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Compliance identification of ecopoints in the municipality of Aracaju according to NBR 15112/2004

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Abstract: The large production of Municipal Solid Waste (MSW) happens in parallel with the large consumption of products present in the world community, including Brazil. In 2023, the Brazilian population generated approximately 81 million tons of MSW, a portion of which can be reused and recycled. In this context, this research aims to investigate aspects of MSW management in Aracaju (Sergipe) based on the verification of the conditions of implementation, design and operation of ecopoints with the determinations of the Brazilian Standard NBR 15112/2004. The methodology used was the bibliographical research on solid waste, followed by the application of a checklist to verify compliance with the parameters set out in the standard at the six ecopoints in Aracaju. The result is that 60% of the requirements of NBR 15112 were met, while 19% were not and 21% were partially met. The positive highlights were the items insulation, personal protective equipment, energy supply, paving, staff qualifications, sketch, descriptive memorial, destination, types of waste receivable and storage locations. The negative aspects were identification, firefighting, dust control and, above all, quantitative control of the waste received. This research aims to help public authorities implement improvements to ecopoints, as well as disseminating knowledge about these public facilities among the population. Future research investigating the capacity, location, receptivity, and costs of the city's recycling centers is recommended.

Key words: Selective collection, construction waste, voluntary delivery point, transshipment and sorting area.

Identificação do cumprimento da NBR 15112/2004 sobre a identificação de Ecopontos no Município de Aracaju

Resumo: A grande produção de Resíduos Sólidos Urbanos (RSU) acontece em paralelo ao grande consumo de produtos presente na comunidade mundial, inclusive no Brasil. Em 2023, a população brasileira gerou aproximadamente 81 milhões de toneladas de RSU, sendo uma parcela dessa quantidade passível de reuso e reciclagem. Nesse contexto, esta pesquisa tem como objetivo investigar aspectos da gestão dos RSU em Aracaju, Sergipe, a partir da verificação das condições de implantação, projeto e operação dos ecopontos com as determinações da Norma Brasileira NBR 15112/2004. A metodologia utilizada foi a pesquisa bibliográfica sobre resíduos sólidos seguida da aplicação de uma lista de verificação para conferência da observância dos parâmetros trazidos pela norma, nos seis ecopontos de Aracaju. Como resultado, obteve-se que 60% dos requisitos exigíveis da NBR 15112 foram atendidos, enquanto 19% não foram e 21% foram alcançados de forma parcial. O destaque positivo foram os itens isolamento, equipamentos de proteção individual, fornecimento de energia, pavimentação, qualificação de pessoal, croqui, memorial descritivo, destinação, tipos de resíduos recebíveis e locais de armazenamento. O destaque negativo foram os itens identificação, combate a incêndio, controle de poeira e, principalmente, o controle quantitativo dos resíduos recebidos. Esta pesquisa se propõe a colaborar na implementação de melhorias aos ecopontos por parte do poder público, bem como, disseminar o conhecimento sobre esses equipamentos públicos entre a população. pesquisas futuras são recomendadas com a investigação da capacidade, localização, receptividade e

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custos dos ecopontos da cidade.

Palavras chave: Coleta seletiva, resíduos da construção civil, ponto de entrega voluntária, área de transbordo e triagem.

Introduction

Brazil, the world's 11th largest economy in the list published by the International Monetary Fund (IMF) in 2022 (ICL Economia 2023), is characterized by significant consumption of goods and services and, consequently, considerable waste generation. In 2023, according to the Brazilian Waste and Environment Association (ABREMA 2024), the Brazilian population generated approximately 81 million tons of Urban Solid Waste (MSW), of which around 6.7% was sent for recycling.

Solid waste generated from human activity is diverse. It is classified according to its origin, risks to public health and the environment, and chemical and physical characteristics (Ito & Colombo 2019), and is categorized as hazardous, non-hazardous, household, industrial, health services, construction, among others (BRASIL 2010). In addition to state and municipal laws, waste management in Brazil is governed by Federal Law 12305 of 2010, which indicates selective collection as an instrument, which, in turn, can be carried out with the use of ecopoints, equipment that receives small volumes of certain waste not collected in conventional collection (Niveiros *et al.* 2021). Ecopoints are governed by regulations, which oblige them to comply with requirements, and are the object of scientific research to understand the challenges and contributions they make in the management of solid waste (Resch *et al.* 2012).

