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Challenges and prospects for sorting and disposing of household solid waste: a case study of a recycling cooperative in Minas Gerais, Brazil

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Abstract

Introduction: This article discusses solid waste generation and the importance of waste picker organizations and cooperatives in Minas Gerais, Brazil.
Objective: From this perspective, the general aim of the research was to evaluate and propose improvements to the sorting and final disposal of household waste collected by a recycling cooperative.
Methodology: The study consisted of bibliographical research and field research. It was a quantitative, observational case study using a questionnaire for managers and cooperative members. The gravimetric composition observed in 2019 and 2020 and from January to July 2021 was obtained by consulting the cooperative's data.
Results: The results showed that there was an increase in the generation of household waste over the years analyzed. The results indicated that in 2019, the most extensive collections were of cardboard waste (290,987 kg), glass (172,760 kg), and white paper (128,582 kg), which accounted for 63.6% of the collection. The total collection during this period was 931,557 kg. In 2020, the largest collections were of cardboard waste (283,334 kg), glass (254,220 kg), and white paper (135,873 kg), which accounted for over 69% of the collection. The total collection during this period was 969,565 kg. From January to July 2021, the total collection was 527,632 kg.
Conclusion: The increase in waste generation over the years indicates the demand for an increase in the hiring of cooperative members responsible for sorting waste and implementing more robust environmental education programs to promote awareness of proper waste disposal practices.

Keywords: recycling, solid waste, recycling cooperatives, waste pickers

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Authors' notes

The authors have no conflicts of interest to declare.
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Resumo

Desafios e perspectivas do processo de triagem e destinação de resíduos domiciliares: um estudo de caso em uma cooperativa de reciclagem em Minas Gerais, Brasil

Introdução: O presente artigo aborda a geração de resíduos sólidos e a importância das organizações de catadores e cooperativas em uma cidade do estado de Minas Gerais, Brasil.
Objetivo: O objetivo geral foi avaliar e propor melhorias para a triagem e a destinação final dos resíduos domiciliares coletados por uma cooperativa de reciclagem.
Metodologia: O estudo constituiu-se da pesquisa bibliográfica e da pesquisa de campo, de caráter quantitativo e observacional, fazendo uso do questionário aplicado aos gestores e aos cooperados. A composição gravimétrica nos anos de 2019, 2020 e de janeiro a julho de 2021 foi obtida consultando os dados da cooperativa.
Resultados: Os resultados evidenciaram que houve um aumento da geração de resíduos domiciliares ao longo dos anos analisados. Os resultados indicaram que em 2019 as maiores coletas foram dos resíduos de papelão (290.987 kg), vidro (172.760 kg) e papel branco (128.582 kg), o que representou 63,6% da coleta. O total da coleta nesse período foi de 931.557 kg. No ano de 2020, as maiores coletas foram dos resíduos papelão (283.334 kg), vidro (254.220 kg) e papel branco (135.873 kg), o que representou mais de 69% da coleta. O total da coleta nesse período foi de 969.565 kg. De janeiro a julho de 2021, o total da coleta nesse período foi de 527.632 kg.
Conclusão: O aumento da geração de resíduos ao longo dos anos indica a demanda por uma ampliação na contratação de membros de cooperativas responsáveis pela triagem de resíduos, bem como a implementação de programas mais robustos de educação ambiental, com o objetivo de promover a conscientização sobre as práticas adequadas de descarte de resíduos.

Palavras-chave: reciclagem, resíduos sólidos, cooperativas de reciclagem, catadores

Resumén

Desafíos y perspectivas del proceso de selección y disposición de residuos domésticos: un estudio de caso en una cooperativa de reciclaje en Minas Gerais, Brasil

Introducción: Este artículo aborda la generación de residuos sólidos y la importancia de las organizaciones y cooperativas de recicladores en una ciudad del estado de Minas Gerais, Brasil. **Objetivos:** Lo objetivo general es evaluar y proponer mejoras para la clasificación y disposición final de los residuos domiciliarios recolectados por una cooperativa de reciclaje. **Metodología:** El estudio constó de una investigación bibliográfica y una investigación de campo, cuantitativo y observacional, utilizando el cuestionario aplicado a directivos y cooperativistas. La composición gravimétrica en los años 2019, 2020 y de enero a julio de 2021 se obtuvo consultando los datos de la cooperativa. Los resultados mostraron que hubo un aumento en la generación de residuos domiciliarios a lo largo de los años analizados. **Resultados:** Los resultados indicaron que en 2019 las mayores recolecciones fueron residuos de cartón (290.987 kg), vidrio (172.760 kg) y papel blanco (128.582 kg), que representaron el 63,6% de la recolección. La recaudación total durante este período fue de 931.557 kg. En 2020, las mayores recogidas fueron residuos de cartón (283.334 kg), vidrio (254.220 kg) y papel blanco (135.873 kg), que representaron más del 69% de la recogida. La recaudación total durante este período fue de 969.565 kg. De enero a julio de 2021, la recolección total durante este período fue de 527.632 kg. **Conclusión:** El aumento de la generación de residuos a lo largo de los años indica la necesidad de aumentar la contratación de cooperativistas encargados de clasificar los residuos y de poner en marcha programas de educación medioambiental más sólidos, con el objetivo de promover la concienciación sobre prácticas adecuadas de eliminación de residuos.

Palabras clave: reciclaje, residuos sólidos, cooperativas de reciclaje, recolectores

Introduction

Technological development, industrial expansion, rapid urbanization, and population growth have significantly transformed Brazil's geographical space. Solid waste production has increased due to the desire to purchase new products and use disposable materials. Treating and adequately disposing of large quantities of waste has been a major challenge for the Brazilian authorities. Understanding what is being generated - the amount and kind of items discarded - is essential for improving solid waste management (Lino, Ismail, Castañeda-Ayarza, 2023).

