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Environment

Development and assessment of a selective collection plan for two districts in the oceanic region of Niterói, based on the template of the pioneer selective collection of São Francisco - RJ

Desenvolvimento e avaliação de um plano de coleta seletiva para dois bairros da região oceânica de Niterói, baseado no modelo de coleta seletiva pioneira de São Francisco - RJ

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ABSTRACT

The growing production of urban solid waste is a reality of modern society. A large part of this quantity can be recycled and/or reused in new processes. In some countries, such as Brazil, a very small percentage of total waste is picked up through selective collection projects, and an even smaller portion is recycled. A selective collection initiative established in the district of São Francisco, in the city of Niterói, in the state of Rio de Janeiro, was successful and kept in operation for more than 35 years, being one of the first initiatives of this type registered in the country. Its methodology is different from the general collection, using an alternative model truck where the materials are stored more diligently without the risk of one damaging the other. The present work implemented, monitored, and evaluated a pilot project of selective collection in the districts of Itacoatiara and Camboinhas, also located in Niterói. An average of 900 kilograms of material with recycling potential were taken weekly in the Itacoatiara district, an amount 3 times higher than what was collected before the operation, proving the effectiveness of the new model. In Camboinhas, similar results were obtained, although they needed to be improved in some respects. Thus, it was found that changing the type of vehicle and optimizing the collection were crucial points to improving the efficiency of the carried-out processes.

Keywords: Urban solid waste; Selective collect; Recycling

RESUMO

A crescente produção de resíduos sólidos urbanos é uma realidade da sociedade moderna. Grande parte desse quantitativo é passível de ser reciclado e/ou reaproveitado em novos processos. Em alguns países, como o Brasil, um percentual muito pequeno do total de resíduos é recolhido por projetos de coleta seletiva e parcela menor ainda é efetivamente reciclada. Uma iniciativa de coleta seletiva estabelecida no bairro de São Francisco, no município de Niterói, no estado do Rio de Janeiro, foi bem-sucedida e mantida em funcionamento por mais de 35 anos, sendo uma das primeiras iniciativas desse tipo registradas no país. Sua metodologia é diferente da coleta comum, utilizando um modelo alternativo de caminhão, onde os materiais são armazenados de forma mais diligente, sem o risco de um danificar o outro. O presente trabalho implantou, monitorou e avaliou um projeto piloto de coleta seletiva nos bairros de Itacoatiara e Camboinhas, também localizados em Niterói. Foram recolhidos semanalmente no bairro de Itacoatiara, em média, 900 quilogramas de material com potencial de reciclagem, valor 3 vezes superior ao do que era coletado antes da operação, comprovando a efetividade do novo modelo. Em Camboinhas, obteve-se resultados similares, ainda que tenha apresentado a necessidade de ser aprimorada em alguns aspectos. Dessa forma, foi verificado que a alteração do tipo de veículo e otimização da coleta, foram pontos cruciais para melhorar a eficiência dos processos realizados.

Palavras-chave: Resíduos sólidos urbanos; Coleta seletiva; Reciclagem

1 INTRODUCTION

Solid waste is caused by basically all human activities. The diversity of its constitution varies from the material discarded in the day-to-day life of a residence, such as packaging and food waste, to the remains of more complex processes, such as treatment plant sludge and radioactive materials.

According to the Panorama of Solid Waste 2021, prepared by the Brazilian Association of Public Cleaning and Special Waste Companies [Abrelpe], in 2020, 82,5 million tons of waste were generated in Brazil. Also, according to Abrelpe, only 4% of this value was recycled. The scenario may be even worse, because, according to the National Sanitation Information System [SNIS], in 2020, Brazil recycled only 2.17% of the total waste collected. Thus, there is a great need for the implementation of models, such as selective collection, aimed at the management of municipal solid waste. In this sense, since the implementation of the National Solid Waste Policy [PNRS] in 2010, until the year 2019, the number of cities that have some type of selective collection went from

56% to 73% (Abrelpe, 2020), suggesting that one of the reasons for the low amount of properly recycled material may be related to the way this material is handled.

