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EVALUATION OF SOLID WASTE MANAGEMENT IN THE MUNICIPALITY OF GUARUJÁ - SP: A PERFORMANCE ANALYSIS BETWEEN THE YEARS 2017 AND 2021

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Abstract

Objective: The evaluation of solid waste management in a municipality is a powerful tool for assessing the efficiency of implemented projects and the execution of activities carried out by managers and other stakeholders. In this regard, this study analyzed the actions of the Municipal Government of Guarujá between the years 2017 and 2021, according to the Regional Plan for Integrated Solid Waste Management of Santos Area Lowlands.
Methodology: The present research was conducted using a qualitative approach through document analysis. Information was collected directly from the Department of Environment (SEMAM) and the Department of Urban Services (SEURB) of the Guarujá Municipality. The collected data were analyzed in accordance with the selected bibliographic references and concerning the conclusions drawn for each identified action.
Originality/Relevance: This research proposes an innovative approach in studying solid waste management in Guarujá, with a focus on the Regional Plan. Emphasis is given to the importance of integrated management, as well as the need to review the strategies adopted by the municipality, providing an original perspective on the matter.
Key Findings: The main results of this study are the significant advancements made by the municipality of Guarujá about planning and implementing public policies to enable solid waste management within its territory.
Contributions: Moreover this study points flaws in current legislation and emphasizes the importance of creating Regionalized Solid Waste Units to ensure the effectiveness of regional plans. Consequently, the findings obtained from this research constitute scientific contributions aimed at driving the implementation of more effective and sustainable public policies in the field of solid waste management.

Keywords: Solid Waste; Municipal Management; Integrated management; Municipality of Guarujá.

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AVALIAÇÃO DA GESTÃO DE RESÍDUOS SÓLIDOS NO MUNICÍPIO DE GUARUJÁ – SP: UMA ANÁLISE DE DESEMPENHO ENTRE OS ANOS DE 2017 E 2021

Resumo

Objetivo do Estudo: A avaliação da gestão de resíduos sólidos em um município é uma ferramenta poderosa para a aferição da eficiência dos projetos implantados e da execução das atividades adotadas pelos gestores e demais atores envolvidos. Nesse sentido, esse estudo analisou as ações da Prefeitura Municipal de Guarujá entre os anos de 2017 a2021, alinhadas com o Plano Regional de Gestão Integrada de Resíduos Sólidos da Baixada Santista.
Metodologia: A pesquisa foi conduzida como uma abordagem qualitativa por meio de análise documental. As informações foram coletadas diretamente da Secretaria de Meio Ambiente (SEMAM), da Prefeitura de Guarujá, Secretaria de Serviços Urbanos (SEURB) e foram analisadas à luz das referências bibliográficas selecionadas e sob o ponto de vista da conclusão de cada ação identificada.
Originalidade / Relevância: Nesta pesquisa, é proposta uma abordagem inovadora ao examinar a gestão de resíduos sólidos em Guarujá, enfocando o Plano Regional. Destaca-se a importância de uma gestão integrada e ressalta-se a necessidade de revisar as estratégias adotadas pela prefeitura, trazendo uma perspectiva original ao assunto.
Principais Resultados: Como principais resultados destacam-se os avanços significativos que o município de Guarujá produziu em relação ao planejamento e implementação de políticas públicas para viabilizar a gestão de resíduos sólidos em seu território.
Contribuições: Adicionalmente, esse estudo revela falhas na legislação vigente e enfatiza a relevância da criação de Unidades Regionalizadas de Resíduos Sólidos para garantir a efetividade dos planos regionais. Consequentemente, as descobertas obtidas nessa pesquisa constituem contribuições científicas que visam impulsionar a implementação de políticas públicas mais efetivas e sustentáveis no campo da gestão de resíduos sólidos.

Palavras-chave: Resíduos Sólidos; Gestão Municipal; Gestão Integrada; Município de Guarujá.