Following the passage of Federal Law Nº. 11.445/2007, Brazil established a legislative framework to enable the implementation of legal instruments such as the National Basic

Sanitation Policy, which included a regulatory framework for basic sanitation. This law defined solid waste management as one of the fundamental tenets of providing services and laid forth the sector's main standards. The policy also stipulates that public urban cleaning and solid waste management services should be the subject of integrated planning to guarantee essential sanitation services. Another legal instrument is the National Solid Waste Policy (PNRS, 2010), instituted by Federal Law Nº. 12.305/2010, which is a significant legislative advance to facilitate the efficient promotion of measures that guarantee the correct management of solid waste generated in Brazil. The Minas Gerais State Solid Waste Plan (PERS), created by Minas Gerais State Law Nº. 18.031/2009 and based on concepts from the National Law, is an additional instrument.

The generation of Municipal Solid Waste (MSW) in Brazil in 2022 was 81.8 million tons, corresponding to 224,000 tons per day. Thus, the average daily waste production per Brazilian was 1.043 kg. Data collected in 2022 showed that the nation's MSW generation was trending lower. The COVID-19 pandemic, the return of waste generation in businesses, schools, and offices, the decrease in the use of delivery services compared to the period of increased social isolation, and the shift in the purchasing power of a population segment are all potential causes. According to regional data and historical trends, the Southeast generates the most waste—111,000 tons per day, or roughly 50% of the nation's total—averaging 450 kg/hab/year. Conversely, the Midwest generates the least waste—approximately 6 million tons annually, or slightly over 7% of the total (ABRELPE, 2022).

Waste pickers' cooperatives are becoming more and more significant in this context, both economically and socially. This is primarily because, in many areas, they offer an alternative to solid waste management and serve as a source of income for those engaged in this business (Siman et al., 2020). Waste picker organizations are present in 394 municipalities in Brazil. With 269 (40%), the Southeast has the highest concentration. The South comes in second with 191 (about 28%), and the Northeast, Midwest, and North come in third and fourth, with roughly 15%, 11%, and 6%, respectively (Instituto Pragma, 2022).

The productive, economic, and environmental analyses generated by the activities carried out by these cooperatives contribute to the structuring actions carried out by the public and private sectors to strengthen the recycling chain. Plastic makes up over 58% of the firm's total turnover, making it the most profitable material in terms of turnover. Even though paper makes up the most significant portion of the material gathered (46%), it only accounts for about 29% of the turnover that the organizations report. The remaining materials comprise less than 15% of the national turnover and are notably less representative. When analyzing the data collected by the survey

contained in the 2022 Recycling Yearbook, it can be seen that there is an average distribution of 32 waste pickers per organization. The Midwest region has the highest average per organization (50), followed by the Southeast and Northeast (31), South (29), and North (22) (Instituto Pragma, 2022).

Furthermore, it becomes evident that recycling solid waste is not only an important economic activity for the chain but also an essential strategy for the environment when considering the environmental effects and the significance of the job done by waste pickers' cooperatives or groups. Recycling can lessen the amount of greenhouse gases released into the atmosphere and the amount of natural resources taken from the ecosystem (Zon et al., 2020; Guabiroba, 2023).

According to Tabernero et al. (2007), cooperatives differ from other types of organizations in the backgrounds of their members. Integrating waste pickers and cooperatives into the public management of solid urban waste is essential for restoring citizenship and valuing the cooperative members (Paiva, 2004; Pablos and Burnes, 2007). They typically share similar life histories (drug users, alcoholics, homeless persons) and have no other professional options than working in the cooperative. These could increase these people's commitment to the cooperative and sense of group membership (Tabernero et al., 2007). Integration has become more well-known as an effective strategy for improving solid waste management and promoting sustainable development.

According to Marchi and Santana (2022), the cost of selective collection in Brazil is 4.6 times that of conventional collection, and only 22% of Brazilian municipalities employ it. The authors also indicate that cooperatives allow workers to sell recyclable items at more excellent prices, resulting in a higher average income than solo collectors.

Hidalgo-Crespo (2023) evaluated the involvement of informal waste pickers (IWPs) in the Guayaquil waste management system. The study's findings suggest that waste collection is primarily a male activity. The average daily mass collected by an IWP is 13 kg, the most commonly collected recyclable waste is polyethylene terephthalate, and their monthly salary is US$179. Furthermore, IWPs prefer to operate alone, with only 16% saying they would join a cooperative despite the significant financial, logistical, and human hurdles (Hidalgo-Crespo et al., 2023).

In terms of management, personnel turnover and inadequate education may impede a cooperative's development and evolution, even before accounting for the possibility of administrative errors. Even with a frequent turnover of personnel and directors, a specialist external review is required to guarantee stability (Botti Capellari et al., 2024).

Consequently, we must learn more about waste picker cooperatives and municipal solid

waste. This strategy has the potential to significantly improve the quality of life for those working in this sector and enhance the recycling process's efficiency.

In this sense, a question was formulated for this work: How can waste picker cooperatives improve the sorting and final disposal process of household solid waste to increase recycling efficiency and workers' quality of life? Therefore, this research aimed to assess and suggest changes to the final disposal and sorting of household solid waste in a cooperative of waste pickers in the Brazilian state of Minas Gerais, MG.

Material and Methods

The material and methods section was organized into Study Location and Qualitative and Descriptive Research.

Study Location

The study location was a recycling cooperative in a city of 97,409 people in the Brazilian state of Minas Gerais (IBGE, 2023). There are 22 (twenty-two) waste pickers in the cooperative, which was founded in 2003. Before 2003, all of the solid waste the city's residents produced was dumped at the dump. This is the only recycling cooperative in the town. The amount of waste dumped at the dump decreased after the cooperative expanded Selective Collection in 2004, which allowed for collection in every neighborhood in the city. Consequently, the dump shut down in 2004, and the area's landfill began functioning in 2005. On the other hand, the cooperative adopted new strategies to improve regional waste management, including the door-to-door selective collection system.

Qualitative and Descriptive Research

Therefore, the following issue served as the foundation for the study problem: How can we enhance the working conditions of those employed in this sector and the final destination and disposal of solid waste brought to the recycling cooperative?

The subject was approached using a combination of qualitative and descriptive research methods. As defined by Silva and Menezes (2001), qualitative research is characterized by assigning meanings and interpreting phenomena, which are fundamental to the process. The application of statistical techniques and methodologies is not necessary. The primary tool for data collecting is the natural environment, and the researcher is the key instrument. As a result, they say of descriptive research: "Researchers typically use an inductive approach to data analysis. The approach primarily focuses on the process and its significance" (Silva, Menezes, 2001).

