



National Solid Waste Policy Instruments and their implications for the infrastructure and operational conditions of recycling cooperatives in the city of Rio de Janeiro

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Authors' notes'

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Abstract

Objectives: The purpose of this study is to assess the impact of the National Policy on Solid Waste instruments – Selective Collection, Reverse Logistics System (RLS) and Sectoral Agreement (SA) – on the infrastructure and operating conditions of nine recycling cooperatives in the city of Rio de Janeiro in 2021.

Methodology: The data collection was conducted through interviews with waste pickers associations and by compiling a database – "Sectoral Agreement of Packaging Industry Map of Actions". There was also an analysis of the correlation between the average income with formalization time, number of members, source of materials and SA activities.

Relevance: The National Policy on Solid Waste (NPSW) recognizes the importance of waste pickers and ensures they are integrated in a shared responsibility model for the product life-cycle, by encouraging them to form cooperatives.

Results: Only three cooperatives took part in the RLS and issued invoices. Approximately half of the SA activities were allocated to a single cooperative, which was more profitable and had a better infrastructure. There was a moderate- to- strong correlation with four of the analyzed variables which meant that there was no standardized procedure for the allocation of investments to cooperatives, and this affected their productive capacity.

Contributions to management: When seeking to make the sector better, the SA must establish criteria to ensure the most precarious cooperatives are included so that their operational and general performance can be improved.

Keywords: waste pickers, selective collection, reverse logistics, cooperatives, sectoral agreement

Implicações dos instrumentos da Política Nacional de Resíduos Sólidos na infraestrutura e condições operacionais de cooperativas de reciclagem no município do Rio de Janeiro

Resumo





Objetivo: Avaliar o impacto dos instrumentos da PNRS – Coleta Seletiva, Sistema de Logística Reversa (SLR) e Acordo Setorial (AS) – na infraestrutura e condições de operação de nove cooperativas de reciclagem do município do Rio de Janeiro.

Metodologia: Foram realizadas entrevistas com as cooperativas para o levantamento da infraestrutura, dos procedimentos operacionais e do seu rendimento médio no ano de 2021. As ações desenvolvidas pelo Acordo Setorial de Embalagens em Geral foram tabuladas. A correlação entre rendimento médio com as variáveis tempo de formalização, número de cooperados(as), origem dos materiais e ações recebidas pelo AS foi analisada.

Relevância: A Política Nacional de Resíduos Sólidos (PNRS) reconhece a importância dos(as) catadores(as) e estabelece sua integração nas ações de responsabilidade compartilhada pelo ciclo de vida dos produtos, incentivando sua organização em cooperativas.

Resultados: Apenas três cooperativas participavam do SLR e emitiam nota fiscal. Aproximadamente metade das ações do AS de embalagens foram destinadas para uma cooperativa, que apresentou maior rendimento e melhor infraestrutura. Houve correlação moderada a forte com quatro das variáveis analisadas. Portanto, não houve padronização na destinação dos investimentos para as cooperativas, impactando a sua capacidade produtiva.

Contribuições para a gestão: Para o melhor desenvolvimento do setor se faz necessário que o AS estabeleça critérios no repasse de ações incluindo também as cooperativas mais precárias, a fim de melhorar a operação e rendimento geral das cooperativas.

Palavras-chave: catadores(as), coleta seletiva, logística reversa, cooperativas, acordo setorial

**Implicaciones de los instrumentos de la Política Nacional de Residuos Sólidos en la
infraestructura y condiciones operativas de las cooperativas de reciclaje en la ciudad de
Río de Janeiro**

Resumen





Objetivo: Evaluar el impacto de los instrumentos de la PNRS - Recogida selectiva, Sistema de Logística Inversa (SLR) y Acuerdo Sectorial (AS) - en la infraestructura y las condiciones de operación de nueve cooperativas de reciclaje en la ciudad de Río de Janeiro.

Metodología: Se realizaron encuestas con las cooperativas para saber sobre la infraestructura, los procedimientos operativos y sus ingresos en el año de 2021. Se tabularon las acciones desarrolladas por el Acuerdo Sectorial de Envases en General. Se analizó la correlación entre el ingreso con las variables tiempo de formalización, número de cooperativistas, origen de materiales y acciones recibidas por el AS.

Relevancia: La Política Nacional de Residuos Sólidos (PNRS) reconoce la importancia de los recicladores y establece su integración en acciones de responsabilidad compartida para el ciclo de vida de los productos, fomentando su organización en cooperativas.

Resultados: Sólo tres cooperativas participaron en el SLR y emitieron facturas. Casi la mitad de las acciones del AS de envasado se destinaron a una cooperativa, que presentó un mayor rendimiento y una mejor infraestructura. Hubo una correlación moderada a fuerte con cuatro de las variables analizadas. Por lo tanto, no hubo estandarización en la asignación de inversiones a las cooperativas, lo que afectó su capacidad productiva.

Aportaciones a la gestión: Para el mejor desarrollo del sector es necesario que el AS establezca criterios en la transferencia de acciones incluyendo también a las cooperativas más precarias, con el fin de mejorar el funcionamiento y el rendimiento general de las cooperativas.

Palabras Clave: colector de basuras, recogida selectiva, logística inversa, cooperativas, acuerdo sectorial

Introduction

Waste pickers play a crucial role in waste management. They collect, sort, and sell recyclable waste to industrial concerns (Silva et al., 2013; Pincelli et al., 2021). By working in



cooperatives, waste pickers are able to retrieve materials that would otherwise be rejected in the production cycle and this gives rise to a circular economy (Siman et al., 2020). Furthermore, waste pickers have significantly assisted in prolonging the useful life of landfills and reducing the demand for natural resources and raw materials in recycling sectors (Santos, 2022).

The National Policy on Solid Waste (NPSW) in Brazil, established in 2010, recognizes the importance of these workers and seeks to ensure "the integration of waste collectors of reusable and recyclable materials in actions of shared responsibility for the product life cycle". Additionally, it defines one of its main objectives as "the promotion of the implementation and development of cooperatives or other forms of association of waste collectors of reusable and recyclable materials" (Brazil, 2010, Art. 7 and 8; Piaia et al., 2019). The NPSW recommends that public authorities prioritize waste picker cooperatives in terms of providing incentive schemes and guaranteeing access to funding programs for the formation of an infrastructure and the purchase of necessary equipment (Magno et al., 2021). Despite this, waste pickers remain the most vulnerable link in the recycling production chain, and have a subordinate position in communal endeavors aimed at fostering a shared responsibility culture (Figueiredo and Bastos, 2021), even though they are responsible for collecting most of the recyclable materials (Pincelli et al., 2021).

Pisano et al. (2022) argue that there are many obstacles that prevent the objectives of the NPSW from being achieved, such as the lack of universal selective collection and reverse logistics, the low recovery rates of recyclable waste, and persistent problems in the management and sustainability of waste picker organizations. These drawbacks require a critical examination of the ideas put forward for improvement. However, the NPSW is widely recognized in Latin America and the Caribbean for its pioneering work to include waste pickers in selective collection and reverse logistics services (Bensen and Fracalanza, 2016; Pisano et al., 2022). The implementation of waste management practices in Brazil is a multifaceted task that must take into account social and economic factors, in addition to environmental concerns



(Fidelis et al., 2021). Van Elk & Boscov (2016) argue that Federal Law No. 12.305 (NPSW) has not yet been fully complied with and there is still much progress to be made.

