan, generating employment, saving energy, as well as environmental preservation and the generation of income and work opportunities for waste pickers.

#### *Associations and waste pickers*

In waste collection systems, it is common to find waste pickers, who are urban workers and natural people under the law and who perform an essential function in the recycling chain. They are responsible for providing the labor necessary to enable the sorting and selection of waste, and they are usually organized into associations or cooperatives.

In this sense, it is important to define what associations are and their purpose within the recycling chain. Associations are organizations formed by people who come together in pursuit of the same objective and begin their activities without necessarily having established assets. An association is a legal entity registered at a civil registry office, freely formed by the union of two or more people (SEBRAE, 2017).



Also known as associativism, this is an important tool that enables a community or group of people to move out of anonymity and gain greater social, political, environmental, and economic visibility (SEBRAE, 2017). Thus, for waste pickers, associations serve to highlight the work of their members; by organizing their efforts collectively, they are able to achieve greater returns from the selected materials.

One of the main advantages an association can offer is the unity of its members, who come together and become a transformative force. In addition, other advantages can be identified, such as collective decision-making, dissemination of information to all members, cooperation and participation by everyone, and shared objectives, among others. On the other hand, duties such as active participation in tasks, political participation through leadership roles, and financial contributions for the maintenance of the association must be fulfilled by all members (SEBRAE, 2017).

There are some differences between associations and cooperatives. One of the main distinctions is the formation of the enterprise: to form an association, capital is not necessarily required, whereas to establish a cooperative, capital is essential. The registration of associations is simpler and less costly. Another distinction is that while cooperative members own the assets, association members do not have ownership of assets (SEBRAE, 2020).

Thus, it can be seen that associations are more accessible to waste pickers, precisely because their creation is simpler compared to cooperatives. They can generate results more quickly since they do not require initial capital. However, the main benefit that waste pickers can obtain from creating this type of organizational model is the visibility achieved through the organization of work, which results in greater bargaining power when selling the selected materials, especially because they are able to reach considerable volumes of recyclables.



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## METHODOLOGY

The research is classified as qualitative, as it is based on observations and the analysis of phenomena without concern for statistical treatment or sample representativeness (BIZERRIL; GASTAL, 2004). The approach of this study is exploratory, as it sought to gain a better understanding of the lived reality through fieldwork, including visits to the association for the application of a research questionnaire and interviews with the person in charge of the site, supported by semi-structured questionnaires.

This is a case study, defined as a “strategy chosen when examining contemporary events, especially when relevant behaviors cannot be manipulated” (YIN, 2001, p. 27). A case study is a research strategy that involves observing an individual unit; in this case, the investigation was conducted at the Association of Recyclers of Pinhais (AREPI), which serves as the object of study.

The decision to choose AREPI as the research site was due to the fact that one of the researchers was familiar with the work carried out by the Association, which is grounded in the mission of contributing to the environmentally appropriate destination of urban solid waste while generating income for its members.

Data collection consisted of bibliographic, documentary, and field research, carried out through on-site interviews, first with the person responsible for the Association and subsequently with other members. Of the 29 members working at the Association, eight were interviewed: four men aged between 25 and 60 years and four women aged between 26 and 59 years. All interviewees agreed to participate in the study and signed an informed consent form.

Using a semi-structured questionnaire, the purpose of the interviews was to gain knowledge about the Association, its processes, and the profile of its associated members.



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Data analysis for this project was carried out based on the content obtained from AREPI through visits and the application of questionnaires. The data contained in this study were analyzed using content analysis (BARDIN, 2016). Content analysis, which assumes the characteristics of a technical and systematic investigative procedure, followed the phases suggested by Bardin (2016).

Selection of the documentary sample (pre-analysis): this was the initial phase of the project, in which preliminary ideas were organized to ensure continuity of the research, and decisions were made regarding the object of investigation, as well as the scope and coverage of the proposed theme in order to align it with the study objectives.

Determination of units and analysis (material exploration): at this stage of the study, searches were conducted for legislation relevant to the area, as well as articles, dissertations, theses, and other studies published on specialized websites related to the research topic. Investigations were linked to themes such as recycling, plastic packaging, and waste pickers' associations, among others, always seeking to align the search with the research objectives.