The research was carried out in three stages. Stage 1 involved bibliographical and documentary research with statistical data on materials sold in 2019 and 2020 from the Recycling Cooperative and from January to July 2021. In Stage 2, questionnaires were used to gather information from the collection, apply it to managers, collectors, and recyclers, and characterize the persons interviewed. Tables 1 and 2 detail the questions created for managers and cooperative members. The University of Ribeirão Preto's ethical committee cleared this study (CAAE: 6699222.0.0000.5498).

Table 1

Questionnaire for managers

Question 1	Is there a selective collection management plan?
Question 2	Does selective collection apply throughout the city?
Question 3	How is selective collection distributed in the city?
Question 4	What waste is collected by selective collection in the city?
Question 5	How often does selective collection take place in the city?
Question 6	Is selective collection carried out by the city or by a private company? If it is a private company, please specify.
Question 7	How many employees work at the cooperative?
Question 8	How many vehicles?
Question 9	How many employees and vehicles does the collection team have?
Question 10	Do all the selective collection and sorting employees wear PPE (personal protective equipment)?
Question 11	What is the final destination of the solid waste collected?
Question 12	Is the sorting plant operated under a concession?
Question 13	Where is the sorting plant located? What structures are present at the sorting plant?
Question 14	Is there any machinery or vehicles on the sorting plant premises?
Question 15	What is the actual quantity in tons of plastic packaging segregated in the sorting process?
Question 16	Does any barrier delimit the sorting plant area? If so, please specify.
Question 17	Are there composting operations associated with the sorting plant?
Question 18	Is there treatment of effluents from cleaning vehicles, equipment, structures, and composting?
Question 19	Is the cooperative's selective collection and sorting costly to the city? If yes, please specify.
Question 20	What is the average pay for the cooperative's employees?
Question 21	What are the cooperative's fixed monthly costs?
Question 22	Is there any training for employees in handling equipment?

Table 2

Questionnaire for cooperative members

Question 1	What is your position at Cooperative?
Question 2	And what is your day-to-day function at Cooperative?
Question 3	How do you consider the working conditions at Cooperative?
Question 4	Have you received training to carry out your work at Cooperative?
Question 5	Are your tasks carried out individually or collectively? Please justify your answer.
Question 6	Do you use any personal protective equipment when carrying out your tasks?
Question 7	How do you feel about working as a household waste collector/recycler? Is this work necessary for your survival?
Question 8	Do you intend to continue in this position, or do you have another life project, such as changing jobs?
Question 9	How do you consider your interpersonal relationships with your supervisors/managers/coordinators?
Question 10	And with coworkers?
Question 11	How does the Cooperative collect and sort solid waste?
Question 12	Are the collection and sorting processes carried out by the Cooperative effective? What improvements do you propose?

Stage 3 analyzed the interviews' results using a SWOT matrix. The SWOT matrix can be used as a relevant tool to help build a strategy, emphasizing the need to properly diagnose the internal and external environments to construct a path guided by strategic thinking and converging with future needs. The opportunities and dangers found in the external world are brought together with organizational strengths and weaknesses from the internal environment, examining the aspects that can be utilized to construct the strategy (Fernandes, 2015). Some authors use this strategy to understand how cooperatives work and identify possible improvements in the process (Botti Capellari et al., 2024).

Potential limitations of the research

Potential research limitations include personal aspects in the analysis of the interviewee's responses and the authors' personal opinions throughout the assessments made in the SWOT

matrix. Another limitation is that the interviewees could be afraid of the questions and the problems the answers could generate. In this sense, the authors carefully analyzed the literature to mitigate these limitations, trying to base the assessments on previous studies and the reality of the lives of waste pickers in different parts of Brazil and the world. In addition, the study was approved by the ethical committee.

Results and Discussion

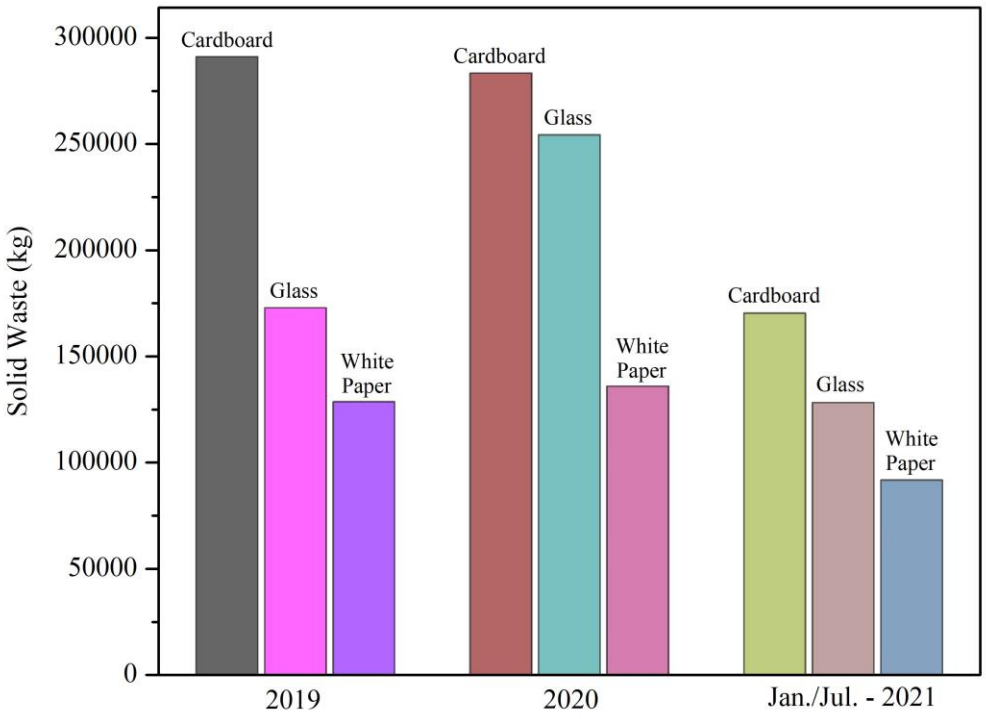
The results and discussion are divided into four sections. The first section describes the solid waste generation in 2019, 2020, and 2021. The following two steps discuss the questionnaire responses of managers and cooperative members. Finally, a SWOT matrix was discussed to improve cooperative management.