In consumer societies, the rise of packaging in the market has led to the emergence of a group of workers known as waste pickers. These people are involved in the collection and sale of waste as a means of subsistence. However, those occupied in this task have to undergo unhealthy conditions and a lack of dignity (Silva, 2020). Waste collectors are agents of sustainability at the expense of unsustainability. The practice is occasionally carried out in unwholesome and hazardous circumstances, with a lack of personal protective equipment (PPE), and at clandestine disposal sites (Galon & Marziale, 2016). In these locations, these laborers diligently and perilously scavenge for recyclable materials mixed up with domestic, commercial, industrial, and medical refuse, amidst the presence of heavy machinery, vehicles, and disease-carrying fauna (Galon & Marziale, 2016; Piaia et al., 2019). The NPSW introduced regulations in 2014 to restrict the use of unsuitable final disposal sites such as controlled landfills and dumps, and thus raised the level of respectability and decency in this category (Piaia et al., 2019). Nevertheless, in 2021, around 39.5% of municipal solid waste was still being disposed of in unsuitable open dumps and controlled landfills (Brazilian Association of Public Cleaning and Special Waste Companies [ABRELPE, 2022]).

This article discusses the implementation of the National Policy on Solid Waste, in particular, the impact of its instruments (selective collection, sectoral agreements, and reverse logistics) on the infrastructure and operational conditions of recycling cooperatives in Rio de Janeiro, more precisely, during the challenging year of 2021, when the country faced the COVID-19 pandemic. The aim has been to establish a correlation between a range of variables and improvements in the performance and operational infrastructure of waste picker cooperatives in Rio de Janeiro, by means of semi-structured interviews. The chosen variables comprise the following: formalization time, number of workers, sources of waste, involvement in reverse logistics systems, collection vehicles, types of material processing, and work tools. It





was expected that, a decade after the implementation of the National Policy on Solid Waste (NPSW) and five years after the enactment of the Sectoral Agreement on Reverse Logistics of Packaging in Brazil, the infrastructure and performance of the cooperatives would have improved.

Benefits of NPSW instruments for recycling cooperatives

Waste picker associations and cooperatives are usually involved in a selective collection of a higher standard which is carried out, in a structured manner, and with enhanced dignity as a part of a social and solidarity economy (SSE). Cooperatives usually provide more employment opportunities and higher income than self-employed waste pickers (Piaia et al., 2019; Magno et al., 2021). The 2023 Ciclosort sample, which was based on a survey conducted in 232 municipalities of door-to-door collection which they or related agents carried out, found that 63.8% of municipalities have formed partnerships with waste picker organizations that offer municipal selective collection services (CEMPRE, 2023).

Although the cooperatives are based on the principles of cooperation and solidarity, Baptista (2014) points out that they are a part of a scenario in which inequalities prevail in the most diverse areas (economic, social, political, and institutional) and this has an impact on the form of association between cooperative members and cooperatives. In view of the fact that solidarity economy initiatives must strike a balance between the economic, social, and political domains, the pressures of the market and the loss of solidarity can make them similar to a conventional corporation (Baptista, 2014; Silva S., 2020). Although cooperatives have to face various problems, according to Silva S. (2020), they still represent "the first step towards breaking away from the individualized way of working in the streets and garbage dumps". The formation of cooperatives makes it possible to trade in larger amounts in goods of a higher standard and to sell directly to recyclers. Cooperatives also enable ties to be



established with public authorities and other agents, which is important when releasing a tender for administrative concession of physical space and applying for funding (Silva S., 2020).

In Articles 18, 19, 33, 36, 42, and 44 of its text, the NPSW laid down the grounds for supporting recycling cooperatives (Brasil, 2010). Article 18 states that municipalities that implement selective waste collection systems with the participation of cooperatives formed by low-income groups, should have priority for federal funding. Article 19 stipulates that municipal plans for integrated solid waste management in all towns and cities should include programs and actions that encourage the participation of interested groups, particularly cooperatives or other associations of waste pickers comprising people of low-income (Brazil, 2010).

In Art. 42, the NPSW determines that the government has the authority to prioritize incentive measures and funding schemes for the "implementation of physical infrastructure and acquisition of equipment for cooperatives or other forms of association of collectors of reusable and recyclable materials formed by low-income groups" (Brazil, 2010). In Article 44, municipalities may impose regulations that offer tax breaks, financial support, and credit incentives for "projects involving a shared responsibility for the product life cycle, mainly through partnerships with cooperatives or other forms of association of collectors of reusable and recyclable materials comprising low-income groups" (Brazil, 2010). The holder of the public services for urban cleaning and waste management must also give priority to the hiring of cooperatives formed of low-income groups, to secure a selective collection service without the need for a bidding and tendering process (Brazil, 2010, art. 36).

According to the Brazilian National System for Water and Sanitation Data (SNIS) in 2021, there was a potential for around 25 to 30% of recyclable municipal waste to be recovered. However, only a small percentage, more precisely 5.4 to 6.4%, was actually recovered in 2020 (SNIS, 2021). Hence, the universalization of recycling services has the potential to significantly increase the income generation of waste pickers. Brazil experiences an annual financial loss amounting to R\$ 14 billion as a result of unsuitable trash recycling practices (ABRELPE, 2020).





In 2021, 75.1% of Brazilian municipalities stated they had selective collection initiatives, but these initiatives do not represent a consolidated, robust, and concrete system that maximizes the potential of the activity (ABRELPE, 2022).

An important NPSW instrument for scavengers is reverse logistics. Manufacturers, importers, distributors, and traders must devise and implement reverse logistics systems (extended to post-consumer products and their packaging) (Brasil, 2010; Rebehy et al., 2019). However, on the basis of the concept of shared responsibility, other stakeholders, such as waste collectors, should be involved in this process (Rebehy et al., 2019). Unlike systems that rely on Extended Producer Responsibility (EPR), the shared responsibility model results in inefficient reverse logistics. This is because the various actors involved have diverse interests and perspectives (Guarnieri et al., 2016; Leite, 2017; Rebehy et al., 2019; van Elk et al., 2023).

In light of this, the regulatory requirements for Reverse Logistics in Brazil have been revised with the enactment of the most recent legislation, in particular Federal Decree No. 11,044/2022 (Brazil, 2022), which has been revoked by Federal Decree No. 11,413/2023 (Brazil, 2023). This incorporates three distinct certificates: the Reverse Logistics Recycling Credit Certificate, the Certificate of Structuring and Recycling of Packaging in General, and the Future Mass Credit Certificate. In addition, Federal Decree No. 10,936/2022 (Brazil, 2022a) is a new regulatory requirement for the NPSW (Pinto, 2023). As a result of this updated legislation, cooperatives have the authority to issue and sell these certificates, which are acquired by companies that want to prove that the equivalent mass of products and/or packaging is returned to the production cycle.

Partnerships between the industrial sector and waste pickers play a role in promoting the socio-economic integration of waste pickers (Environmental Exchange of Rio de Janeiro [BVRIO], 2017; van Elk et al., 2021). Regulations, sector-specific agreements, and commitment terms are required to ensure these partnerships are effective (Brazil, 2010; Brazil, 2022; Brazil, 2023).



Currently, the most important regulatory standard related to general packaging reverse logistics and cooperatives, is the 'Brazilian Sectoral Agreement for the implementation of reverse logistics of general packaging' (Ministry of the Environment [MMA], 2015; Guarnieri et al., 2020; van Elk et al., 2021). The rules were endorsed by a wide-ranging and extensive coalition of firms, that included packaging manufacturers and importers, manufacturers and importers of disposable products, as well as distributors and traders of disposable products (Silva L., 2020). Packaging manufacturers are obliged to purchase directly the materials collected by the cooperatives through intermediaries (middlemen) or recyclers. The manufacturers of disposable products must allocate resources for the development of infrastructure, training and tools for the cooperatives. Essentially, this agreement offers direct advantages to the cooperatives (MMA, 2015; van Elk et al., 2021). The agreement was structured into two distinct stages of execution: Phase 1, which took place from 2012 to 2017, and Phase 2 started in 2020 and was scheduled to conclude by the end of 2022. The years 2018 and 2019 constituted the timeframe between the phases (van Elk et al., 2021).