Managing solid waste in a way that is appropriate for public health, the conservation of natural resources and the protection of the environment is one of the fundamental principles underpinning the provision of public basic sanitation services (BRASIL 2007). Failure to manage properly implies damage to the other components of basic sanitation (drinking water supply, sewage disposal and rainwater drainage) due to the interference of waste in the functioning of these components. The environmental degradation caused by the improper waste disposal can be seen in the contamination of surface and groundwater and soil, air pollution, and public health problems (Martins 2017).

Given the context in which Brazil is inserted, marked by the production of a large amount of waste, the importance of its proper management for the correct application of basic sanitation, and the responsibility that public authorities and society have in this regard, the curiosity arose to verify whether in Aracaju, capital of Sergipe, the management of part of the Urban Solid Waste takes place to the satisfaction of the legislation and standards in force, through a survey of the municipality's ecopoints.

The main objective of this study is to compare the conditions of implementation, design and operation of the ecopoints in Aracaju with the Brazilian Standard ABNT NBR 15112/2004. Specifically, this study aims to obtain from legislation, standards and literature, what is covered about the proper functioning of an ecopoint, understand how the management of certain waste is carried out from the context of Aracaju's ecopoints, and provide information to support the best use of existing and future ecopoints, regarding, for example, physical structure, security, identification, storage, reception and destination protocol, and qualitative and quantitative control.

Methodology

Study area and waste management

Aracaju is located in the east of the state of Sergipe and has a territorial area of 182.163 km² and a population of 602,757 inhabitants (IBGE 2022). The Municipal Environment Department of Aracaju was created in 2013 (Santos *et al.* 2023). In the same year, the Municipal System for the Sustainable Management of Civil Construction Waste and Voluminous Waste

was established through Municipal Law 4452, which includes the Municipal Program for the Management of Civil Construction Waste that indicates the management of Small Volumes of Civil Construction Waste and Voluminous Waste, those contained in volumes of up to 1 m³.

In 2016, the Greater Aracaju Intermunicipal Solid Waste Plan was published, establishing guidelines to strengthen the management of different types of waste. Among the strategies defined is the incentive to properly set up ecopoints in neighborhoods, based on population concentration criteria, in accordance with the recommendations of the Ministry of the Environment. These ecopoints have the function of temporarily receiving waste from selective collection (dry), construction and demolition waste, prunings, materials subject to reverse logistics and bulky waste, such as discarded furniture and appliances. For Aracaju, the plan foresaw the installation of 34 ecopoints by 2035, with the implementation of the 26th unit by 2024, in a scenario projected for a population of 735,199 inhabitants (SERGIPE 2016).

According to the 2022 Management Report of the Aracaju Municipal Urban Services Company, the first ecopoint installed was in the Industrial neighborhood in 2018, followed by the Coroa do Meio and Santos Dumont neighborhoods in 2019, then by the Dezessete de Março neighborhood in 2020, and finally the Ponto Novo and Inácio Barbosa neighborhoods in 2022. In 2024, there were six units in operation in the municipality, with the location of the ecopoints reaching different regions (**Figure 1**).