One of the first initiatives of this type began in Brazil 25 years before the creation of the PNRS. In 1985, in the district of São Francisco, located in the city of Niterói, Rio de Janeiro (Ferreira, Eigenheer & Sertã, 1986), led by the then professor of the Fluminense Federal University, Emílio Eigenheer. The Selective collection in São Francisco, considered an upper-middle-class district, was started with about 100 houses, and in 2012, the number of participating households reached the amount of 1200, corresponding to more than a third of the existing households in the district (Eigenheer & Ferreira, 2015). Currently it is made with the aid of a box type truck, offering no risks to the integrity of the materials.

Based on data from the Public Cleaning Company of the City of Niterói (CLIN), even with the service being considered satisfactory in the district, collecting on average 19,8 tons of recyclable material per month (CLIN, 2021), this amount, added to the ones in the other districts of the city, allowed the proportion of recyclable material to be estimated at about 5% in the year 2022 (CLIN, 2022).

Thus, in addition to continuing with its sustainable agenda, the city must advance with its efforts to achieve the goal established by the National Solid Waste Plan [Planares], which determines that the states of the Southeast Region of Brazil must reach the value of 20% of recyclable materials properly disposed by the year 2040 (Decreto n. 11.043, 2022), a value less rigorous than that established by the PNRS of 50% by the year 2031 (Lei n. 12.305, 2010).

With this, the following article proposes a change in the current way of handling disposed recyclable material in the city of Niterói, in the hopes of improving the overall quality and quantity of the collected material, but also presenting new means to achieve the proposed goal, looking for ways to maintain it or even exceed it from the level indicated from lasting practices, since one of the main objectives of good solid waste management is the protection of public health, avoiding the

proliferation of diseases, the contamination of the environment, as well as problems of a socioeconomic nature (Almeida, 2019).

1.1 National Solid Waste Policy and Plan

According to the Brazilian Federal Law n. 12,305 of 2010, which established the PNRS, waste is now called waste when all possibilities of treatment and recovery are exhausted, and the final environmentally appropriate disposal is its only destination option (Lei n. 12.305, 2010). Likewise defined by the PNRS, the concept of waste is established as any substance or matter that is considered useless or disposable, requiring a suitable place for its disposal. One of the types is called Municipal solid waste [MSW], the waste generated in homes, with a mixture of several different materials, and this diversity is a characteristic that differentiates them from the others.

An important strategy in waste management is selective collection, which can be classified as a service that collects solid waste previously sorted at the source according to its constitution and composition aiming at recycling. This prior separation is of utmost importance, directly affecting the quality of the material. In material sorting centers, waste pickers are not able to filter materials effectively, as more fragile ones, such as paper and cardboard, are more vulnerable to the organic remnants present in materials such as plastic and PET bottles when all are mixed. Thus, the habit of separating waste in homes promotes the environmental education of the population, stimulating sustainability in daily practices, helping in the reuse of materials, and reducing waste, in addition to generating jobs in a large chain (Ribeiro & Besen, 2006).

The PNRS provides that all waste should be treated and that only tailings and waste that do not have economically viable or technologically available treatment methods should be sent to landfills (Lei n. 12.305, 2010). During the year 2021, in Brazil, about 60% of the MSW collected was sent to landfills (Abrelpe, 2021). However,

studies such as that of Passos Ibiapina, Oliveira & Leocadio da Silva (2022), point to the fact that developed countries, such as Germany, have already presented a movement for the closure of existing landfills, seeking the total reuse of their waste, evidencing the deficiency still existing in Brazilian waste management.

Established by Brazilian Federal Decree n. 11,043 of 2022, known as the Planares, which differs from the PNRS in the sense that it instrumentalizes it at the national level, offering long-term objectives and guidelines. In this sense, the Planares data on recycling are extremely relevant. For Baldé (2017), recycling closes the cycle of sustainability in a modern society, reducing the use of natural resources and reducing environmental impacts. However, according to Planares (2022), Brazil still has extremely low recycling rates.