Selective collection in the municipality of Rio de Janeiro

Rio de Janeiro sends an average of 8,822 tons per day to municipal reception sites, of which 19,345 tons per year are recyclable waste (Rio City Hall, 2021). The main selective collection model for recyclable household waste is door-to-door collection, which is carried out in 122 of the city's 160 neighborhoods.

After the collection phase, the material is sent to the 25 cooperatives and associations of waste pickers registered with the Urban Cleaning Company of the City of Rio de Janeiro (COMLURB) for sorting. Two of these cooperatives are sorting centers: one in the neighborhood of Irajá and the other in Bangu. After waste reaches the cooperatives, it is distributed free of charge to the waste pickers and is often an assortment of mixed items, although it comes from selective collection. In the cooperatives, the recyclable materials are sorted and undergo processes such as pressing and baling. After these stages, the waste is sold to provide an



income for the waste pickers (Rio City Hall, 2021). Before the waste reaches the recycling industry, it is sold to intermediaries who fix the purchase price of the materials, and only after this stage does it actually reach its final destination.

Federal Decree No. 5,940/2006 was an important measure for increasing the income of waste pickers, since it led to the separation of recyclable waste by federal public institutions and its mandatory destination to cooperatives, as part of the Solidary Selective Collection Program (Brazil, 2006). Decree 5.940/2006 was one of the pioneering public policy initiatives for the inclusion of waste pickers, since it required the public administration to set an example with regard to the proper destination for waste (Oliveira, 2018). In Rio de Janeiro, the Municipal Solidary Selective Collection Program was established by Municipal Decree 30.624/2009 (Rio de Janeiro, 2009).

In 2022, a new decree regulating the NPSW, Federal Decree No. 10,936/2022, was issued to improve its provisions and ensure its more effective implementation. One of the consequences of the new regulation has been the revocation of Decree No. 5,940/2006, with the exclusion of the "Solidarity Selective Collection Program" and its replacement by the "Citizen Selective Collection Program" (Brasil, 2022). The Citizen Selective Collection Program requires public entities to continue separating recyclable material and sending it to cooperatives. However, cooperatives will be able to collect this waste if they meet the following requirements: i) being "formally constituted by collectors of reusable and recyclable materials", ii) having the right facilities for sorting and classifying waste, iii) having an allocation system among cooperative members, and iv) being registered and accredited in the National Information System on Solid Waste Management (SINIR) (Brazil, 2022).

Methodology

Characterization of the survey and sample





This research adopts a qualitative-quantitative approach and includes a multiple case study, as more than one waste picker cooperative was involved. The techniques relied on in this case study were questionnaires, interviews, audio recordings and photographic records. The empirical research was conducted through phone calls, WhatsApp messages, and field visits to 9 cooperatives between September 2 and 15, 2021, without prior testing. As this was during the pandemic period, most of the interviews were conducted by phone. Photographic and audio recordings of the interviews were carried out in the cooperatives that could be visited. An attempt was made to contact all 25 cooperatives registered with COMLURB, but it was not possible to contact all of them for a number of reasons. These included the following: a) changes in the telephone numbers of the cooperatives, b) the impossibility of conducting the interview by technological means or by telephone, c) a refusal of the respondents to take part in this research. All the interviewees were managers of the cooperatives. Table 1 shows the time period of the interviews and the cooperatives interviewed.

Table 1

Dates and methods used to interview the sampled cooperatives

Cooperatives	Neighborhood	Interview type	Date
A	Campo Grande	Phone	09/02/2021
B	Campo Grande	Phone	09/03/2021
C	Maria da Graça	In-person	09/06/2021
D	Benfica	In-person	09/09/2021
E	Ilha do Governador	Phone	09/13/2021
F	Vargem Pequena	Phone	09/13/2021
G	Pavuna	Phone	09/13/2021
H	Paciência	Phone	09/14/2021
I	Bangu	Phone	09/15/2021

Source: Silva, 2022





The hypothesis that the NPSW instruments led to improvements in the infrastructure and an increase in the income of the cooperatives in 2021, was tested by selecting the following variables for assessment: number of cooperative members, the time the cooperative was founded, the number of processing activities and electrical appliances used in the process, the range of material sources, and the number of actions from the sectoral agreement.

Characterization of the study area

The study was conducted in the municipality of Rio de Janeiro, which has an area of 1,200,329 km², with an estimated population of 6,775,561 in 2021 and a population density of 5,265.82 inhabitants/km² (Brazilian Institute of Geography and Statistics [IBGE], n.d.). It borders on the municipalities of Itaguaí, Nova Iguaçu, São João de Meriti, Mesquita, Nilópolis and Duque de Caxias. In 2020, the average monthly income was 4.0 minimum wages per person (R\$ 4,400 or U\$S 789), with 31.4% of the population earning up to half a minimum wage. In addition, 94.4% of households had basic sanitation, 70.5% of urban households had public streets with trees, and 78.4% had urban facilities (e.g. presence of culverts, sidewalks, paving, and curbs) (IBGE, n.d.).

Data Analysis and Collection

The interviewees selected were cooperative members who held leadership positions, such as president or technical director. They were contacted by phone and asked to take part in the interviews. At the time of contact, they were told about the general objectives and main topics of the interview and a date and time for this was agreed upon. The interviews were conducted by phone and recorded by means of the voice recorder application and later transcribed. Prior to the interview, the interviewee signed or recorded an Informed Consent Form (ICF) that described the data, the risks and benefits of the research, and ensured the identity of the interviewee and the cooperatives would be kept confidential, as well as the use of the data for technical and academic publications. Before conducting the interviews, the project



was submitted to the Ethics Committee of the State University of Rio de Janeiro and was approved under Registration No. 5.060.829.

The text of the interview included questions on the following topics: a) improvements to the cooperative resulting from the packaging sectoral agreement; b) the incomes of cooperative members in 2019 and 2021, in light of the adverse effects of the pandemic; c) material sources - COMLURB, companies or households; d) material processing activities and infrastructural facilities; e) participation of the cooperative in a reverse logistics system.

Possible answer categories were formed in advance, for the analysis of the results of the interviews in order to guide the research and to allow the answers to be examined in standardized categories for purposes of comparison between the cooperatives. The data were summarized and analyzed with the aid of descriptive statistical tools (minimum, maximum and average) and displayed in graphs.

The activities carried out as a part of the Packaging Sector Agreement, which made improvements to the infrastructure and operations of the cooperatives, were obtained on the institutional website - Coalizão Embalagens (Sistema Coalizão Embalagens, 2023). The names of the cooperatives were identified and the activities were categorized as shown in Table 2, as well as being arranged in graphs.