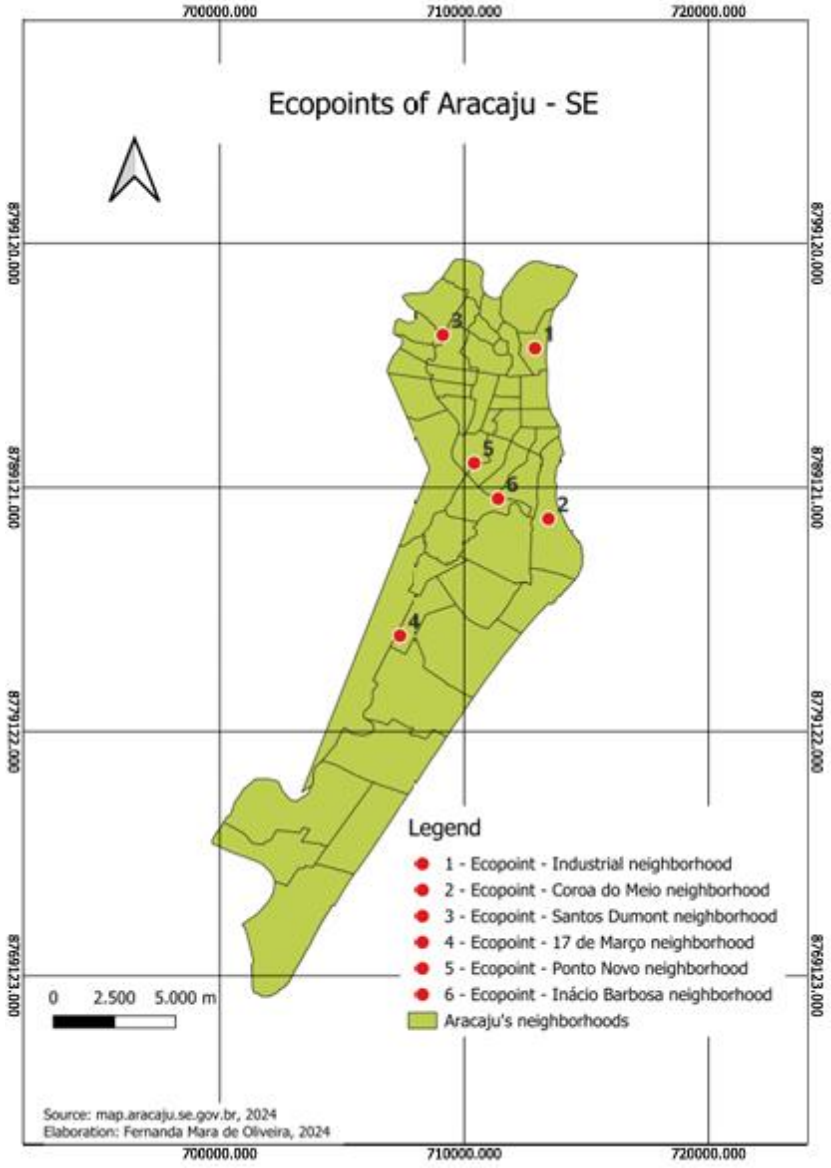

Figure 1. Location of ecopoints in the neighborhoods of Aracaju city.

Methodological approach

In order to identify the compliance of Aracaju's ecopoints in terms of implementation, design and operation conditions, the research was carried out in three stages. Initially, a bibliographical survey was carried out on the subject, then a practicable checklist was drawn up with the items from NBR 15112 that refer to small volume delivery points, namely that each item required by the standard was transformed into a question with three possible results (yes, no or partial), and finally, the list was applied between the months of April and May 2024, through visits to the ecopoints and communication via e-mail with the Municipal Company, and the data obtained was subsequently tabulated.

This research is quantitative and qualitative, since it collects information and treats it statistically, and because it describes and characterizes the sites analyzed through the information collected in the checklist and visits (Richardson 2012).

For organizational purposes, the ecopoints were listed according to **Table 1**, and the results for each requirement of the standard investigated, obtained from the survey, were tabulated in an electronic spreadsheet. The results of the questions were detailed and commented on in the light of the bibliographical research, and the discussion was carried out in the same order as the requirements set out in NBR 15112.

Table 1. Designation of Aracaju's ecopoints by neighborhood for organizational purposes.

Aracaju's Ecopoints	
Ecopoint – Industrial Neighborhood	Ecopoint 01
Ecopoint – Coroa do Meio Neighborhood	Ecopoint 02
Ecopoint – Santos Dumont Neighborhood	Ecopoint 03
Ecopoint – 17 de Março Neighborhood	Ecopoint 04
Ecopoint – Ponto Novo Neighborhood	Ecopoint 05
Ecopoint – Inácio Barbosa Neighborhood	Ecopoint 06

Results and Discussion

Based on the tabulation of the checklist's answers, it can be seen that the ecopoints in Aracaju obtained the results as shown in **Figure 2**. The different weightings for the implementation, design and operation conditions are shown in **Figure 3**. The tabulated data was discussed according to the order established by NBR 15112: e.g., implementation, design and operation.