Among the main reasons for these results, Silva, Nazari, Hernandes, Corrêa, L & Corrêa, E (2018) verified in their research that one of the most recurrent problems for recycling is the impracticability of the separation of waste in the plants, resulting from an undue sorting in the sources, either due to ignorance or neglect of the population, also pointing out the possibility of the ineffectiveness of some environmental education plans. Thus, Bianchini (2001) believes that to function satisfactorily, recycling programs, as well as selective collection programs, must emphasize the importance of the participation of all actors in the process. This is reinforced by Melo, Mendez & Mahler (2022), who described that one of the most important factors for improving waste management is the existence of an efficient information system that allows any citizen to obtain clear, safe and accurate data.

In the search for more incentives for citizen participation in this process, Brazilian Law n. 14,260 of 2021 was published, which establishes the creation of the Support Fund for Actions Aimed at Recycling [Favorecicle] and the Investment Funds for Recycling Projects [ProRecicle], granting individuals and legal entities a deduction in part of their income taxes, through support for recycling projects approved by the Ministry of the Environment (Lei n. 14.260, 2021). Parallel to this, to increase the rate of recycled waste,

Planares established a goal indicating, gradually, how much the percentage of MSW collected and that it is properly recycled in all regions of Brazil should be.

1.2 Municipal plan for basic sanitation

The Municipal Basic Sanitation Plan (PMSB) of Niterói, which was done in 2020 by the Secretariat for Conservation and Public Services of Niterói [Seconser] as a requirement of Brazilian Law n. 11.445 of 2007, diagnoses the sanitation situation of the city, creating projects, goals, and objectives that helps expand the access of basic sanitation to the population, in addition to developing plans for possible incidents. In one of its guidelines, the PMSB of Niterói determines that a good information generation system is always available, with truthful data and obtained from a good technique (Seconser, 2020).

In Niterói, the waste management model chosen was the one recommended by the PNRS, seeking to reduce, reuse and recycle the waste generated through good environmental education. In view of this, Pereira & Heller (2015) considered, from several studies, that plans that use planning methods that contain the participation of all the actors involved present more satisfactory results and that really influence the quality of basic sanitation, resulting in the improvement of public health.

1.3 Public cleaning company of the city of Niterói

The joint venture company is subordinate to the city of Niterói and responsible for urban cleaning and final disposal of solid waste generated throughout the city, collecting on average 765 tons of waste daily, between household and public waste. Of this total, the amount being sent to sorting is only between 3% and 5% (CLIN, 2022). To carry out its assignments, it relies on several types of collection, each strategically decided aiming at a different goal. For a better understanding, the modalities of selective collection in Niterói will be detailed below:

Door-to-Door Selective Collection: It is carried out in an analogous way to the general waste one, but with some differences. It is expected that the residents, previously registered, make the prior separation of their waste, which is then disposed on the sidewalks and picked up by trucks of the compactor type, usually on days and times different from the general one. A negative point is that, by the nature of the truck, if the material is not properly separated, the entire amount gathered could be compromised, demonstrating that this type of truck is not the most ideal for this service.

1.4 Selective Collection at Voluntary Delivery Points

Known as PEVs or Ecopontos, they are places where the residents themselves goes to deliver their waste. In addition to being more practical for the population, this modality is a more efficient alternative when compared to the Door-to-Door, as it considerably reduces the costs of the service. This material is examined, and the person has the choice to donate it or weigh it to obtain discounts on certain taxes.

1.5 Collection from Semi-Buried Collectors

In this type, the material is deposited in large containers buried in the ground, also known as Moloks. Almeida (2019) discusses in detail about the modality, arguing that the containers have good aesthetics, do not exude odor because they are hermetic, in addition to the entire process of taking the stored material being approximately 15 minutes. The Moloks are part of a project to improve waste collection in poor districts in the city, replacing conventional dumpsters.