Table 2

Types of sectoral agreement activities that target cooperatives

ACTION	SUBTYPE	Specification
Infrastructure and operational improvements	Equipment or tools	Big Bag Personal Protective Equipment (PPE) Picking Carts Containers Work Tables Sorting Tables Barrels Pallet Carts
	Machines	Bale Elevator Hydraulic Press Scales Stacker Conveyor
	Operation	Improvements in the Electrical system Improving the Shed and strengthening the structure Improving Hygiene and the sanitary system Operational costs Improvements in production and the sorting process Improving the roof
Institutional training	Advice	Management of non-conformities Environmental non-conformities Dealing with non-conformities Permanent management of advisory practices Formation of associative or cooperative groups

Continued on the next page





Operational training	Process	Production process training and improvement Shed operation Separation/sorting process Valuing and classifying materials Supply of training kits and resources
Technical diagnosis	Technical diagnosis	Demand for an improved infrastructure
Advice about Indicator management	Advice about Indicator management	Advice to plan indicators
Operational support for the Covid pandemic	Equipment /Tools	Donation of cleaning/hygiene materials

Source: Map of Actions (Coalizão Embalagens System, 2023)

Finally, there was assessment of the correlation between the average income of the cooperative members (dependent variables) and each independent variable. The following independent variables were selected: a) number of cooperative members, b) foundation time (registration of Tax Identification Number), c) number of processing activities, d) number of different electrical tools/devices used in the process, e) number of PPEs used in the process, f) number of material sources, and g) number of measures taken by the Packaging Sectoral Agreement. These independent variables were selected to assess how much the average income could be related to infrastructure, operating conditions, foundation time and number of members. The linear correlation analysis was conducted in the Excel® program, by means of the “Data Analysis” tool.

Results and Discussion

Foundation time and number of cooperative members

The cooperatives that have been registered with a tax identification number have been classified as "formalized". Table 3 shows the year of formalization of the cooperatives studied. Five cooperatives had been formalized between 0 and 9 years until 2021, while four





cooperatives had been formalized between 10 and 20 years. The average formalization time was 9 years and 3 months. The minimum time was 4 years, and the maximum formalization time was 17 years.

In terms of the number of active members, cooperative C was the most numerous. In 2021, this organization had 81 members, a much higher number than other Brazilian cooperatives. The average number of members in the cooperatives sampled was 21. This number of cooperative members is lower than the average number of associates in cooperatives in Brazil (37 people) and in the South-East region (29 cooperative members) (The National Association of Waste pickers [ANCAT] & Instituto Pragma, 2021). Some of these cooperatives reported a significant decline in membership as a result of the pandemic.

Table 3

Year of registration of the sample cooperatives

Cooperatives	Year of registration	Number of members
A	2013	7
B	2005	20
C	2005	81
D	2017	19
E	2007	12
F	2014	11
G	2015	7
H	2014	5
I	2014	41

Source: Research data



In the municipalities of São Paulo and Belo Horizonte, the first recycling cooperatives were established between 1988 and 1993 (Silva, 2017). In Rio de Janeiro, the first initiatives to promote the formation of cooperatives emerged during ECO-92. At that time, COMLURB carried out a project called the Program for the Formation of Waste Pickers Cooperatives, which was designed to formalize the work of approximately 2,000 people who collected waste on the streets. Since most of the autonomous waste pickers were homeless, in 1993 and 1994, there was a focus on turning areas under viaducts into recycling spaces (Romani, 2004). None of the cooperatives in this study were among the pioneering projects in the municipality, and their formalization occurred nine years after the first activities recorded by Romani (2004). However, Cooperative C was one of the two cooperatives that had the longest periods of formalization and the best infrastructural and, operating, performance.

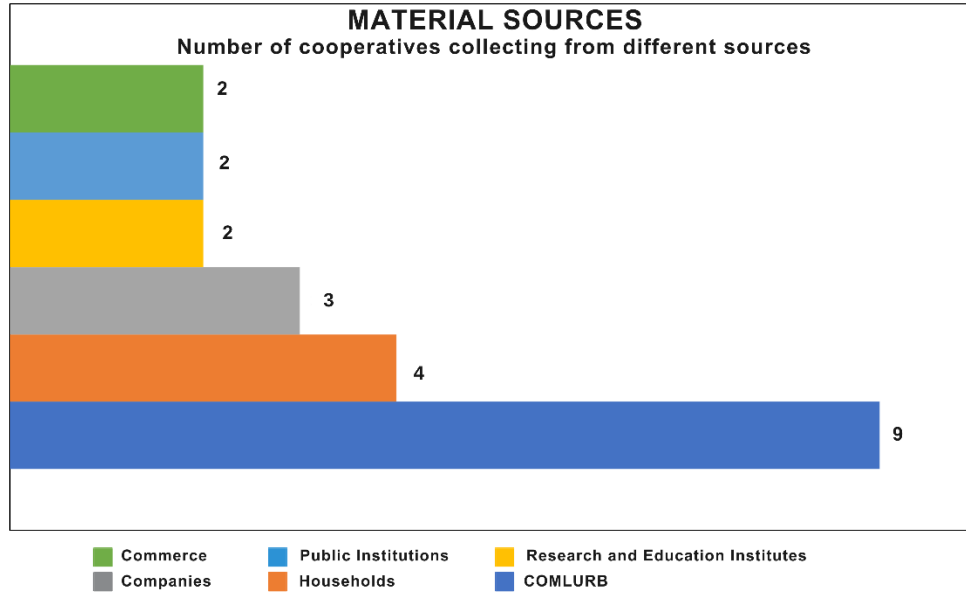
Material sources in the cooperatives

The interviews showed that COMLURB was the main supplier of recyclable materials for the cooperatives, as shown in Figure 1. All the cooperatives are registered with COMLURB and thus are sent waste from the municipal selective collection.

Five cooperatives (A, E, G, H and I) only receive waste from COMLURB. One cooperative (F) received materials from three different sources (COMLURB, households and companies). Cooperatives B and D received materials from four or five different sources, including COMLURB, households, companies, commerce, educational and/or public institutions, while Cooperative C received materials from six different sources.

Figure 1

Number of cooperatives for different material sources



Source: Research data.

According to the Brazilian Yearbook of Recycling 2021, 43% of cooperatives stated that they only had one source of waste. The fact that the material of COMLURB was destined to cooperatives was a certain advantage during the acute phase of the pandemic. However, dependence on a single source increases the vulnerability of these associations, as is also highlighted by ANCAT and Instituto Pragma (2021). During the pandemic, there was a significant decrease in the number of COMLURB trucks arriving at the cooperatives (Henrique & Mattos, 2020; Prefeitura da Cidade do Rio de Janeiro, 2020). In addition, the quality and quantity of the materials collected declined, which reduced the sale value of the waste and the average income of the cooperative members.

In Rio de Janeiro, intermediary trucks often pass through the streets and neighborhoods before the COMLURB truck arrives. Many of these intermediary trucks first contact the building staff and residents, who separate the materials for collection. One of these trucks is the famous



"junkyard car" that drives through the streets collecting scrap metal. One of the most common materials collected by these trucks is drink cans, which have the highest market value. In the same places, autonomous collectors also walk around and open up plastic bags to "mine" the most valuable materials. All these parallel activities affect the income of the cooperatives and complicate their dependence on COMLURB materials. As Zon et al. (2020) point out, Brazilian municipalities face many difficulties in implementing selective collection, while waste picker associations also face many challenges when competing in the waste management market.