EVALUACIÓN DE LA GESTIÓN DE RESIDUOS SÓLIDOS EN EL MUNICIPIO DE GUARUJÁ, SP: UN ANÁLISIS DE RENDIMIENTO ENTRE LOS AÑOS 2017 Y 2021

Resumen

Objetivo del Estudio: La evaluación de la gestión de residuos sólidos en un municipio es una herramienta poderosa para medir la eficiencia de los proyectos implementados y la ejecución de las actividades adoptadas por los administradores y otros actores involucrados. En este sentido, este estudio analizó las acciones de la Municipalidad de Guarujá entre los años 2017 y 2021, alineadas con el Plan Regional de Gestión Integrada de Residuos Sólidos de Baixada Santista.
Metodología: La investigación se llevó a cabo mediante un enfoque cualitativo a través del análisis documental. La información se recolectó directamente de la Secretaría de Medio Ambiente (SEMAM), la Municipalidad de Guarujá y la Secretaría de Servicios Urbanos (SEURB), y se analizó a la luz de las referencias bibliográficas seleccionadas y desde el punto de vista de las conclusiones de cada acción identificada.
Originalidad/Relevancia: En esta investigación se propone un enfoque innovador al examinar la gestión de residuos sólidos en Guarujá, con un enfoque en el Plan Regional. Se destaca la importancia de una gestión integrada y se resalta la necesidad de revisar las estrategias adoptadas por la municipalidad, aportando una perspectiva original al tema.
Principales Resultados: Entre los principales resultados se destacan los avances significativos que el municipio de Guarujá ha logrado en cuanto a la planificación e implementación de políticas públicas para viabilizar la gestión de residuos sólidos en su

territorio.
Contribuciones: Además, este estudio revela fallas en la legislación vigente y enfatiza la relevancia de crear Unidades Regionalizadas de Residuos Sólidos para garantizar la efectividad de los planes regionales. En consecuencia, los hallazgos obtenidos en esta investigación constituyen contribuciones científicas que buscan impulsar la implementación de políticas públicas más efectivas y sostenibles en el campo de la gestión de residuos sólidos.

Palabras llave: Residuos Sólidos; Gestión Municipal; Administración integrada; Municipio de Guarujá.

Introduction

Sanitation and solid waste management has appeared as a critical global challenge. With rapid urbanization and population growth, the demand for effective and sustainable solutions has become imperative. This scenario calls for a proactive and innovative approach, both in technological and administrative terms, to mitigate negative impacts on the environment and public health (Mondal & Mandal, 2023; Aranha, 2020).

In recent years, growing urbanization in the world's major urban centers has accelerated the pressure on sanitation and solid waste management systems. It is estimated that, by 2050, around 68% of the world's population will be concentrated in urban areas, which is equivalent to almost 6.5 billion people. Such a phenomenon imposes an unprecedented demand for efficient sanitation infrastructures and innovative waste management strategies (Mondal & Mandal, 2023; Picchiai & Senigalia, 2019).

In Europe, the effectiveness of integrated waste management systems stands out. Countries like Germany and Sweden have succeeded in adopting policies of shared responsibility between the public and private sectors. The promotion of advanced recycling practices and the controlled incineration of non-recyclable waste have significantly reduced the amount of waste sent to landfill. The implementation of selective collection and advanced treatment technologies also contributes to lessening environmental impacts (Novais, 2023).

Whereas in the United States, the approach to solid waste management is diverse due to the country's geographical dimensions and socio-economic variation. Conspicuous progress has been made in cities like San Francisco, where rigorous recycling and composting policies have achieved high rates of waste detour from the traditional stream. At the same time, public awareness programs and tax incentives have encouraged the adoption of sustainable practices at municipal and state levels (Thorstensen, Rebouças Mota, Arima Júnior, Thomazella, & Mitsui Zuchieri, 2022).

In the vast and diverse region of Asia, we can find a wide range of economic and demographic realities that reflect the complexity of the continent. Within this scenario, countries such as Singapore and Japan shine as outstanding examples of innovation and

efficiency in waste management (Correa, Sguarezi, & Melo, 2022).

In Singapore, a nation that faces substantial challenges due to a shortage of physical space, we witness a truly exceptional approach to dealing with its waste. The country has developed a waste management system that stands out for the precision and efficiency of selective collection, as well as the application of controlled incineration techniques. This process not only reduces the amount of waste to be disposed of in landfills, but also converts the resulting ash into valuable and usable materials, contributing to the conservation of natural resources (Guo, et al., 2021).

For its part, Japan has long been a pioneer in adopting policies aimed at the circular economy. The country invests vigorously in advanced recycling technologies, promoting the transformation of waste into new products or materials. Besides Japan takes a comprehensive approach to stimulating sustainable production, encouraging the creation of goods that minimize environmental impacts from the initial design and manufacturing phase (Guo, et al., 2021).