1.6 Selective Collection of São Francisco

This was the first experience of its kind implemented in Brazil (Eigenheer, 1993), being elaborated from initiatives between the Community Center of São Francisco [CCSF] and the Fluminense Federal University. Eigenheer & Ferreira (2015), who have

participated in the project since the beginning, reports that the operation worked with the same equipment from its beginning until 2013, when CCSF and the public cleaning company of the city of Niterói formed an agreement. It does not need prior registration, with the company's collectors moving on foot through the streets of the São Francisco, picking the material previously separated and arranged on the sidewalks. They analyze the material to be sure that it is a recyclable waste and deposit them in carts and bags, where later a team in a box type truck will take the material. Due to the nature of the truck, the material disposed in its interior is not compromised by the existing compaction effect in the hydraulic compactor type truck, preventing possible materials that still have traces of organic matter from mixing with properly cleaned or more fragile materials, resulting in a more refined material, leading to greater use during sorting.

Eigenheer & Ferreira (2015) state that the idea was never to expand this model to other areas and believe that the operation that occurs in São Francisco cannot be replicated easily. The authors, however, admit that since the partnership with the public cleaning company of the city, the possibility for the application of this model to other districts has increased, especially when considering the norms of the PNRS and the goals of the Planares.

2 MATERIALS AND METHODS

One of the methods used in the present work was the bibliographic and documentary review, based on articles, theses, books, and publications obtained through research platforms, such as Google Scholar, Capes Periodical, and the Online Scientific Electronic Library - SciELO, in addition to the research of the main laws at the local and national level that deal with the theme of selective collection and municipal solid waste. These studies were published since the year 1986, with the pilot project done in the district of São Francisco, fundamental for this study, until the year 2022, with the most recent ideas on the theme of waste collection, as well as the national and the city of Niterói databases on waste information.

For the implementation of plan in the district of Itacoatiara, a field visit and data gathering were carried out with the residents of the locality, in addition to considering the data from the most recent demographic census, of 2010, conducted by The Brazilian Institute of Geography and Statistics [IBGE]. To make the graphs, the Microsoft Excel program was used.

In addition to the operation that was already being carried out in São Francisco, another district, Camboinhas was analyzed to verify the effectiveness of the newly established plan. All data related to the amount of waste collected and information in general about the operations carried out in the city of Niterói used in this study were provided by the public cleaning company of the city of Niterói.

3 THE DEVELOPMENT OF THE SELECTIVE COLLECTION PROJECT IN ITACOATIARA

The district of Itacoatiara is in the oceanic region of the city of Niterói, 37 kilometers from Rio de Janeiro – capital of the State. It has a total area of 2.6 square kilometers, having only one road to access it, a remarkable feature when compared to other districts of the oceanic region. In addition, Itacoatiara has a natural vocation and develops actions in favor of the conservation of the environment, such as preservation of local vegetation and keeping most of its streets unpaved, contributing to greater absorption of rain by the groundwater of the district (Barroso, 2003).

According to IBGE (2010) data, Itacoatiara has 1227 inhabitants distributed in 400 residences, however, as these data are based on the census survey that occurred in 2010, the information gathered by the team during the development of the project, in July 2022, is more current. The team visited 623 residences, including buildings and condominiums of houses, and in the households visited, it was found that at least 1900 people live in the district.

Prior to the implementation of this operation, the district already had a door-to-door selective collection program carried out by a third-party company. It was made by prior registration and performed by trucks of the compactor

type. However, since the year 2021, the company has been experiencing financial difficulties, which has led to the dismissal of employees and the reduction of its efficiency in fulfilling its obligations (Fernanda, 2022). The decrease in the quality could be observed during the field visit.