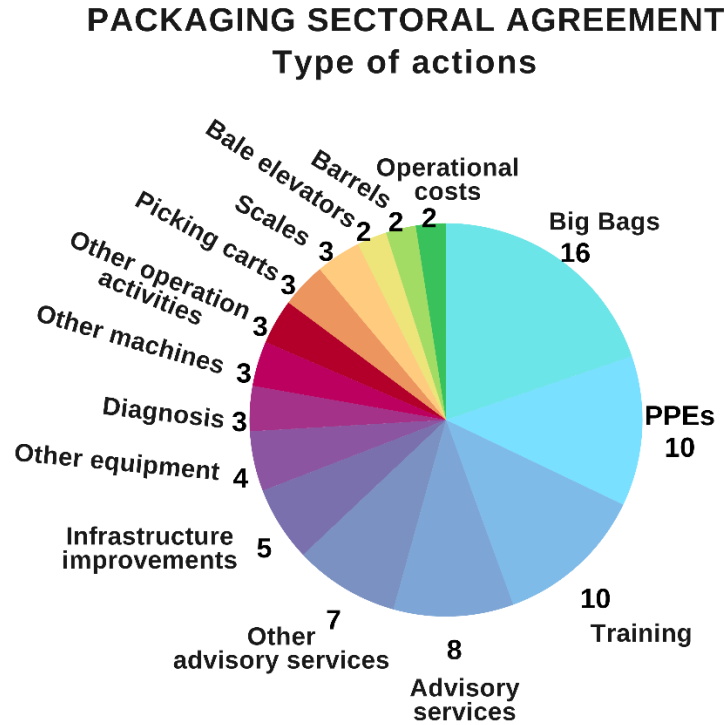
Reverse Logistics Systems and Sectoral Agreement Activities

Reverse logistics is an important tool for recycling in Brazil, and participating in reverse logistics systems (RLS) is a means of enabling cooperatives to increase their income. Three of the cooperatives interviewed agreed to take part in the RLS and issue invoices. The RLS programs mentioned in the interviews were ABIHPEC, UNILEVER, Natura, 3 Corações and ANCAT. In a study with cooperatives in the city of São Paulo, between 15 and 21 cooperatives stated that they were involved in RLS programs, and the ABIHPEC and ANCAT programs were mentioned. The cooperatives recorded a rise in earnings and an improvement in the ergonomic processes, but the positive effects were considered to be small (Perônico, 2021).

Figure 2 shows the number of activities directed to the cooperatives as a result of the Sectoral Agreement of Packaging.

Figure 2

Activities arising from the Sectoral Agreement of Packaging



Source: Research data

Figure 2 shows that most of the items supplied under the terms of the sectoral agreement, consisted of big bags and personal protective equipment (PPE). Elevators, barrels, scales and picking carts were distributed in smaller amounts. There were 25 activities related to training and advisory services, mostly aimed at Cooperative C. However, the terms of the sectoral agreement was insufficient to bring about better conditions for cooperatives. In addition, there were great differences in the number of activities carried out for the recycling cooperatives in this study. Some cooperatives received a large number of targeted activities and were "privileged" and other cooperatives undertook a very few or none at all.

Cooperatives have to be supported so that they can compete with recycling centers and earn a reasonable income. This includes targeted action plans to distribute electrical equipment

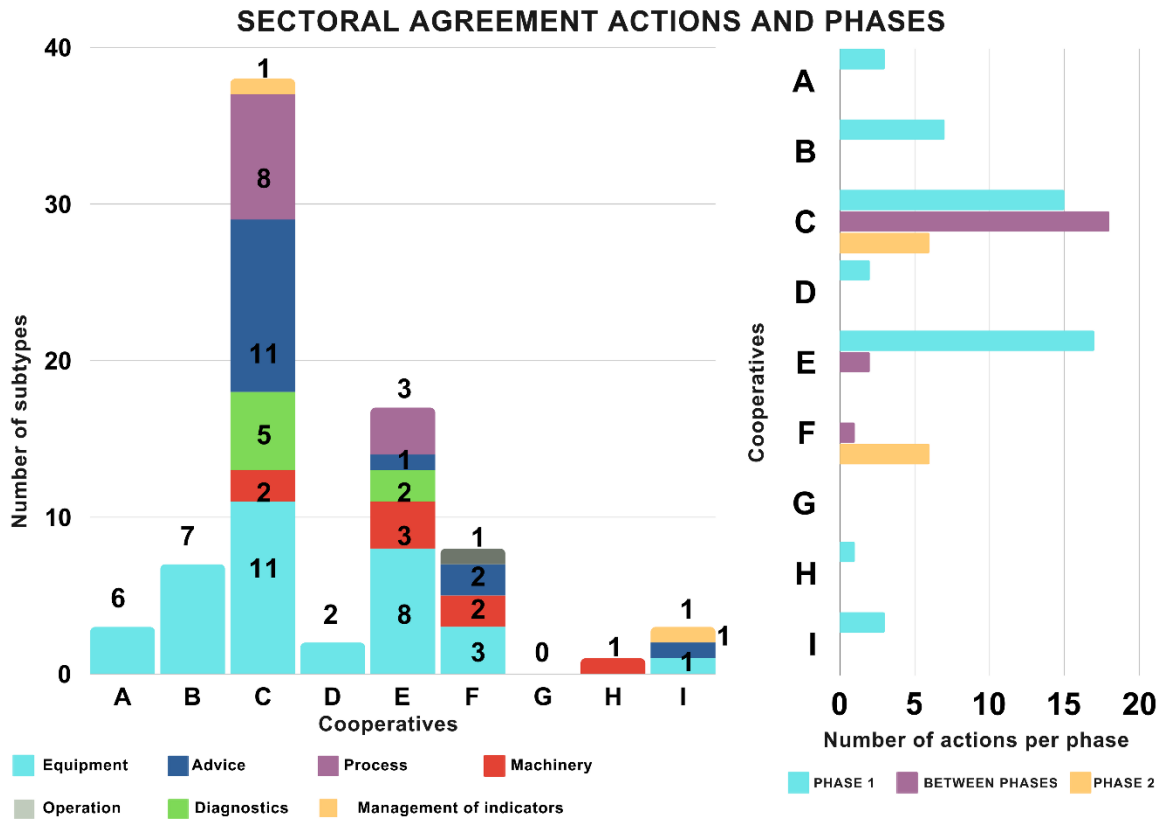


such as presses, scales, conveyors and paper shredders, as well as training and technical advice to improve their spatial, ergonomic and financial organization. As Pisano et al. (2022) rightly point out, the actions of the Sectoral Agreement should improve the efficiency of the sorting, processing and marketing processes in the cooperatives. Participants in the Sectoral Agreement rely on the collection system and sorting procedures provided by the municipalities and cooperatives, but do not offer a substantial counterpart, such as the provision of sheds and operational costs (Rohrich, 2022). The main sectoral agreement investments in Phase 1 (78%) were concentrated on the recycling park, with a small share going to the cooperatives (Rohrich, 2022). These investments benefited the small private recycling centers and scrap merchants.

Figure 3 shows the number of subtypes of activities carried out by the Packaging Sector Agreement. These subtypes included equipment, advice, processes, machinery, operations, diagnostics and indicators of effective management - per cooperative. Additionally, Figure 3 also shows the number of actions per phase (Phase 1 - 2012 to 2017; Between phases - 2018 and 2019; Phase 2 - 2020 to 2023) for each of the cooperatives.

Figure 3

Action subtypes and related sectoral agreement phases by cooperative



Source: Research data

The number of sectoral agreement support activities ranged from 0 (Cooperative G) to 39 (Cooperative C). The average number of activities per cooperative was nine. About 50% of the aid was concentrated on a single cooperative (Cooperative C). Cooperative E was the second to receive the most support from the agreement (19). All the other seven cooperatives received between 0 and 7 support activities. At the same time, the activities of the sectoral agreement were concentrated on Phase 1 and decreased in the other phases. Of the nine cooperatives, six received some activities in Phase 1, from 2012 to 2017 (Figure 3). The data shows that the support was not constant. Some cooperatives went years without receiving any support.