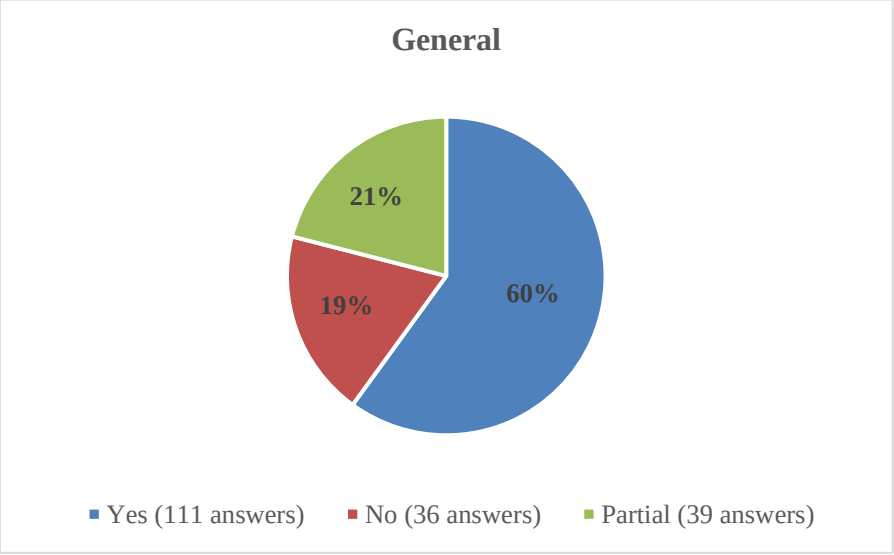

Figure 2. Checklist answers regarding NBR 15112 conditions, in general terms.

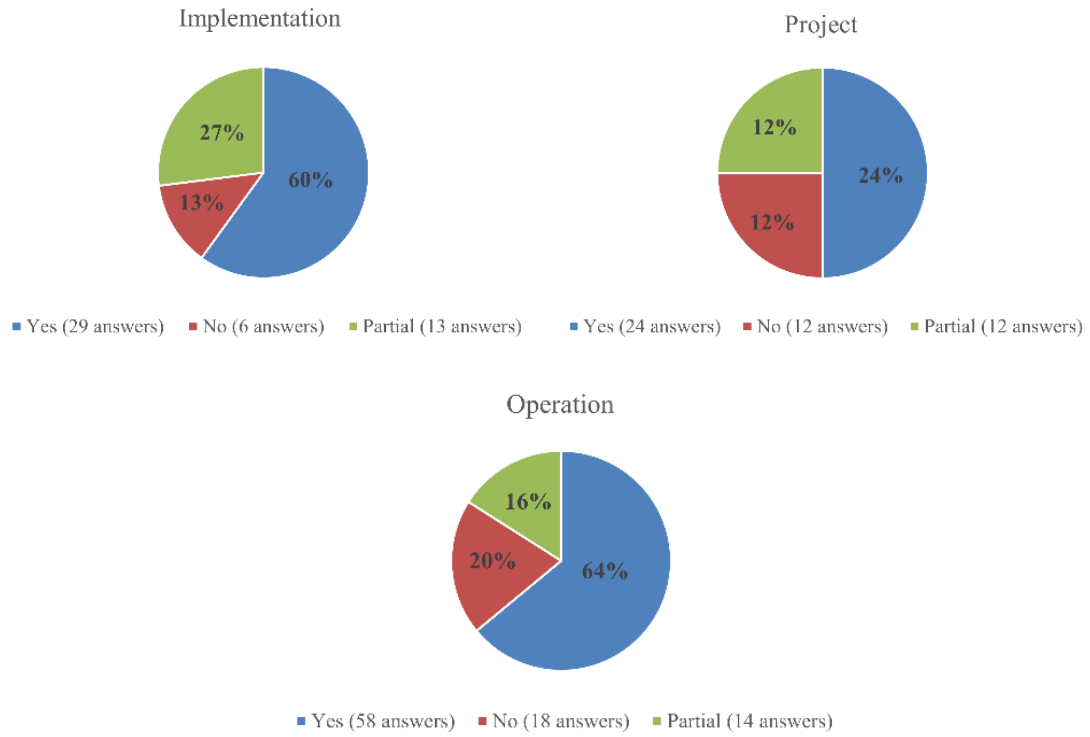

Figure 3. Checklist answers regarding NBR 15112 conditions, presented separately.