Solid Waste Generation In 2019, 2020, and 2021

Based on the analysis of the gravimetric composition, the main types of materials collected by the cooperative in 2019, 2020, and from January to July 2021 were cardboard, white paper, mixed paper, iron, plastic, glass, high-density polyethylene (HDPE), bucket/bowl, aluminum, PET, PET oil and electronics (Figure 1).

Figure 1

Main solid waste collected by the cooperative in 2019, 2020, and January to July 2021



The cooperative's results for 2019 indicated that the most extensive collections were of cardboard waste (290,987 kg), glass (172,760 kg), and white paper (128,582 kg), which represented 63.6% of the collection. Electronic waste accounted for the smallest collection (2,223 kg). 35 kg came via door-to-door sales, which were conducted at the cooperative. The sum of cardboard, glass, paper, and electronic waste was 594,553 kg, and the total collection in 2019 was 931,557 kg. The difference is materials such as iron, plastic, buckets/bowls, aluminum, pet, pet oil, cups, raffia, meta, and boxes.

Approximately 69% of the collection in 2020 consisted of cardboard waste (283,334 kg), glass waste (254,220 kg), and white paper waste (135,873 kg). Metal waste accounted for the smallest collection (789 kg). A total of 969,565 kg was collected within this time frame. The difference is materials such as iron, plastic, buckets/bowls, aluminum, PET waste, cups, raffia, and boxes. The volume of sales at the door in 2020 was 45,854 kg. The remaining material is either disposed of in a landfill or recycled.

Approximately 74% of the waste collected between January and July 2021 consisted of cardboard waste (170,295 kg), glass waste (128,184 kg), and white paper waste (91,739 kg). The smallest collection comprised 80 kg of waste from crates - a plastic box with a grid used to store

soft drinks or beer. The total of waste collected during this period was 527,632 kg. The difference is materials such as iron, plastic, buckets/bowls, aluminum, PET waste, cups, raffia, and electronic waste.

There was a 6.5% decrease in the total amount collected between January and July 2020 (564,828 kg) and January to July 2021 (527,632 kg). Between January and July 2021 and 2019, 2020, there was an increase in the amount of waste generated and collected from households. Door-to-door sales were lower in 2019 than in 2020 and from January to July 2021 due to the more significant amount of waste generated and collected in 2020 and 2021.

The supply of products for sale has increased, and purchases have increased. In this situation, there's a chance to boost revenue for the cooperative and people who make purchases through it. For example, the buyers of the waste at the cooperative's door can sell it for a higher price than they paid for it.

The environmental impact of the COVID-19 pandemic is evident in the increase in the disposal of household waste such as plastic and cardboard, which would justify the need to hire more employees to sort household waste on the conveyor belt, in addition to raising public awareness about the separation of solid waste produced in households. In Brazil, just 4% of solid waste is recycled. Paper, aluminum, and plastic (mainly used for PET packaging) are the most often recycled commodities by cooperatives. The recycling rate is low compared to similar developed countries such as Chile and Argentina, where the average recycling rate is 16%. In addition, recycling rates are very distant from the 60% achieved in wealthy nations like South Korea and Germany (INTERNATIONAL SOLID WASTE ASSOCIATION, 2022). The primary elements influencing Brazil's recycling process are end consumers' knowledge of properly separating and disposing of solid waste, the availability of appropriate disposal locations, and the lack of infrastructure to allow these recyclable materials to return to the production cycle.

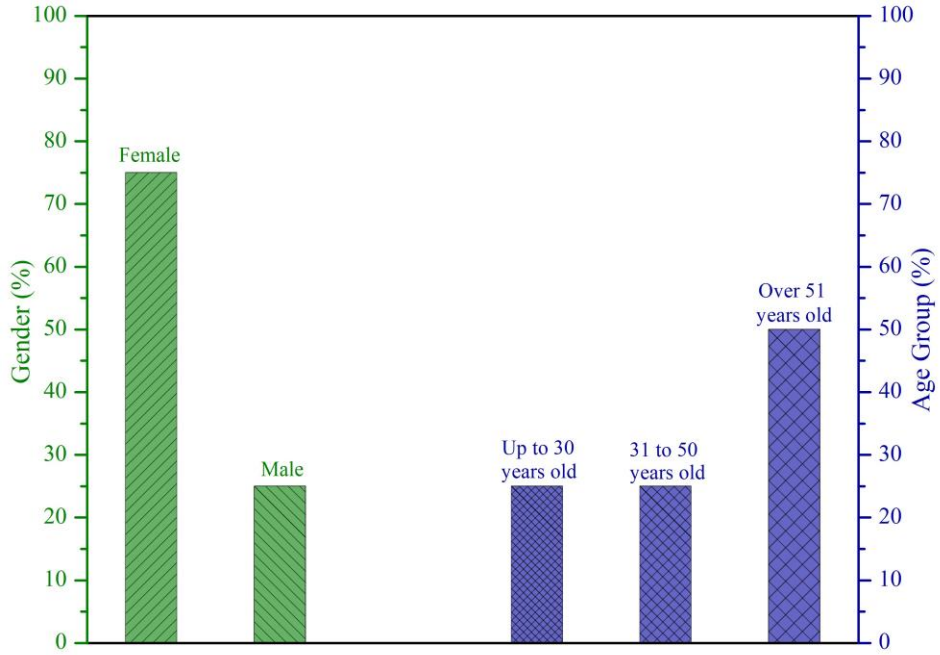
The final destination of the recyclable solid waste collected at the cooperative is sent to the recycling industry, while disposable waste is sent to the landfill. Weekly household waste collection is performed along prearranged routes in the city under study. The waste is then bagged and loaded into a truck equipped with a mesh cage for more efficient transportation to the cooperative. In this way, door-to-door collection and the municipality's collection programs, in which the cooperative acts as the executing agent, have helped the city's selective waste collection program achieve its goals.