Selection of categories and data organization (treatment of results, inference, and interpretation): based on the analysis of the consulted literature and the questionnaires administered at the Association of Recyclers of Pinhais (AREPI), this stage of the study highlights the interpretation of the data obtained and the need to relate them to the initial research proposal, so that the study follows a linear trajectory and reaches an appropriate final outcome.

In order to validate the evidence, the data analysis in this research was conducted through the cross-referencing of information obtained from bibliographic and documentary research (books, articles, laws) with the data collected in the field.



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## RESULTS AND DISCUSSION

After the theoretical and methodological paths have been covered, this section presents and examines the information collected from the Association of Recyclers of Pinhais (AREPI).

AREPI is part of the recycling chain and has contributed to the environmentally appropriate disposal of plastic packaging, as well as to the generation of local employment and income.

### *Characterization of the Association of Recyclers of Pinhais – AREPI and Its Members*

AREPI was founded by the Municipal Government of Pinhais, in the state of Paraná, on December 16, 2010. It is located at Rua Alto Paraná, 1765, adjacent to the organic waste transfer unit. Its objective is the social inclusion of waste pickers through the generation of work and income, focused on the socioeconomic and environmental sustainability of the local community.

AREPI is an independent, non-profit association with legal personality. All revenue generated from its activities is distributed as income among all its members, in equal shares.

AREPI operates from Monday to Friday, from 7:30 a.m. to 4:30 p.m., with a one-hour break for rest and meals for the members, and on Saturdays from 7:30 a.m. to 11:30 a.m., totaling 44 working hours per week, as stipulated by the Brazilian Consolidation of Labor Laws (CLT).

The Municipal Government of Pinhais maintains the collection service for recyclable waste separately from the collection of urban solid waste. Recyclable waste collection takes place twice a week, while the collection of other solid waste and rejects occurs three times a week, according to the neighborhood schedule.





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Both types of waste collection are carried out by the company Transresíduos Ambiental S/A.

The facility belongs to the municipality, which covers the costs of electricity, water, and telephone services, in addition to providing uniforms, boots, gloves, and other personal protective equipment (PPE). Other expenses such as food, cleaning materials, office supplies, fuel, among others, are covered by the association itself.

The association has the necessary equipment to carry out operational activities, including: a conveyor belt for material sorting; two presses used to compress and bale waste; two pallet jacks for moving the bales; two industrial scales used to weigh the bales; and a gas-powered forklift with a load capacity of 2.5 tons, used to move and load bales and other volumes. All of this equipment was donated by the Municipality. AREPI also has its own truck, with a load capacity of 5 tons, used to collect recyclable waste from partner companies; this vehicle was acquired with its own resources.

In addition to the operational infrastructure, AREPI has a room designated for administrative activities, as well as support spaces for its members, including bathrooms and changing rooms. AREPI also has its own kitchen, where meals are prepared daily for the workers.

Currently, 29 people work at the site, all as association members. Of these, 15 are men and 14 are women, aged between 25 and 60 years. They joined AREPI through referrals from the Social Assistance Reference Center (CRAS) of the municipality of Pinhais, as well as through recommendations from family members and colleagues who were already associated members. All members have some level of formal education; the lowest level achieved was completion of elementary school. None of the members have private health insurance; all rely on the Unified Health System (SUS). The workers are



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contributors to the National Social Security Institute (INSS), and the contributions are paid by AREPI and later deducted from each member's remuneration.

The members live close to the association, with some even being neighbors, while the vast majority live between 1 and 3 kilometers from the site. In general, turnover is low, and members rarely leave the association. Many have worked at AREPI for 10 years, and the most recent members have been part of the association for at least 2 years. Over the 12 years of AREPI's existence, some members have retired through contributions to the INSS.

When asked about their work at the association and whether they enjoy the daily tasks they perform, all respondents stated that they greatly enjoy working at AREPI. They report that the environment is excellent, with everyone helping and cooperating to carry out the work in a calm manner, even though it is manual labor that requires physical effort. The workers feel motivated and are fully aware of the positive impact they have on nature and the environment by reducing the amount of waste improperly discarded, as well as the volume sent to and deposited in sanitary landfills.