I. Implementation conditions

A) Insulation

All the ecopoints visited had fences around their perimeters, and access was through a metal gate, by which employees were able to control the entry of people. To a certain extent, the ecopoints kept their distance from neighboring buildings, with at least two sides occupied by unbuilt areas with some vegetation. Ecopoint 03, on the other hand, was located between houses in the neighborhood. Although there was no shrub or tree fence around the perimeter of any of the ecopoints, this distance provided relative protection for the neighborhood from possible noise. In terms of aesthetics, all the units had well-preserved buildings, landscaping and were in keeping with the region, without contrasting with the aesthetics of the area.

B) Identification

The approval's identification of the projects was not observed during the visits. At Ecopoints 01, 03, 05 and 06, the signs indicating permitted waste were in good condition, but in the rest, they were in place, but already worn out. The service hours sign was installed and visible only at Ecopoints 01, 05 and 06. Failure to identify an ecopoint can lead to it being used inappropriately, and can also put people off actively participating in the waste management chain through ecopoints (Silva 2012). In a survey on the environmental perception of the ecopoint in the Coroa do Meio neighborhood, residents and users interviewed reported the need for the community to place signs to locate the equipment (Moreira *et al.* 2022).

C) Safety equipment

The employees of all units visited had personal protective equipment. All ecopoints had electricity supply in the internal area of the guardhouse and in the external area of the courtyard, this provided comfort to the employees and allowed the equipment to remain illuminated at night, in order to inhibit the action of invaders. However, none of the ecopoints had a fire- fighting system. Since there is combustible material among the waste received in the

ecopoints, the installation of fire extinguishers according to fire class becomes indispensable and is a measure that protects property and people (employees and surrounding population).

D) Environmental protection systems

The unloading of construction waste into the collection box was done manually with a shovel, which did not generate significant dust, but the box had no physical cover to prevent the spread of particles by the wind. During the exchange of boxes, it was found that the box is covered for transportation, but while it remains in the ecopoint it remains uncovered. Physical protection or even spraying water on the stored material are ways to mitigating the emission of dust generated, which would reduce damage to the health of employees, users and the local community (Araujo *et al.* 2017).

With regard to noise containment from vehicles and equipment, it was observed that this was not necessary in the context of the ecopoints visited, since there was no use of machinery on site and the circulation of vehicles for delivering and collecting waste was not intense.

All of the ecopoints investigated had asphalt paving on the floor of the external area used for access, operation and storage. This type of coating prevents soil contamination caused by material leaking from the waste containers and allows the area to be used any weather conditions - on rainy days traffic is not prevented and on windy days there is no circulation of dust (Bernucci *et al.* 2006).

II. General conditions for the project

A) General

According to NBR 15112, the project for small volume delivery points must contain the following items: registration information, descriptive memorial, sketch of the project and photographic report of the area. For the ecopoints in Aracaju, these items were partially complied with, as the photographic report of the area prior to the construction of the ecopoint could not be verified, since it was not made available by Aracaju Municipal Urban Services Company.

B) Registration information

The ecopoints were set up on land owned by the municipality and built by a qualified entrepreneur in accordance with the requirements of the calls for tenders, four of which were financed by the municipality's own funds and two by funds from the Inter-American Development Bank (IDB). Compliance with this item can be seen as a step towards consolidating the ecopoints system in the municipality, as the risk of the equipment having its location changed is low, given that it is built on its own land.

With regard to the qualifications of the ecopoints employees, it was reported that they are trained in receiving, storing and delivering waste. This could be verified during the visits, as they demonstrated the minimum knowledge required to operate the equipment. Gonçalves *et al.* (2022) noted the importance of the operator having knowledge of the solid waste disposal procedure in order to guide the population using the ecopoint.

Furthermore, ecopoints could be spaces for promoting environmental education by improving the qualifications of their operators and bringing in more trained people to develop activities with the community that uses these spaces. An example of this is Fortaleza (CE), where important programs such as E-carroceiro, Recicla Fortaleza, Planeta Limpo and Ecopolos have been developed, with the municipality's ecopoints as support bases (Alexandre 2021).