Questionnaire for Managers

Figure 2 shows the age group and gender of the cooperative's managers. As can be seen, women make up 75% of the cooperative's leadership, with males making up the other 25%. Most people in this age group (50%) are over 50, followed by those in the 31–50 age range and those in the up to 30 age range.

Figure 2

Gender and age group of the cooperative's managers



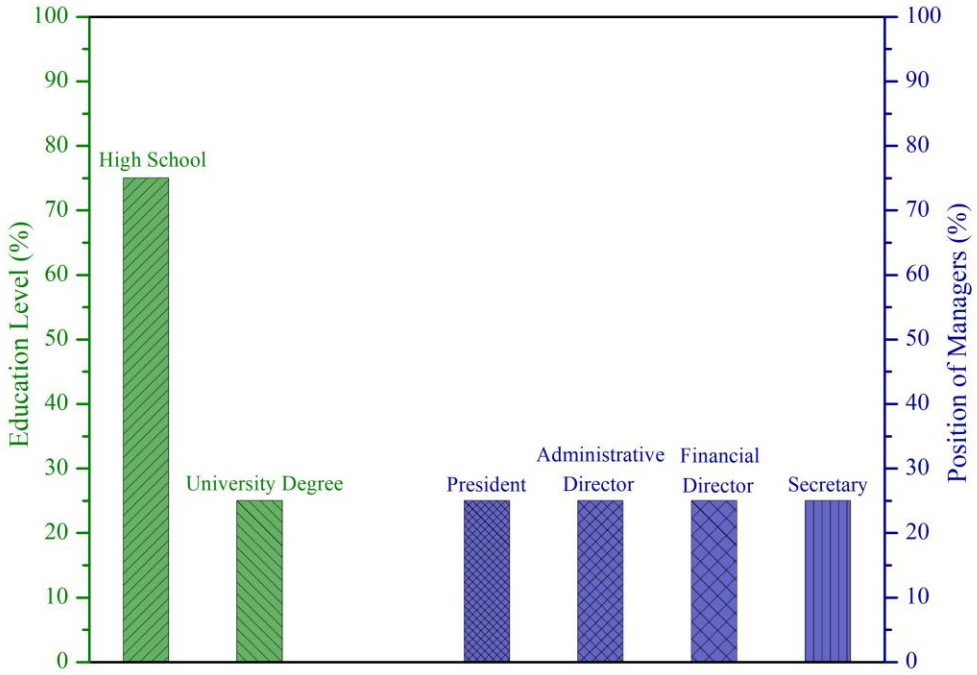
Regarding education (Figure 3), 25% have finished a university degree in environmental management, while 75% have completed high school. The positions are distributed among the managers as President, Financial Director, Administrative Director, and Secretary, with one manager in each position. Studies in cooperatives in cities in Rio de Janeiro/BR indicate that 9% are illiterate, 77% have only incomplete primary education, and 14% have incomplete high school (Esteves, 2015).

Nonetheless, in many cases, there is an interest in continuing their studies, especially among younger women. Previous studies conducted in the Southeast (Rio de Janeiro/RJ) and Midwest (Goiânia/GO) regions of Brazil by Silva (2002), Magera (2003), Martins (2007), and Bosi (2008) likewise found low levels of education. These researchers contend that one factor

preventing people from entering the formal labor market is their educational attainment.

Figure 3

Level of education and position of the cooperative's managers



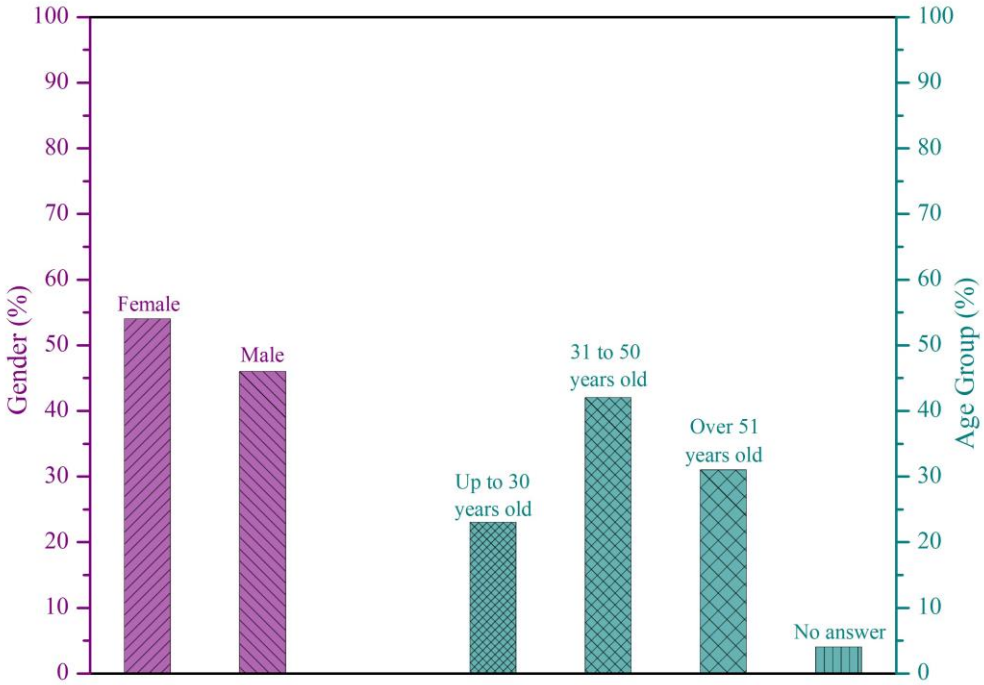
Continuing with the results obtained from the questionnaire, it is essential to note that the responses showed that all the managers said there was "no" selective collection management plan. The city is only covered by 85% of the selective collection rate. There must be complete coverage since the cooperative must hire more staff, expand its fleet of collection vehicles, and increase its financial collection. The cooperative members train the team to handle the equipment themselves. It is recognized in this context that thorough planning is necessary to complete the tasks at hand. This covers handling equipment, wearing personal protective equipment (PPE), following detailed instructions for doing tasks within the cooperative and carrying out selective collecting outside of the workplace in the most efficient way possible. Nonetheless, selective collection has advanced social, environmental, and economic sustainability at the local, state, and federal levels.