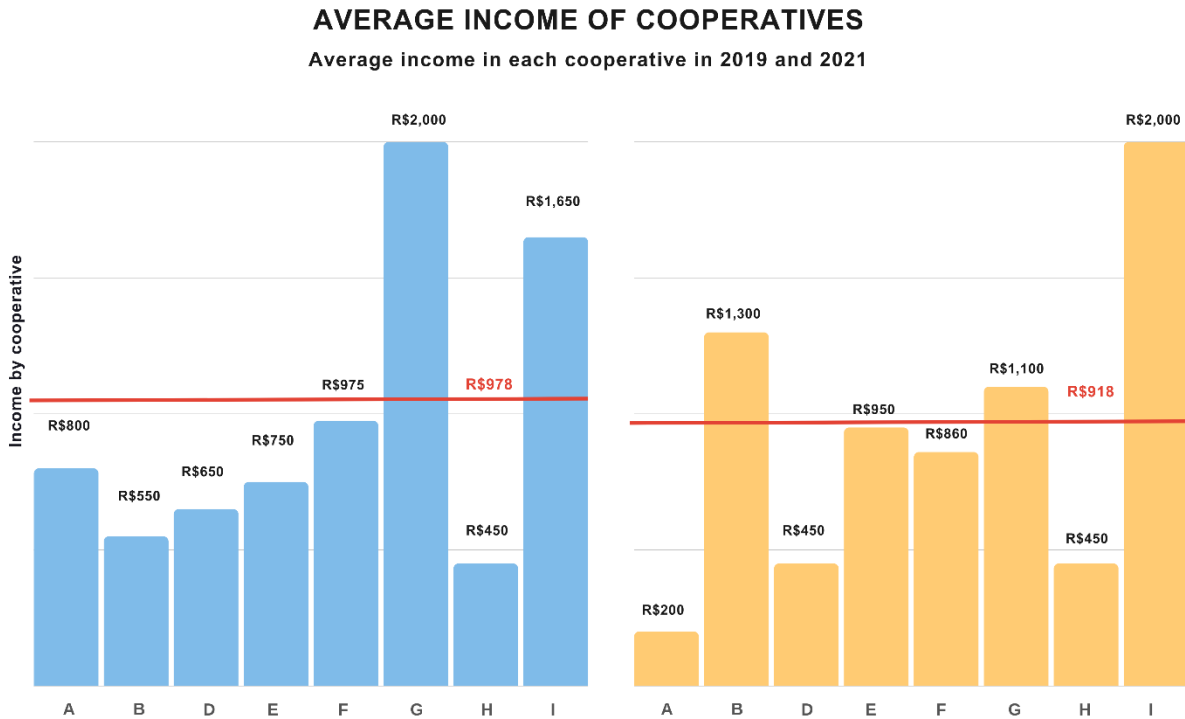
Regarding to machinery and electrical appliances, Cooperative C received a bale elevator, and a scale, Cooperative E received a scale, a pallet cart, and a stacker, and Cooperative F received a scale, a bale elevator, and a press. Cooperative H received only one item in Phase 1 of the Sectoral Agreement, which was a scale. Few cooperatives received machinery and electrical equipment (Figure 3). Thus, a higher number of activities from the sectoral agreement could help to improve the infrastructure and maintain the the cooperative equipment in a good condition.

Income of the cooperatives

The average value of the cooperative members' dividends was around R\$1,301.00 in the pandemic year of 2021, while in 2019, before the pandemic, it was R\$1,053.00. Both amounts were higher than the minimum wage for the respective years 2019 (R\$998.00) and 2021 (R\$1,100.00), or in other words, an increase of 6% and 18% respectively. However, this increase in average income can be attributed to Cooperative C. If this cooperative is removed, the average income fell below the minimum wage in both 2019 and 2021, as shown in Figure 4, which compares the income of the cooperatives' income between 2019 and 2021, without Cooperative C.

Figure 4

Average income of cooperative members (without Cooperative C)



Source: Research Data

In Figure 4, four cooperatives showed an increase in income, which can be explained by the rise in the price of recyclable materials for sale, such as cardboard and aluminum, during the pandemic (ANCAT & Instituto Pragma, 2021). The three cooperatives whose income declined or remained the same in 2021 (A, G and H) only received waste from COMLURB and stated there was a reduction in the amount of material they received during the period of the survey. In two cooperatives (C and I) there was an increase of above 100% among those that experienced a rise in income. As can be seen, Cooperative C has a large number of members and varied sources of materials. On the other hand, although Cooperative I only receives material from COMLURB, it had a greater working capacity because of its large number of members (30). The other two cooperatives had an increase of around 25%. Of the cooperatives



that experienced a decrease in income, one reduced its income by 75%, and recorded an average income of R\$ 200.00 (Figure 4).

Vehicles for collection

Five cooperatives stated that they did not have a vehicle for waste collection and depended exclusively on the arrival of materials at the cooperative. Four cooperatives said that they had trucks. During the interviews, the "we don't have a truck" respondents explained that they could not afford to buy vehicles for external collection. Some cooperatives said that the Brazilian National Bank for Social and Economic Development (BNDES) once offered them a loan to buy vehicles. However, according to the interviewees, this BNDES payment never reached the cooperatives.

With regard to the waste left at the cooperative facilities, the respondents mentioned another drawback which is that people think that the cooperatives have to pay for the materials provided. This attitude arises from ignorance of the socio-environmental role and financial operations of a recycling cooperative.

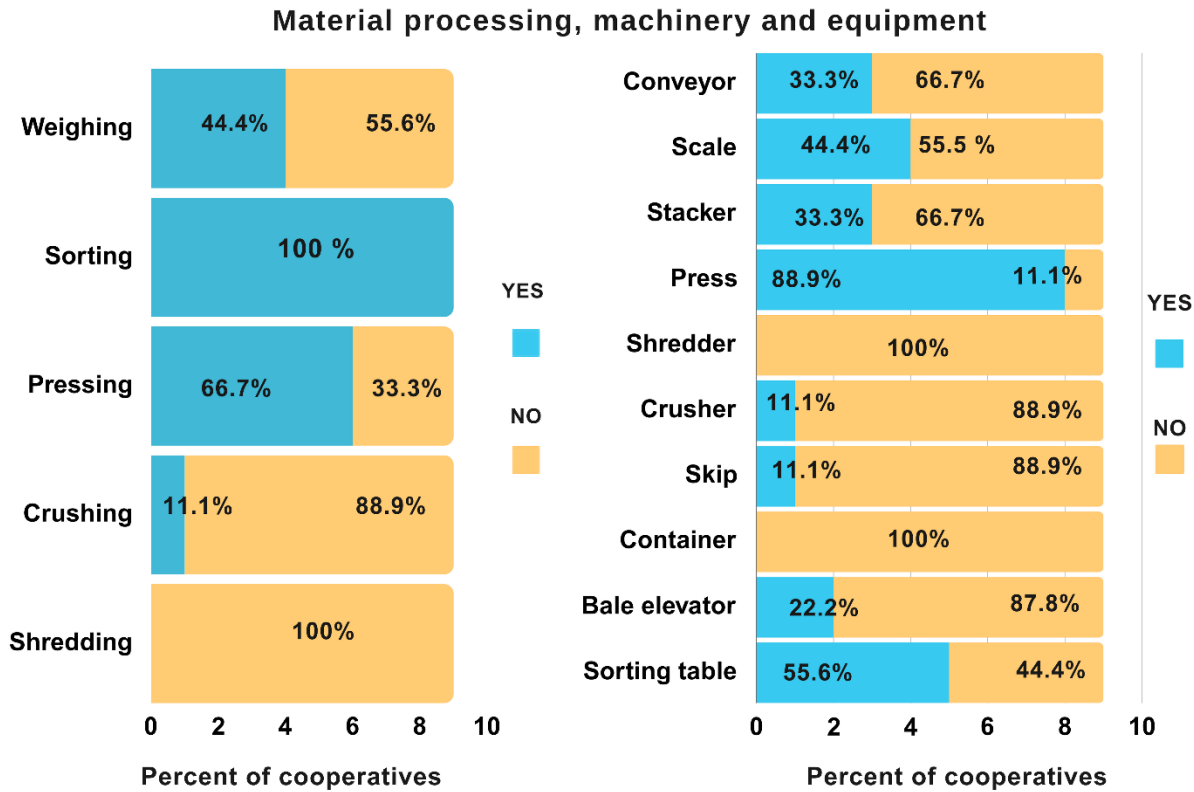
Having a vehicle allows cooperatives to travel and also gives them the autonomy and freedom to bargain and collect materials from private companies and commerce, and does not mean they are restricted and only dependent on COMLURB.