Complaints such as the non-collection of recyclable material and the impossibility of new registrations were recurrent. In addition, another frequent observation of the residents was about the way the material was handled: the residents carried out the separation and prior cleaning of the material, which when was picked up, it was disposed of inside the compactor truck and mixed with all the other waste already there. As it didn't have a prior inspection, there was no certainty that the material was properly cleaned, which caused a spread of organic material from the dirty materials to the clean ones, potentially rendering the entire mass useless. Thus, the public cleaning company of the city of Niterói was designated to replace the areas previously served by the outsource company and with the expectation of performing a better performance.

The methodology chosen to be used and replace the one that was previously used was the one used in São Francisco, with a previous visit by a trained team that disclosed the project in a didactic way, with the operation being done fully throughout the district without the need of a previous registration and with the material being taken and stored in a box type truck.

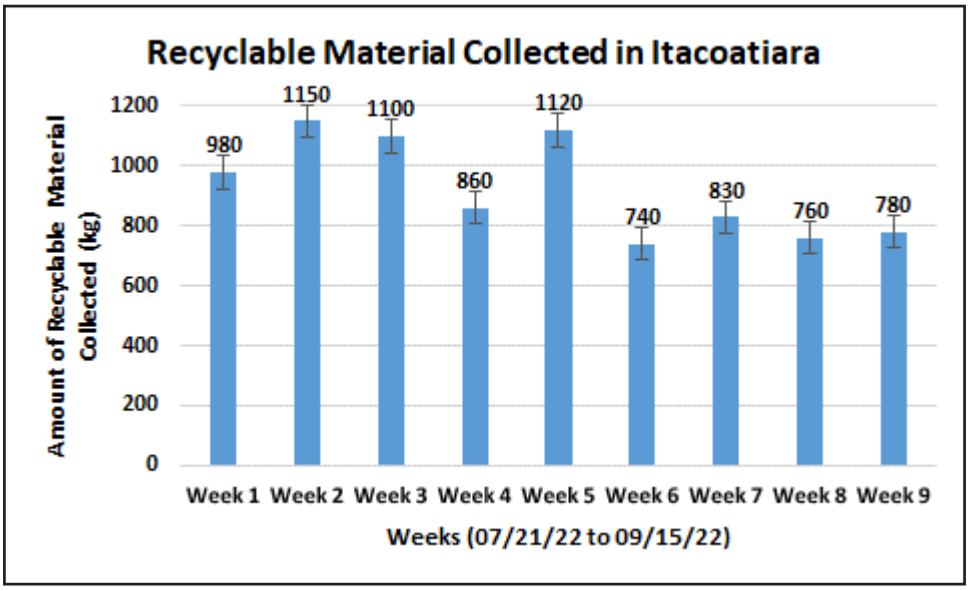
As seen earlier, the project implemented in São Francisco was not conceived with the intention of being replicated, which can be proven by the fact that no similar operation has been done in the city of Niterói since its creation in 1985. Thus, the district selected to be the first to replicate the methodology was Itacoatiara, because the two have similar characteristics: they are mostly residential districts, with residents of high economic and sociocultural standard, as well as a resident's association that supports the implementation of sustainable measures. In addition, Itacoatiara has a small area, low number of residences and a favorable geographical configuration, even considering that part of the streets is not paved when compared to other districts in the region.

After choosing Itacoatiara, the fieldwork was started with a team of five people, that visited all the residences in the district over four days. Among the 623 households visited, 264 were received by the team and of these, 122 did not participate in the operation that was carried out until then. The team then disclosed the start of the new operation, leaving with the residents a newsletter with basic guidelines on how it works.

With the information disclosed to the population, planning for the start of the operation began. For logistical reasons, the collection of recyclable material in Niterói are carried out on Tuesdays, Thursdays, and Saturdays. Considering that Itacoatiara has a very crowded beach on weekends, leaving the area with high traffic, and the route made on Tuesdays by the team already had many addresses, the day chosen for this one was Thursday. Due to the small size of the district when compared to São Francisco, it was decided that only one day a week would be enough.