Questionnaire for Cooperative Members

Analyzing the waste pickers questioned using the survey data demonstrated that, as Figure 4 shows, approximately 54% were female and 46% were male. The following was the age range: 42% of respondents are between the ages of 31 and 50, 31% are over 51, and 23% are up to 30. 4% of respondents did not specify their age. According to the results of the analysis, the majority of the cooperative's waste pickers are in the age range of 31 to 50. In the study presented by Esteves (2015), 69% of the waste pickers interviewed were male, making up the majority of professionals.

Figure 4

Gender and age group of the cooperative's collectors



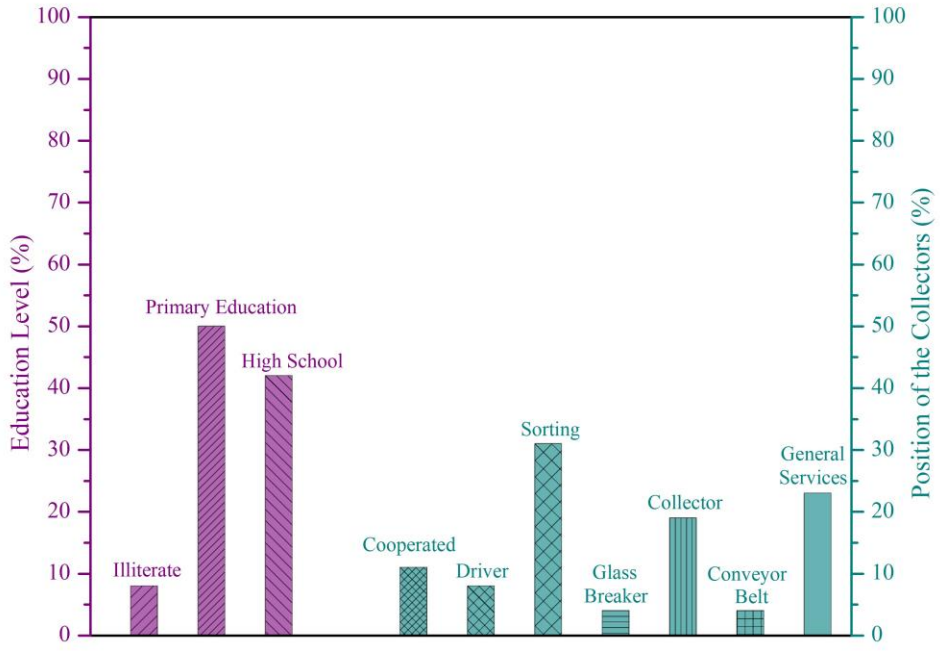
Esteves (2015) evaluated the state of Rio de Janeiro's waste picker and recycling cooperative landscape and observed that 39.5% of waste pickers are between the ages of 45 and 65, while 56.5% are between the ages of 25 and 45. The age factor in research by Bosi (2008) showed that waste pickers between the ages of 30 and 60 constituted the majority. Despite the distributional variability, the waste picker group primarily comprises young individuals (Porto et al., 2004). Age is one of the main criteria influencing participation in the formal labor market in

Brazil's current economic climate, where hiring young workers is more advantageous. Recycling cooperatives do not have selection criteria; hence, this is not the case (Esteves, 2015).

Furthermore, studies on the educational attainment of waste pickers in cooperatives show that 14% have only completed high school, 77% have only completed their primary education, and 9% are illiterate (Esteves, 2015). Nonetheless, many people, particularly younger women, want to continue their education. Figure 5 shows the educational level of the cooperative under study: 42% have completed high school, 50% have not completed elementary school, and 8% are illiterate. According to an analysis of the responses, most workers are employed in the sorting and solid waste collection sectors (Figure 5).

Figure 5

Level of education and position of the cooperative's collectors



The low schooling is also discussed by Franco et al. (2017), who note that the collectors' attempts to emancipate themselves are hampered by the social and economic environment in which they are placed. These obstacles include the collectors' inadequate education, which frequently restricts self-management to operational decisions while leaving strategic choices in the hands of outside parties.

The perceptions of the waste pickers questioned about the working conditions at the Cooperative were considered to be "excellent", "special", "good", "normal", "favorable",

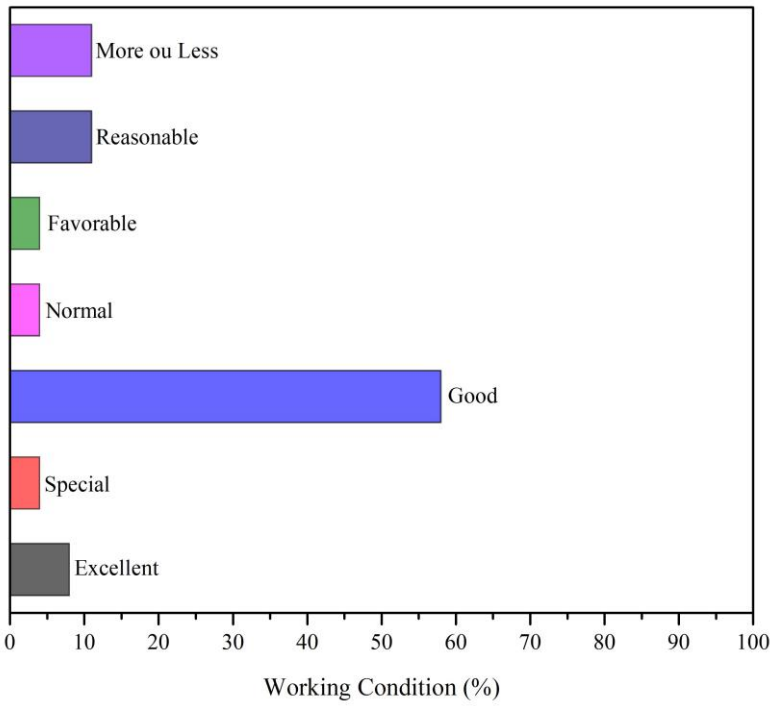
"reasonable"; and also "more or less". Therefore, 58% of the Cooperative's waste pickers consider their working conditions to be good, according to Figure 6. Various studies in the literature have emphasized the need to provide acceptable working circumstances, citing the precarious reality found in cooperatives as a result (Duarte et al., 2022; Bonini-Rocha et al., 2021; Araújo et al., 2015). The reality differs from the concept of adequate work elaborated by the International Labor Organization in several aspects, such as the amount of money people receive from their jobs, access to social security, and safety at work (Araújo et al., 2015).