Nevertheless, in Africa, solid waste management faces unique challenges, with marked variability between countries. In places like Rwanda, policies banning single-use plastics and environmental education initiatives have shown positive impacts on reducing pollution. However, the waste management infrastructure in many African nations still lacks adequate investment and strategic planning (Adedara, Taiwo, & Bork, 2023; Braga & Ribeiro, 2021).

In Oceania, New Zealand stands out for its focus on integrated solid waste management and the promotion of the circular economy. Waste minimization strategies, combined with awareness campaigns, have contributed to a significant reduction in the amount of waste going to landfills (Khan, et al., 2022).

In this context, technological innovation is emerging as a key element in transforming the sector. The application of remote monitoring technologies, smart sensors and the Internet of Things (IoT) makes it possible to collect and analyze data in real time, allowing waste management strategies to be quickly adapted, according to local and seasonal needs. Moreover, advances in thermal treatment methods, such as pyrolysis and gasification, have shown significant potential in transforming waste into clean energy sources (Benedicto, Filho, Georges, & Ferrari, 2020; Picchiai & Senigalia, 2019; Besen, Ribeiro, Fracalanza, Jacobi, & Gunther, 2021).

Such contradictory scenario reveals a disturbing dichotomy of the present day, in which, whole humanity gets technological advances in various segments, at the same time so many people face difficulties and deprivation with regard to access to basic resources such as drinking water and sanitation. High technology and progress in certain sectors of society should be vehicles for improving the quality of life of all individuals, nevertheless there are still persistent challenges that need to be overcome to ensure that these benefits are truly inclusive

and comprehensive (Jacobi & Giatti, 2015; Kaza, Yao, Bhada-Tata, & Van Woerden, 2018).

The challenges faced globally are diverse and complex. The scarcity of financial resources, the lack of adequate infrastructure, accelerated urbanization, climate change and socio-economic inequalities are just some of the main obstacles hindering the progress of basic sanitation around the world. This situation is exacerbated in emerging countries and isolated communities (Oliveira & Silva, 2023; Siman, et al., 2020).

The suitable management of solid waste is also an urgent challenge. The increase in waste production, especially in urban areas, demands efficient and sustainable solutions for its management. Inadequate solid waste disposal can lead to soil, water and air pollution, as well as posing risks to human health (Correa, Sguarezi, & Melo, 2022).

Brazil, like many developing nations, faces pressing challenges on basic sanitation and solid waste management. Inadequate access to sanitation services and inefficient waste management represent significant obstacles to public health, the environment and the country's socio-economic development. Given this scenario, significant progress has been made through the incorporation of both technological and administrative innovations (Benedicto, Filho, Georges, & Ferrari, 2020; Benedicto, Filho, Georges, & Ferrari, 2020; Yamane, Dutra, & Siman, 2023).

Across the history, Brazil has faced considerable regional disparities in terms of basic sanitation, with more developed urban areas benefiting from more advanced infrastructure compared to rural and peri-urban regions. Nevertheless, in recent decades, there has been a growing acknowledgment of the critical need for investments and public policies aimed at universalizing access to sanitation services (Jacobi & Giatti, 2015; Ferraz, 2008).

The digital revolution and the application of smart technologies have played an essential role in transforming the sanitation and solid waste management sector in Brazil. Real-time monitoring systems, IoT sensors and integrated management platforms have made possible more effective control of processes, optimizing the use of resources and reducing losses. In addition, the introduction of advanced water and sewage treatment technologies has improved the quality of the services provided. More efficient purification processes and the implementation of reuse systems have contributed to alleviating water scarcity in various regions of the country (UNESCO, 2023; Correa, Sguarezi, & Melo, 2022; Jacobi & Giatti, 2015).

In order to meet the population's sanitation imperatives, municipal public administration in Brazil faces budgetary, technological, cultural and environmental difficulties (Kuss, Carlan, Behling, & Gil, 2015; Saidón & Verrastro, 2017). There is a growing movement, consolidated in 2010 with the 12.305/2010 Bill (*National Policy on Solid Waste*), which seeks to achieve austerity in integrated solid waste management, especially in metropolitan areas.

The Municipality of Guarujá was chosen as the object of study for this research, due to

its importance in the Metropolitan Region of Santos Area Lowlands, the ease of access to information – due to the professional relationship with the municipality – and due the performance presented in recent reports such as the Green Blue Town Program (*Programa Município Verde Azul*, PMVA).