The first day took place on July 14, 2022. The amount of material taken during that day, however, was not accounted for, as the equipment for the measurement was not in operation. In the subsequent weeks, the weighing of the material was carried out without the occurrence of problems, as detailed in figure 1.

Figure 1 – *Amount of material collected in Itacoatiara*



Source: CLIN (2022)

The graph shown in figure 1 shows that in the first 9 weeks in which the process was performed and recorded, it can be observed a good adherence of the residents of Itacoatiara, with a weekly average of just over 900 kilograms being collected weekly, a value well above the 300 kilograms per week that were collected by the outsource company previously. The residents also gave several compliments regarding the vehicle used. Until then, the compactor type truck was the one used, which in addition to exuding a bad odor around it, reapplied the same methodology used in the general waste: the material was quickly thrown into the truck without much concern and mixed with the other materials present through the compaction, eventually mixing an improper material with a clean material, preventing a possible recycling in the future.

As previously reported, the type of truck used was the box truck, in which the previously analyzed material is carefully stored inside by the collectors. That way, even if an incorrect material has been taken, it won't be mixed with the others to the point of making them all unusable for recycling. Finally, because it was always closed and the material inside remains intact, the truck does not exude a bad odor. It was also found that the look of the truck is more pleasant, removing a little the stigma that the compactor truck has in relation to waste.

Another praiseworthy change is the fact that the collectors are now sitting protected inside the vehicle, and they only leave when the truck stops, solving the recurrent issues of potential traffic accidents due to the usual way they hang on the external part of the compactor truck and the fact that they are usually running after it, while also preventing them from working full time while standing. Nevertheless, those problems still happen daily on the general waste collection, which even though is not allowed in the law, it is silently accepted by society by the fact that everyone wants their waste taken (Patruni, 2018).

With the positive feedback, it was decided that one more district should receive the program, and if the result was positive, in addition to its remaining in place, the method

used would gain another sample in its favor. For this, the district of Camboinhas, also located in the oceanic region of Niterói, was chosen to be the next to receive the method.