In this context, it can be said that the waste pickers questioned proposed many improvements for the Cooperative under study, including informing the population about the need to separate solid waste and the importance of recycling, hiring more workers to work on the sorting belt; buying a forklift to make it easier for employees to work; increasing the length of the belt and its efficiency (perhaps buying a new belt); hiring another worker for the yard that receives the trucks that collect solid waste; improving food for employees (snacks); putting up awnings in the glass breaking area to avoid the sun. It's important to note that the suggestions proposed by the waste pickers are all necessary to improve working conditions at the cooperative, and many of these proposals are fundamental rights that they need to be made aware of.

When asked if they had gotten any training to perform their jobs, the respondents said that "they learn on their own" and that "cooperative members/colleagues" had provided the training. Training must be administered more effectively and using particular methodologies by a competent professional to assure employee safety. A worker's performance depends on many factors, one of which is their level of sustainability, which is indicated as "Very favorable" by training or formal professional qualification to perform activities related to the tasks carried out within the cooperative (Guabiroba, Jacobi and Abegão, 2023).

Figure 6

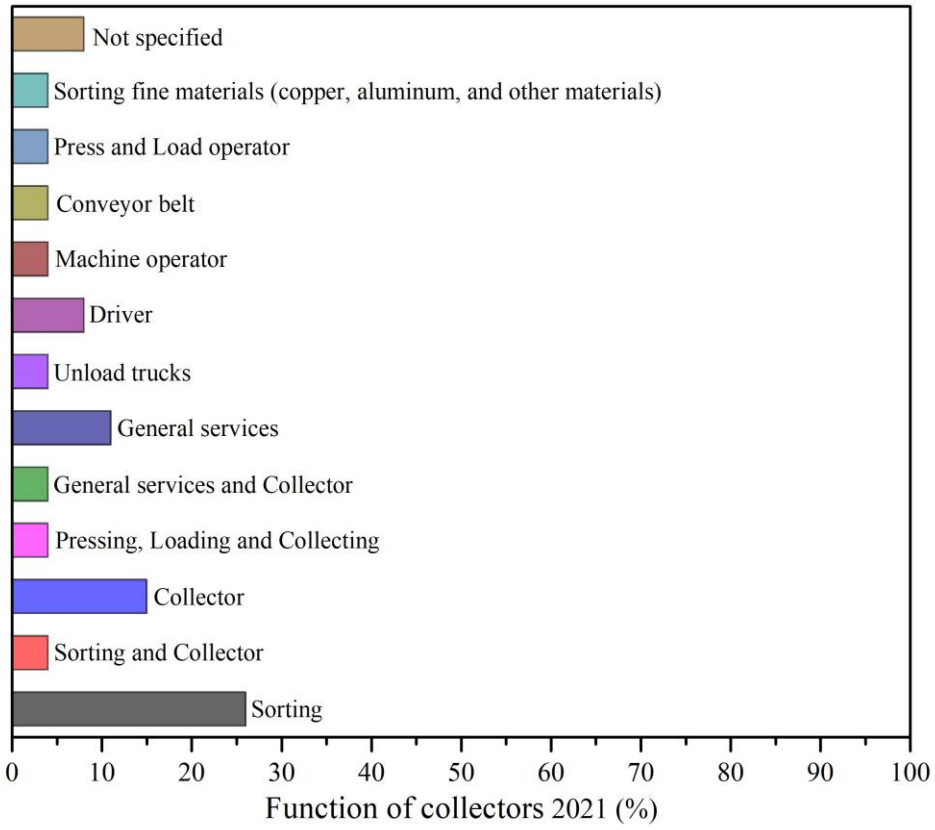
Working conditions in the cooperative



Each employee's functions are shown in Figure 7: 26% of employees exclusively work in the sorting business, 15% are collectors, 11% are in general services, 8% are drivers, 4% rotate between sorting and collecting, 4% are involved in pressing, loading, and collecting, 4% provide general services and collect, 4% unload trucks, 4% operate machinery, 4% work on the conveyor belt, 4% operate presses and load, 4% specialize in sorting fine materials (copper, aluminum, and other materials), and 8% have no particular role. When analyzing the results, sorting is the function that requires the most significant number of employees at the cooperative, and of all the tasks carried out at the cooperative, sorting is the function that requires the most time.

Figure 7

Function of the collectors in the cooperative



Regarding using personal protective equipment when carrying out tasks, 100% of the respondents said they use personal protective equipment, including gloves, uniforms, boots, masks, belts, and goggles. According to Esteves' (2015) research, 73% of the cooperatives studied in Rio de Janeiro, Brazil, supplied their employees with personal protection equipment (goggles, masks, boots, lab coats, gloves, and goggles). Of the 408 cooperatives analyzed, approximately 215 were checked on-site. Considering the conditions in the cooperatives that could be analyzed, 13% needed clean and organized working environments.

As for the importance of the work for their survival, they were unanimous with "yes" and "definitely". The literature reports that 31% of women are waste pickers out of "necessity", i.e., they need this work to survive and support themselves. Nevertheless, for the men interviewed (69%), working as a waste picker was considered the "only opportunity", accounting for 29.2% (Esteves, 2015).

SWOT Matrix

The SWOT matrix of the cooperative studied is shown in Table 3.