### *Characterization of the processes*

The Association's internal processes include: receipt of waste; sorting and selection of waste; dispatch and sales; administrative processes; and the identification of rejects.

These processes generally occur in the same way as in other associations with similar structures, involving task organization, division of activities, administrative controls, customer contact, among others. Among the processes mentioned, the one that stands out is the identification of rejects.

On a monthly basis, AREPI separates approximately 20 tons of waste that has no value for recycling. This includes organic waste such as food scraps and leftovers, garden trimmings, among others. It also includes contaminated



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recyclables such as disposable diapers, dirty and contaminated paper and plastics, adhesive tapes, etc. Among these residues, it is very common to find packaging produced from biaxially oriented polypropylene film (BOPP), which is widely used for food packaging.

According to the eCycle portal, “BOPP is the acronym for the English term biaxially oriented polypropylene, which refers to a polypropylene film,” commonly found as food packaging from a wide variety of sources. BOPP packaging is used to preserve the characteristics of snacks, cookies, chocolates, pasta, cereal bars, among many other products. It is lightweight and easy to print and laminate; however, it is difficult to recycle and therefore has no market value or acceptance for commercialization (ECYCLE, 2020).

These residues are separated from the others at the end of the conveyor belt and, because they are contaminated or have no recycling value, are quickly sent to the transfer sector adjacent to AREPI. From there, they are forwarded together with other urban solid waste to the regional sanitary landfill located in Fazenda Rio Grande, Paraná, managed by the company Estre Ambiental S/A. AREPI performs the containment of BOPP packaging but does not sort it precisely because there is no market for this product. As a result, this packaging is ultimately classified and disposed of as reject material.

#### *Destination of packaging and income generation*

Through the sorting and selection process, AREPI sells the waste to companies specialized in the recycling sector. There are different buyers for the selected waste, and for each type of material sorted there is a company qualified to purchase it. In sequence, the main organizations that acquire these materials are presented in Chart 1.



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Chart 1: Main customers who purchase materials from AREPI

| Firm                     | Material            |
|--------------------------|---------------------|
| Lagrisul Aparas de Papel | Paper and Cardboard |
| Herculano Ambiental      | Plastics            |
| Betifer Reciclagem       | Metals              |
| Recicladados Recitotal   | Glass               |
| Termotécnica             | Styrofoam           |

Source: The authors 2023.

Paper and cardboard are the types of waste with the largest quantities sorted and, consequently, are the most commercialized; however, their selling price is considered low compared to other materials. In March 2023, paper and cardboard were traded at R\$ 0.25 per kilogram.

Plastics rank second among the types of waste with the largest quantities sorted at AREPI; however, the selling price of plastics offsets the lower volume, as they are more highly valued compared to paper and cardboard. Table 1 shows the prices, by type of material/resin, negotiated in March 2023.

Table 2: Selling prices of plastic waste by type of material/resin.

| Material/description  | Price    |
|---|----------|
| Transparent PET (soft drink bottles)  | R\$ 2,90 |
| Blue PET (water bottles)  | R\$ 2,20 |
| Green PET (soft drink bottles)  | R\$ 2,20 |
| Oil PET (vegetable oil bottles)   | R\$ 1,25 |
| White HDPE (cleaning product packaging)   | R\$ 3,70 |
| Colored HDPE (bleach packaging)   | R\$ 2,70 |
| Black HDPE (lubricating oil gallons)  | R\$ 1,10 |
| LDPE (grocery bags and garbage bags)  | R\$ 0,40 |
| Transparent PP (cream cheese containers)  | R\$ 1,60 |
| White PP (margarine containers)   | R\$ 1,10 |
| Colored PP (ice cream containers, buckets, basins)  | R\$ 0,90 |
| PS (disposable cups)  | R\$ 0,95 |
| PVC (linings, pipes and other various parts)  | R\$ 0,40 |
| PP (bottle caps)  | R\$ 0,70 |
| LDPE (stretch film, bubble wrap)  | R\$ 1,50 |
| Others: vegetable crates, crates, plastic pallets, automotive and electronic parts, among others. | R\$ 4,75 |

Source: The authors, 2023.