Operational activities and tools

All the cooperatives said that they are involved in sorting recyclable waste, which is the basic activity for selecting materials and offering them for sale, as shown in Figure 5.

Figure 5

Operational capacity of cooperatives



Source: Research data

The managers stated that the material collected by COMLURB has a high level of contamination, including health services waste. All the cooperatives (100%) carry out sorting, although only 4 cooperatives used scales to weigh the materials. Material pressing is practised by 6 cooperatives but only cooperative C carries out waste crushing.

The six cooperatives interviewed said they did not have an electric conveyor belt and were not interested in this appliance because it consumes too much electric energy, and thus leads to expensive bills. As for the press, only one cooperative (Cooperative H) said it did not have the kit to press the materials. As for the paper shredders, none of the respondents had them, nor did they have containers to store the materials, which were separated into bags. Since paper and cardboard are the waste materials most often sold by cooperatives (ANCAT &



Instituto Pragma, 2021), paper shredders would make it easier to process bales and increase the value-added sales.

There is an asymmetry in the infrastructure of the different cooperatives interviewed. While some (Cooperatives C, E and I) had a wide range of items, such as a conveyor belt, bale elevator, skips, crusher and stacker, other cooperatives that were evaluated did not even have a scale and/or press (Cooperatives A, F and G). Without a scale, they were unable to count all the items they had collected or plan their stock for sale, while without a press, a lot of physical exertion was required. There are differences between the availability of space and facilities required for work, which are related to the level of support for these associations from public authorities, the business sector and local communities (Gutberlet et al., 2016). Some cooperatives complained that their equipment was broken and that they lacked sufficient funds for maintenance. In a study on best practices in waste management in cooperatives, Abreu et al (2020) showed that is necessary to reserve 10% of the cooperative's profits for a maintenance fund. However, as the average income is often less than the minimum wage, there is no possibility of keeping money in reserve, because the need to survive speaks louder. The Institute for Applied Economic Research (IPEA), in a series of papers presented at the event "Waste pickers: a national meeting", published a reference book with an overview and cartographic map of waste pickers in Brazil. In this book, several chapters mention that cooperatives suffer from precarious conditions or a lack of infrastructure (Costa & Pato, 2016; Galon & Marziale, 2016).

The reason for this shortcoming may be related to the lack of support that these organizations provide. Without machines to improve the processing of the materials, the value-added profit of the sale is low. Without a sufficient income, there is no capacity to reserve funds for maintenance or improve the working facilities (Wirth & Oliveira, 2016). As a result of this vicious circle, there is still a situation of vulnerability, despite the fact that Brazil has had the instruments and a national policy for the inclusion of this category for more than 10 years.



Cooperatives and their infrastructure and operational conditions

Figure 6 shows the correlation between income and variables related to the infrastructure and operation of the cooperatives. The correlation was established both with and without Cooperative C, since this cooperative had a much higher income and better infrastructure than the others. The data from Cooperative C increase the average income and could skew the results.

In the correlation made with all the cooperatives, four of the independent variables - number of sectoral agreement activities, number of electrical appliances per cooperative, number of processing activities and number of cooperative members - showed a strong -to- very strong correlation ($r > 0.7$) with the average income. The correlation between average income and number of material sources and formalization time was moderate ($0.4 \leq r \leq 0.6$). The correlation between income and the number of PPEs was weak ($r = 0.12$). The variable with the highest correlation with income ($r = 0.96$) was the number of members, which suggests that the higher the number of members, the higher the income. The other highest correlation coefficients were related to processing activities ($r = 0.91$), the number of sectoral agreement activities ($r = 0.83$), and the amount of electrical equipment ($r = 0.81$).

In the linear correlation without cooperative C, four of the variables also showed a moderate- to- strong correlation with average income: number of PPEs ($r = 0.65$), amount of electrical equipment per cooperative ($r = 0.70$), number of processing activities (0.72) and number of cooperative members (0.73). This correlation tends to indicate that an increase in the number of members, processing activities, equipment and the use of different types of PPE, leads to an increase in income. The inclusion of Cooperative C made the values of the correlation coefficients stronger, by strengthening the relationship between the variables.

Almost none of the cooperatives received a reasonable number of aid from the Packaging Sectoral Agreement or had several sources of materials, so these variables were not related to the increase in average income as in Cooperative C. The use of more types of PPE

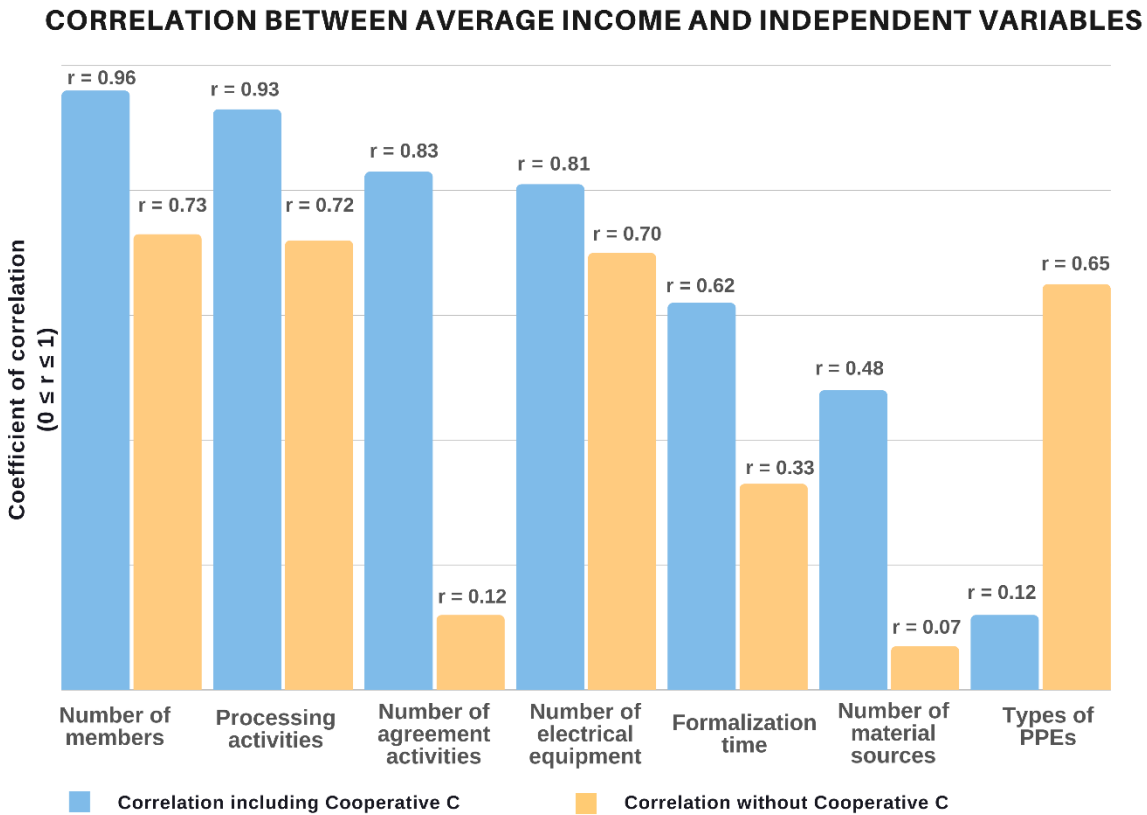


showed a moderate correlation with income after the exclusion of Cooperative C, which suggests that cooperatives with better working conditions may have higher incomes.