Table 3

SWOT Matrix (Strengths, Weaknesses, Opportunities e Threats)

Internal environment	**Strengths**	**Weaknesses**
	- Cooperative members perceive that they perform significant work for society; - Workers do not maintain a relationship of subordination with the cooperative's managers; - Environmental awareness among cooperative members.	- The poor educational background of the cooperative members often limits self-management to operational decisions, while strategic decisions remain the responsibility of external agents; - No support from private companies or the city government; - Low salaries for cooperative members; - Lack of campaigns to expand environmental education.
External environment	**Opportunities**	**Threats**
	- Getting support from the city government or a private company; - Making other sectors of society aware of the importance of the cooperative's work; - Workers' access to social security and safety at work; - Developing public policies, environmental education, and occupational health programs that integrate the dimensions of the problem in their interfaces and can rescue the dignity of these workers; - Increasing salaries for cooperative members; - Provide training for cooperative members; - Improving the cooperative's equipment; - Improving the cooperative's capacity for coordination, its effectiveness in establishing support networks, and its ability to obtain financial and institutional resources.	- Intermediaries who collect household waste before the collection truck passes by; - The poor education of waste collectors and the lack of specialized training can compromise the improvement of their performance; - Low pay can discourage people from staying in their jobs.

According to the SWOT Matrix of the cooperative under study, one of the decisive factors (Strength) is that the cooperative members perceive that they do meaningful work for society. In addition, the waste pickers do not have a subordinate relationship with the cooperative's managers, facilitating the autonomy necessary for meaningful work and raising the cooperative members' environmental awareness. Considering that the independence of the waste pickers makes it easier for them to carry out their work, this allows their awareness of its importance to show how conscientious they are about caring for the environment, both at home and at work.

Although many waste pickers believe they contribute much to society, many may not see

the worth in their work due to preconceptions they have internalized over time. Research has shown that employees can have a subordinate relationship with cooperative management, which challenges the business's cooperative goal and reduces the autonomy required for working successfully (Schmitt et al., 2020).

Among the weaknesses, it can be seen that the poor schooling of the cooperative members limits self-management to operational decisions, reducing or disabling the collectors from making decisions and developing strategies that collaborate with the managers and with the improvements of the cooperative. In addition, the cooperative does not have the support or partnership of private companies or the city council. The municipal government needs to intervene and provide more support for the cooperative under study; the cooperative members have low salaries, and there needs to be campaigns to raise collective awareness, i.e., society.

Forming partnerships between cooperatives and public or private businesses would be an appropriate alternative to improve the quality of workers' sites. In this sense, it is proposed to verify the type of support made possible by partners for the cooperative (transfer of physical space for sorting, transfer of equipment, such as collection conveyor belts and presses, education and dissemination actions carried out by the municipality and donation of recyclable materials by companies in the city). Furthermore, the possibility of partnerships and support can be identified by verifying the cooperative's capacity for articulation, establishing support networks, and obtaining financial and institutional resources (Guabiroba, Jacobi, and Abegão, 2023).

In terms of opportunities, it is possible to get support from the city council or a private company; raise awareness among other sectors of society of the importance of the cooperative's work; provide workers with social security and workplace safety; develop public policies, environmental education and occupational health programs that integrate the dimensions of the problem in their interfaces and can restore the dignity of these workers; increasing the wages of cooperative members; providing training for cooperative members; improving the cooperative's equipment; improving the cooperative's capacity for coordination, the effectiveness of establishing support networks and the capability to obtain financial and institutional resources.

The existence and actions of intermediaries who gather household waste before the collection truck arrives pose a threat because they drastically lower the likelihood that collectors will make money from selling recyclable material at the cooperative's door and to the locations where the products are recycled. Threats also include the collectors' poor educational background and lack of specialized training, which may impede their ability to perform better. It is common knowledge that members of cooperatives who have received more training are more knowledgeable about their jobs and, therefore, make more significant contributions to the

cooperative. People may be discouraged from remaining in their careers by low remuneration. Competitive pay often serves as a source of attraction and motivation for employees, encouraging them to stick around and make valuable contributions to the company. A higher salary can encourage workers to invest in their training.

When analyzing the threats mentioned in other studies of cooperatives in the literature, the main threats described are not having management methods implemented in the cooperative, not having the freedom to sell the product on the market due to the lack of structure (Lopes, Silva, Medeiros, 2020). It is also mentioned that there is competition among collectors because some non-associated individuals "take possession" of the waste before it is dumped. In most cases, these people work for public cleaning services and gather the most valuable materials for the recycling industry, or they are independent non-associated collectors who work independently while associated collectors choose the remaining waste to be dumped (Martins Filho et al., 2018; Moreira, 2012). Based on the study and the SWOT matrix analysis, significant improvements could be made to the organization and the way employees work to increase the operational efficiency of the cooperative's recycling process. Identifying areas that could be optimized, derived from the SWOT analysis, offers an approach to improving working conditions, thus promoting an environment that is more favorable to worker well-being and productivity.

Conclusions

Household waste generation during the COVID-19 pandemic has increased according to an analysis of the gravimetric composition of solid waste collected in 2019, 2020 and from January to July 2021. The COVID-19 pandemic has had a significant impact on the environment, which reinforces the need to recruit more people for the process of separating solid waste on the conveyor belt, in addition to carrying out projects related to raising awareness among the population about the importance of the environmentally appropriate separation, destination and final disposal of household waste. Improvements are still needed in the sorting and final disposal of household waste at the cooperative studied, and the acquisition of new technologies would be an alternative to improve the work of the cooperative members.

The Cooperative initially received financial support, training, and logistical support, which allowed it to grow and produce positive outcomes since its founding, including increased infrastructure, increased cooperative members, and advancements in the economic sector. In general, the selective collection program still needs improvement to achieve its intended sustainability. It was observed that there was an increase in productivity and better working

conditions over this period, which includes 2020 and 2021. The community and corporate donations have donated large amounts of material. Institutional partnerships have also helped with infrastructure and training, and the municipality has offered incentives to ensure the activity's stability.

Optimizing the selective collection program is key to getting the most out of solid waste and automatically reducing the amount of waste sent to landfills. Among the factors that affect the selective collection program (legislation, inspection, solid waste management fees), environmental education for the population is a viable alternative for improving the quality of work and increasing the income of waste pickers.

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