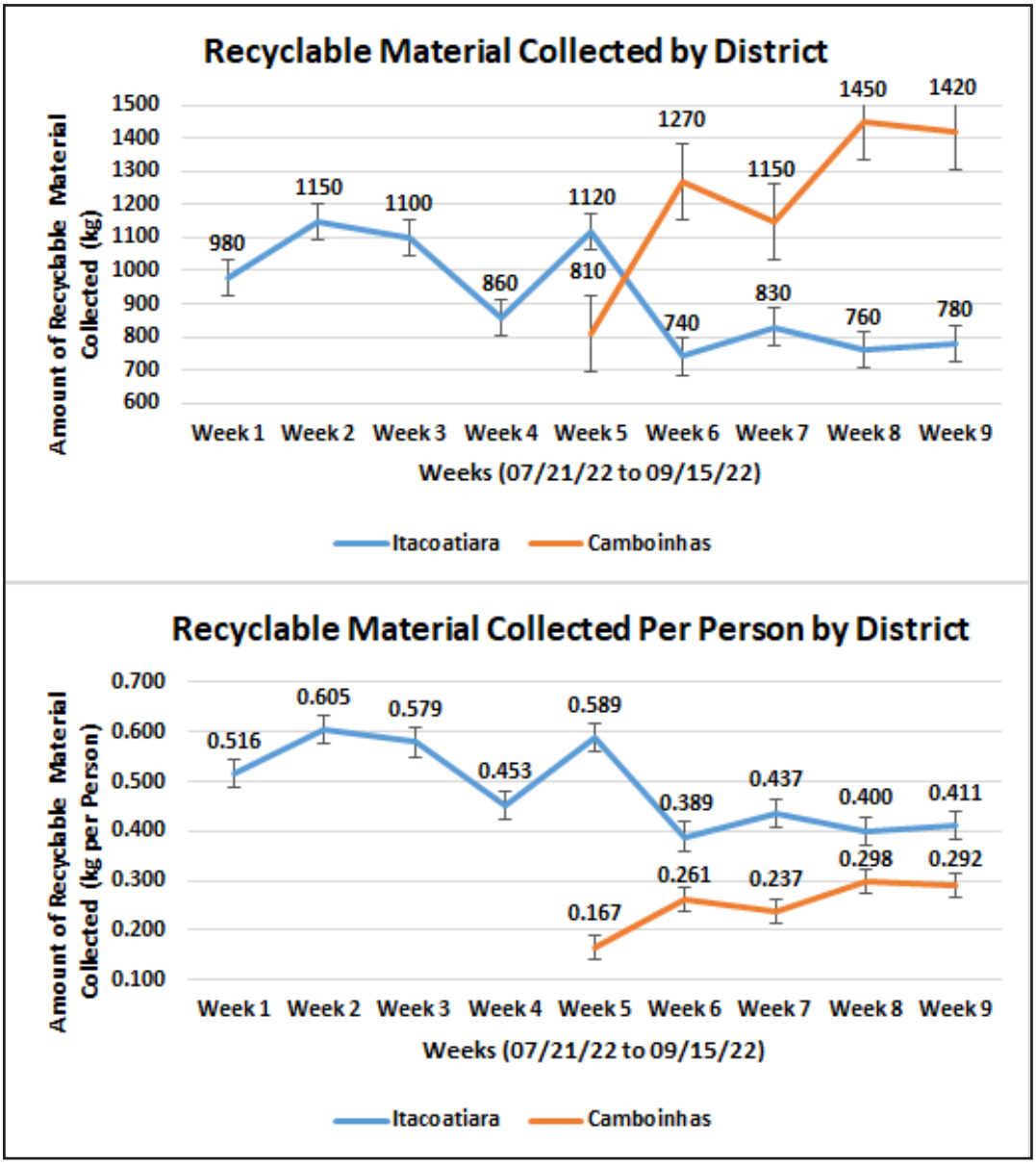
4 THE DEVELOPMENT OF THE SELECTIVE COLLECTION PROJECT IN CAMBOINHAS

Camboinhas, like Itacoatiara, is one of the districts with the highest acquisition power in Niterói, with both being courted by the sea of the region, served by a road map that provides only a place for entry and exit of vehicles and have an association of residents with high participation in the affairs of the district. However, Camboinhas has several buildings within its territory, a wide boardwalk on its beach, as well as a mall near its entrance, characteristics that evidence the change and advancement of the urbanization process that Camboinhas has suffered in its environment over the years (Torres, 2015). The district lies between São Francisco and Itacoatiara in terms of number of inhabitants, with about 3138 people living in the region, according to the IBGE (2010). In addition, it has a greater number of buildings in relation to the other two districts, also containing a greater amount of commercial real estate and a reasonable number of dead-end streets.

In the same way as in Itacoatiara, the team previously went to Camboinhas for the announcement of the upcoming service, correctly instructing the steps to be performed to those who received the team, counting about 4860 inhabitants during it. Once again there were complaints about how the process was carried out so far, with additional comments made in relation to autonomous waste pickers in the region, that allegedly had the habit of leaving material scattered along the sidewalk while searching the waste bags, a factor that had not been identified in Itacoatiara. To mitigate this situation, some waste pickers were located and instructed to carry out their gathering in a more orderly manner, establishing a mutual partnership with the collectors of the city's public cleaning company in the same way that had been done in São Francisco.

It was also decided that Camboinhas would receive the operation only once a week; However, because it has a larger area, two box type trucks would be responsible for it. Thus, the graphs shown in figure 2 were made, first comparing the values in kilograms collected in both districts in the same period, and second, the per person comparison of the material collected in the two districts.