C) Descriptive memorial

It is possible to say that the description of the implementation, operation and devices, contained in the standardized descriptive memorial common to Aracaju's ecopoints, has been

met because there is a breakdown of the materials that will be used in the ecopoint as a whole (internal and external areas, equipment, boundaries, sidewalks, signs and lighting) and, briefly, a breakdown of the operation, with a list of the waste allowed for delivery. However, there was no information on safety equipment, such as a fire-fighting system, or on the suitability of the site in terms of topography, access and surroundings.

D) Sketch of the project

All the ecopoints were supplied with plans of the situation, location, floor, roof and cross-sections. These plans show the boundaries, accesses, buildings, the reception and sorting area, the temporary waste storage and the devices used, in accordance with NBR 15112. The designs for the guardhouse, warehouses and façade were standardized. The positioning of each building and the area for the maneuvering yard differed, as they varied according to the area of the site so as to allow the site to be used properly.

E) Photographic report

Photographs of the sites where Aracaju's six ecopoints would be built, i.e.: images of what the areas looked like before construction, were not available. In view of this, the requirement was considered to be in breach of the standard, regardless of whether or not the report existed, since it could not be verified. The presentation of the images from before the ecopoints could reinforce the importance of these equipment due to the positive transformation of the landscape of the sites, which were probably areas of irregular waste disposal.

III. Operating conditions

A) Control of waste reception

NBR 15112 exempts the presentation of the Waste Transportation Control document when users deliver waste to ecopoints, but prescribes control of the material received as to origin, quantity and quality. This control was found to be precarious at all the ecopoints visited. The employees said that the only information they recorded was the license plate number of the user's vehicle, the user's address and the time of delivery.

Considering that Municipal Law 4452/2013 defines the volume of one cubic meter (1 m^3) as the maximum limit for waste delivery per user, the lack of quantitative control does not allow the operator to verify this. Resch *et al.* (2012) observed that, in São Paulo, the definition of this same limit is a means of avoiding the use of ecopoints by large generators, who must contract private collection. Ito & Colombo (2019) believe that the delivery of larger volumes could be allowed by payment fees equivalent to the extra volume of waste and lower than the fees charged by private individuals, as it would encourage the population to use the ecopoints and not dispose of it illegally. The lack of information on the volume of waste delivered to each ecopoint in Aracaju makes it impossible to take measures such as those mentioned by the authors, for example.

B) Qualitative and quantitative control of waste

There was no record of the waste received through monthly reports, but there was proof of the destination, which was due to the fact that the recyclables were only collected by the cooperatives, Cooperativa dos Agentes Autônomos de Reciclagem de Aracaju (CARE) and Cooperativa de Reciclagem do Bairro Santa Maria (COORES), which had a partnership with Aracaju City Hall. To the same extent, the collection and transportation of Construction and Demolition Waste (C&DW) was only carried out by the Termoclave Company, with duly licensed collectors, while the collection of tailings was done by Torre, a registered company.

Aracaju Municipal Urban Services Company said that each material was weighed using a scale by the company responsible for the collection, at the destination of each piece of waste.

Additional details on the quantity coming from each ecopoint to the destinations were not answered. From the point of view of integrated solid waste management, Barros (2012) points out that reliable data collection followed by repeated technical analyses is essential in order to give precision to management plans, improve the operating conditions of services and subsidize consequent political and administrative decisions.

Quantitative and qualitative control done correctly allows intervention in order to make the best use of the ecopoints and the implementation of actions to encourage their use, such as exchanging waste for benefits from public services. Silva (2012) was able to observe over- or under-utilization of ecopoints in São José do Rio Preto (SP), based on data collected on the volume of waste received per ecopoint. Alexandre (2021) reported on the experience of Fortaleza (CE), which has the "Recicla Fortaleza" and E-carroceiro programs in its ecopoint system. In the former, registered users delivered recyclable materials in exchange for bonuses on their electricity bills and public transport, while in the latter, registered cart drivers exchanged recyclables, construction rubble, prunings and bulky items for bonuses worth money to be used in local businesses.

C) Operation guidelines

Aracaju's ecopoints are authorized to receive all types of waste, with the exception of household (organic), industrial and health service waste.