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The presentation of Table 1 demonstrates the complexity of plastics in relation to other types of waste. Although they may appear similar or, in some cases, identical, they originate from different resins, applications, or processes. For this reason, they require separation and are negotiated at different prices.

One factor that illustrates this complexity is the reduction in price based on the color of the packaging. For example, white HDPE packaging has a higher value than colored HDPE packaging, which in turn achieves a higher negotiated price than black HDPE packaging. This is a common practice in the plastics sector, where resins that are light-colored or colorless are always more highly valued due to their ease of transformation into other products and different colors. If the resin is dark-colored, it does not have this ability to change color, which ultimately limits its application in various products.

Considering all these types of plastics and resins, AREPI produces approximately 40 tons of recyclable plastic waste per month. In some months of the year, the quantities fall below this amount, while in others they exceed it, causing monthly revenue from recyclable plastic waste to range from approximately R\$ 100,000.00 to R\$ 120,000.00. These values may vary not only due to the quantities and types of waste sorted, but also due to fluctuations in market prices for recyclable materials at the time of sale. Nevertheless, the revenue generated from the sale of plastic waste is higher than that from other waste streams, such as paper, metal, glass, or polystyrene. In other words, plastics are more highly valued. Thus, recyclable plastic waste is the main source of revenue for AREPI.

The revenue from waste materials - plastics, paper and cardboard, metals, glass, and polystyrene - is used to cover the association's expenses, such as fuel costs, internet services, food, social security contributions for members, as well as the payment of remuneration, among other expenses. The initial revenue amount, after deducting the association's costs, is divided equally



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among the 29 members, generating individual income. These earnings range from approximately R\$ 2,000.00 to R\$ 3,000.00 per month and may vary according to the factors mentioned above.

It can be concluded that the task of sorting recyclable plastic waste is fundamental to income generation for waste pickers, since plastic products are more highly valued compared to other recyclable materials. At the same time, this activity contributes to environmental protection by reducing the amount of plastic that could otherwise pollute and contaminate the environment.

## CONCLUSIONS

After completing all the necessary investigations, from the theoretical framework to the elements of field research, this article demonstrates the contribution to the recycling of plastic waste through a waste pickers' association, while also enabling the generation of local employment and income for its members.

Through this study, it was possible to establish a link between the National Solid Waste Policy and the Association of Recyclers of Pinhais, proving both the effectiveness of the law and the efficiency of the Association as an instrument of socioeconomic development.

Based on the analyses and field research, it was possible to observe the presence of contaminated and non-recyclable waste during the sorting and selection process, which is subsequently classified as reject material. It was also observed that plastic packaging produced from biaxially oriented polypropylene (BOPP) film, commonly used for food protection, is not selected because it has no commercial value, nor is there any company qualified to purchase this type of waste. As a result, it is considered to reject material and is sent to sanitary landfills together with other residual waste. This finding opens the way for further studies and research on this material.



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Daily, AREPI sorts of tons of waste that are sold to recycling companies, which transform them back into raw materials. Thus, it can be stated that AREPI has been fulfilling its two main objectives: the first related to the generation of work and income, providing socioeconomic development for its members; and the second related to environmental issues, ensuring the environmentally appropriate destination of recyclable materials and removing them from sanitary landfills and other inadequate final disposal methods for urban solid waste.

Plastic, due to its versatility and wide application, has become indispensable in modern society. However, the accelerated growth in the consumption of single-use plastic products, those discarded soon after consumption, brings socio-environmental impacts. The seriousness of this scenario is intensified by the fact that 98% of these single-use plastics originate from fossil fuels, which increases greenhouse gas emissions and directly contributes to the worsening of climate change, one of the greatest challenges faced by contemporary society.

Although the recycling rate of plastic waste is still small in Brazil, each initiative contributes to reducing the volume of waste destined for landfills, decreases pressure on natural resources, and mitigates negative environmental impacts. In addition, recycling promotes job and income generation, especially when carried out by associations of waste pickers, who play an essential role in the sustainable production chain.

Therefore, even if recycling is not enough to solve all the problems caused by the excessive use of plastics, it represents an important step in building a circular economy and in the search for more responsible and inclusive solutions for the future of the planet.



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