Figure 2 – Behavior of the collections carried out in Itacoatiara and Camboinhas



Source: CLIN (2022)

Analyzing the graphs in figure 2, we can see a progressive increase in the amount collected in Camboinhas, which is greater than Itacoatiara in the same period, because of the numbers of inhabitants being different in the two districts. The per person graph reveals that the values of recyclable material discarded per inhabitant are considerably low. The values of Itacoatiara, considering that the operation is carried out once every seven days and a total of inhabitants is estimated to be around 1900, demonstrate that, on average, 0.487 kilograms per person of waste are properly collected and recycled weekly. Camboinhas, which has 4860 inhabitants according to the survey, presents even lower results, with about 0.251 kilograms per person of recyclable waste generated on average and that are properly collected weekly. A hypothesis for the behavior verified in Camboinhas would be the low engagement of the population in the separation of waste. On one hand, the few residents of Camboinhas who participate in the operation contribute a considerable amount of recyclable material, on the other hand, many residents do not participate.

A common behavior between the two graphs was also observed. In Itacoatiara, there is a gradual increase in the amount of material up to a certain point, when it decreases, and its results demonstrate a stability. An exception to this occurred in week 4 of the analysis, referring to August 11, 2022, when the unstable weather conditions of the day may have provided a non-participation of some residents. This same behavior can be expected in Camboinhas, where the initial data still represent the phase of gradual increase, but considering the proportions of the population of each district, it is possible to affirm that the amount of material collected is satisfactory.

Thus, it was possible to confirm the statements of Barsano & Barbosa (2013), that a selective collection works properly when the population that will be served by it is properly oriented about the process and consequently, volunteers to participate. In this case, the team's previous visit to the districts, not only announcing the operation itself, but raising awareness among residents, seemed to be of great importance for the good results of the project.

CONCLUSIONS

In compliance with the objectives previously determined for the development of this work, a selective collection process was implemented, monitored, and evaluated in the districts of Itacoatiara and Camboinhas, in Niterói, based on the methodology used in São Francisco. Once the operation began, the results were quite satisfactory, with quantities of material collected higher than those previously obtained.

However, even though the operation was received with positive eyes, a drop in the amount of material gathered after the first few weeks was observed. This may be justified by the loss of interest of some residents in the process, probably caused by the need to keep doing it every week, which can lead to the less interested residents to give up after a certain time. To maintain the enthusiasm of the population, in hopes to increase the amount gathered, it is recommended that an analysis be made periodically on the streets or regions that least contribute to the operation and later send a team to these places for a more intense dialogue with these residents.

Another possible issue is the fact those who misses the collecting day will have to either store the material for another week or dispose it with the general waste. For that, a combination of methods already used in the city can be employed in the districts as another form of aid. The installation of a semi-buried container in the access to Itacoatiara, for example, could benefit those residents who do not participate because the operation happens only once a week. In Camboinhas, where there is a greater supply of space and a larger contingent of people, a voluntary delivery point could be built, for example.

Likewise, residents and companies that are more assiduous with the environmental issue or that lacked an incentive are already able to contribute directly to new projects and receive tax benefits as rewards. These possible investments, in the medium and long term, can make such operations more effective, which allows the transfer of efforts to other locations, helping to considerable increase in the amount of material to be properly recycled.

The collectors from the company are working in a safer environment, even though the change of vehicles made the operation take longer to finish, which is making some of the unhappy. That could be solved with the deployment of more trucks and workers, but neither are currently possible due to lack of resources. For the moment, a compromise between them and the company could be made, looking for the best way to keep the ongoing operation.

Ultimately, the study showed positive results even in its early stages, presenting potential and doable improvements. The population is also aware of the environmental issues faced by the country and is earnestly trying to individually help the cause despite the challenges that may arise. For future works, it is recommended to continue the analysis of the most recent data from the districts studied, as well as the comparison with data from possible districts to receive the same methodology, seeking to deepen the conclusions found in this work. It is also recommended to search for strategies that reduce the expenses used on them, in view of the possible damages to the environment, either through a more sustainable methodological plan, or with the use of different forms of collection.

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