The correlation between the average income and the number of material sources, the number of activities of the sectoral agreement, and the formalization time was weak if it did not include Cooperative C in the analysis. In the two different correlation analyses, the variables that best explain the increase in income, are the number of cooperative members, the processing activities, and the amount of electrical equipment. In fact, these variables increase the value added sales of the material and makes it possible to increase the productivity of the cooperative and, hence, its income.

Figure 6

Linear Correlation Analysis



Source: Research data





Table 4 provides an overview of the infrastructure and operating conditions of the cooperatives. Cooperative C has a better infrastructure and operating conditions because it has machinery and equipment such as a press, scale, forklift, bale elevator, shredder, and sorting table, and it carries out four of the five main processing activities (weighing, sorting, shredding, and compacting). In addition, this cooperative has a larger number of cooperative members. These factors enhance its performance, which is the best among the cooperatives evaluated. The operational capacity and infrastructure of Cooperative C, combined with its large membership, mean that it can receive and process a greater volume of material. For this reason, Cooperative C is able to diversify its sources of materials, by collecting from homes, companies, public and educational institutions, and commercial establishments, as well as the material received from COMLURB. Cooperative C has also received the largest number of activities from the Sectoral Agreement, including machines, equipment, and technical advice to improve processes (administrative, sanitary, accounting, electrical, environmental, and internal layout), as well as being given advice on how to handle the sorting process and offer training to improve the production processes.

Cooperative I said it earned the second highest average income. This cooperative also had the second highest number of members, processing activities, and amounts of electrical equipment. However, despite having the second highest income, Cooperative I was not part of the RLS. Cooperative B had operational benefits and the third highest income, as well as the third highest number of members, different sources of waste collection, and the longest period of formalization. This cooperative also received the third highest number of Sectoral Agreement activities, with seven activities in Phase 1.

**Table 4***Infrastructure and operational condition of the cooperatives*

COOPERATIVE	A	B	C	D	E	F	G	H	I
YEARS OF REGISTRATION	6	17	17	4	14	7	6	7	7
NUMBER OF MEMBERS	7	20	81	19	12	11	7	5	30
HAVE A TRUCK?	NO	YES	YES	YES	YES	NO	NO	NO	NO
PROCESSING ACTIVITIES	2	2	4	2	2	2	2	1	3
WEIGHING?	NO	YES	YES	YES	NO	NO	NO	NO	YES
SORTING?	YES	YES	YES	YES	YES	YES	YES	YES	YES
PRESSING?	YES	NO	YES	NO	YES	YES	YES	NO	YES
SHREDDING?	NO	NO	NO	NO	NO	NO	NO	NO	NO
CRUSHING?	NO	NO	YES	NO	NO	NO	NO	NO	NO
NUMBER OF APPLIANCES/TOOLS	1	3	6	3	4	2	1	1	5
TYPES OF PPEs	3	5	7	5	4	4	5	2	4
NUMBER OF MATERIAL SOURCES	1	5	5	4	1	3	1	1	1
A PART OF A RLS?	NO	NO	YES	NO	YES	YES	NO	NO	NO
NUMBER OF ACTIVITIES RECEIVED FROM THE AGREEMENT	3	7	39	2	19	1	0	1	3
TECHNICAL ADVISORY ACTIONS?	NO	NO	YES	NO	YES	YES	NO	NO	YES
RECEIVE EQUIPMENT?	NO	NO	YES	NO	YES	YES	NO	YES	NO
AVERAGE INCOME IN 2021 (R\$)	200.00	1,300.00	4,400.00	450.00	950.00	860.00	1,100.00	450.00	2,000.00

Source: Research data.

On the basis of the results above, it can be concluded that the combination of these three instruments - selective collection, reverse logistics and sectoral agreements - provide benefits for the income of the cooperatives, which underlines the importance of the NPSW. However, these measures must also be aimed at cooperatives which have a poor infrastructure



and operational conditions, and low incomes, such as cooperatives A, D and H interviewed in this study. These cooperatives have incomes ranging from R\$ 200 to R\$ 450.00 per month.

Conclusion

The aim of this study has been to assess the impact of the instruments established by the National Policy on Solid Waste, such as selective collection, reverse logistics and sectoral agreements, on the operating conditions and infrastructure of recycling cooperatives in the municipality of Rio de Janeiro. The research is based on the hypothesis that variables such as the number of cooperative members, time of foundation, number of processing activities, electrical equipment, range of material sources and number of activities received from the sectoral agreement, would serve as indicators of improvement in waste picker cooperatives. For this reason, semi-structured interviews and technical visits were conducted in approximately 50% of the cooperatives in the municipality in 2021. However, for the purposes of this study, 36% of the cooperatives in the municipality were included, since nine cooperatives gave information about their income. The research project was approved by the Ethics Committee at 'Plataforma Brasil'.

A contrasting scenario can be found in the cooperatives in the sample evaluated. The greater support from the Sectoral Agreement improved the operational infrastructure and performance of some of them, while others were given little aid or support and had to carry out their activities in precarious conditions, without basic equipment such as scales or presses. This asymmetry reflects the reality of Brazilian cooperatives, where some are well structured but many do not have the minimum of an operating infrastructure.

The hypothesis raised in the introduction of this study was confirmed since the reception of waste from different sources, as well as the greater number of cooperative members, the processing activities, and the electrical equipment, all resulted in a higher income for the cooperatives. This hypothesis is also confirmed by the strong correlation obtained, even if Cooperative C, which is an outlier, is excluded from the analysis. In fact, a larger number of



cooperative members tends to increase the number of workers who have a large capacity for processing and increase the value-added sales of the materials.

Competition with private recyclers that have a better infrastructure and material processing capacity puts these organizations in a disadvantage. Cooperatives tend to handle low quality waste and a significant amount of rejects, and have a poor infrastructure (with limited mechanization and automation) to process these materials better and faster and increase their sales value. In addition, the volatility of sales values and the tax exemptions on imported solid waste causes a degree of instability in this category.

The informal administrative capacity of the cooperatives influenced the size of the sample, since the members or cooperatives did not have cell phones and also changed their numbers constantly, which made communication difficult for conducting the interviews. This is a difficulty inherent in this category, which causes management problems for the cooperatives.

Finally, the recently issued Federal Decree 10.936/2022, which regulates the PNRS, and Decree 11.413/2023, which establishes and regulates reverse logistics credits, will allow an improvement and higher level of investment in recycling cooperatives. In this way, it will be possible to improve the conditions of the cooperatives, as well as the indicators for waste management, such as waste recovery rates and the recycling data for measuring traceability and reliability.

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