During the survey, it was found that all ecopoints receive electronic waste, recyclable waste (paper, plastic, glass, metal), mandatory reverse logistics waste (batteries, light bulbs, tires), as well as bulky waste of different origins and small-volume C&DW. The majority of the C&DW received was class A and B, but class C was not refused. The gypsum waste (class B) received was sent to the reject box, which was then sent to the landfill. Class D waste was not accepted at the ecopoints. According to Municipal Company, tires were collected by Recicla Limpe and sent to the appropriate destination, while batteries and light bulbs were collected by Reciclus, a specialized company responsible for the correct disposal of these materials.

The material received at the ecopoints arrived partly sorted by users and what wasn't sorted was classified by the cleaning agent according to its nature and packed in boxes, containers and bays. One box was 30 m^3, where class A C&DW was kept until it was collected and then delivered to the construction recycling plant (RCD Tabocas), located in the municipality of Nossa Senhora do Socorro, next to the capital. The other box was 5 m^3, where bulky waste that couldn't be recycled and other waste resulting from all the sorted material was kept, such as class C C&DW waste and tree pruning waste, for example - at Ecopoint 05 there were two of these boxes. And the containers or bays were used to store waste such as paper, plastic, glass, electronics, tires and others until they were collected by the accredited recycling cooperative. In this way, it can be seen that the waste was properly disposed of according to type. According to employees at all ecopoints, they called for the collection of stored material as the spaces were completely filled, in order to avoid the build-up of material, and only allowed authorized persons to remove it.

As for construction waste, it was taken to a recycling plant in the state, which in turn had an operating license, valid until October 2025, according to the Environmental State Administration. Given that the waste collected by the cooperatives was sold for processing at industrial facilities across the country, it was not possible for this study to verify the licensing status of these processing operations.

Conclusions

In the municipality of Aracaju, all six active ecopoints analyzed by the survey showed that most of them complied with the parameters set by the standard. With regard to the implementation of the ecopoints, the requirements of fencing, access, distance, landscaping, provision of PPE, power supply, lighting and floor covering were satisfactory, but the items of identification, fire-fighting and dust control systems did not fully comply with the standard. As

for the project, the positive highlights are the qualifications of the developer and operator of the equipment, the standardization of projects and the descriptive memorial, and the negative highlight is the absence of photographic record. About the operation, it is worth that the requirements for waste disposal, types of waste received and storage sites have been met, but the opposite is true for the quantitative and qualitative control of the waste received and collected.

Non-compliance with quantitative and qualitative control does not allow for the generation of data necessary for solid waste management. Among the data are the rates of volume of waste delivered in relation to different factors such as class and characteristic, delivery period, user address, form of transportation used by the population, frequency of delivery, as well as the rates of quantify of waste collected from the ecopoint according to destination in relation to day, month and year. From this data, it would be possible to make diagnoses to understand whether the equipment is operating at the capacity for which it was designed, or even calculate how much each ecopoint costs the public authority.

Another important issue is the transparency of the data relating to ecopoints, which must be given because it is the administration of public facilities. Furthermore, when the data is known to everyone responsible for shared waste management (government, citizens, the private sector and organized civil society), each entity is called to account for its failure. For example, with the periodic reports on waste received and collected, it is possible to identify the timid purchase of recyclables by industries, demonstrated by the cooperatives' lack of interest in collecting some materials, or even the community's low adherence to using the ecopoint due to the low volume of waste delivered.

The non-compliance with some of the requirements of NBR 15112 found in this study can be solved by making adjustments to the physical structure of the ecopoints, from revitalizing the nameplates to installing fire-fighting and dust control systems, and by making changes to the work routine, through the implementation of qualitative and quantitative control of the waste received and disposed of, as well as the production of detailed reports.

For future research, it is recommended to investigate Aracaju's ecopoints from other points of view, in order to understand solid waste management in the city and provide a theoretical basis for public authorities and society to develop improvements to the system. This research can be carried out in terms of (1) capacity for receiving, storing and flowing material at each ecopoint; (2) the strategy for choosing the location of ecopoints in the city; (3) the perception of the community that makes direct use of the ecopoints; (4) the cost involved in installing and maintaining ecopoints.

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