The general purpose of this study is to identify and analyze the progress made in Integrated Solid Waste Management in the municipality of Guarujá between 2017 and 2021. In doing so, it seeks to reveal crucial aspects that have the potential to overcome the challenges faced by that municipality in relation to solid waste management. This study not only contributes to the effectiveness of the National Solid Waste Policy (PNRS), but also represents a valuable scientific contribution to the matter, by providing a detailed and grounded analysis of the progress made in this area. In concluding this first part of the introduction, we highlight the importance of fully understanding the advances and challenges faced in the field of solid waste management, not only to improve public policies, but also to promote sustainability and quality of life in the Guarujá region.

Guarujá's Municipal Solid Waste Management Plan was conceived from an isolated perspective, that is, it only took into account the geographical limits of the municipality. However, there have always been important interactions with neighboring municipalities. Similarly, with Federal Bill 14.026/2020, which came into force during the period under analysis, the vision beyond borders became a duty, thus imposing the regionalized vision as a fundamental principle, the study was based on the terms of article 2, item XIV of the new Legal Framework for Sanitation (SEMAM-GUARUJÁ, 2022).

The actions identified in the data collection were corroborated by the information found in the documents of the National Solid Waste Information System (SINIR, 2020), the Urban Cleaning Service report (SLU, 2022) and the certification of the Blue Green Blue Town Program Municipality Program (PMVA) 2022.

The Blue Green Municipality Program (PMVA) is the main parameter for assessing the environmental management of São Paulo municipalities. From ten important environmental directives, number 10 is precisely the one that evaluates solid waste management, in eight criteria that range from the continuity of the Municipal Plan to the evaluation of the IQR - Waste Landfill Quality Index (SEMAM-GUARUJÁ, 2022).

In this context, the present study aims to provide a comprehensive analysis of the path and substantial progress made by the municipality of Guarujá regarding solid waste management. It unequivocally highlights the crucial importance of an integrated approach to the success and sustainability of these improvements. When considering the panorama of waste management, it becomes clear that synergy between different sectors and the application of coordinated practices play a fundamental role in the effectiveness of the actions implemented. In this way, by fully understanding the path taken and the results obtained, we

not only contribute to the continuous improvement of public policies, but also strengthen the foundations for a more sustainable and resilient community in Guarujá and its surrounding region.

Theoretical Grounding

Efficient solid waste management is a contemporary imperative, given the increasing urbanization and industrialization that characterize modern societies. In the Brazilian context, the National Solid Waste Policy (PNRS), instituted by Bill 12.305/2010, represents a fundamental regulatory framework. This policy establishes clear guidelines for the sustainable management of solid waste, promoting minimization, reuse, recycling and environmentally correct final disposal (Ferraz, 2008).

The Santos Area Lowlands Regional Integrated Waste Management Plan (PRGIRS-BS) is a strategic guide for integrated waste management in the region, providing guidelines and targets for the continuous improvement of management practices. Such plan serves as an important reference point for evaluating progress in the municipality of Guarujá (PM-Guarujá, 2012).

Considering the normative and strategic context pointed, it is also essential to understand the specific challenges facing Guarujá in its process to improve solid waste management. Issues such as population expansion, collection and transportation infrastructure, as well as community awareness, emerge as critical factors influencing performance in this field (PM-Guarujá, 2012).

According to the 2010 demographic census, carried out by the Brazilian Institute of Geography and Statistics (IBGE), Guarujá had more than 290,000 inhabitants. According to an estimate by the same agency, in 2021, the population was close to 324,900 inhabitants, with a population density of 2,026.80 inhabitants per square kilometer, ranking it 4th among the most populous cities in the Santos region (IBGE, Instituto Brasileiro de Geografia e Estatistica - IBGE Cidades, 2010; IBGE, Instituto Brasileiro de Geografia e Estatística - IBGE Cidades, 2022).

The city's GDP is around R$9.1 billion and 67% of the added value comes from services, followed by public administration (18.9%), industry (18.9%) and agriculture (0.4%) (IBGE, 2010; IBGE, 2022). This scenario has undergone variations that have not yet been adjusted due to the COVID-19 pandemic, nevertheless it provides an overview of the region's economic movement.

In spite of this, the characteristics highlighted above, Guarujá is located on Santos Island (figure 1), with 25 beaches. It is a city with strong tourist and port potential, so this characteristic imposes planning based on seasonality, both for the summer season and for the

grain export terminals installed in Guarujá (Rabinovici, Barros-Freire, Goldberg, & Neiman, 2021; PM-Guarujá, Agenda 21 Permanent Forum, 2012).

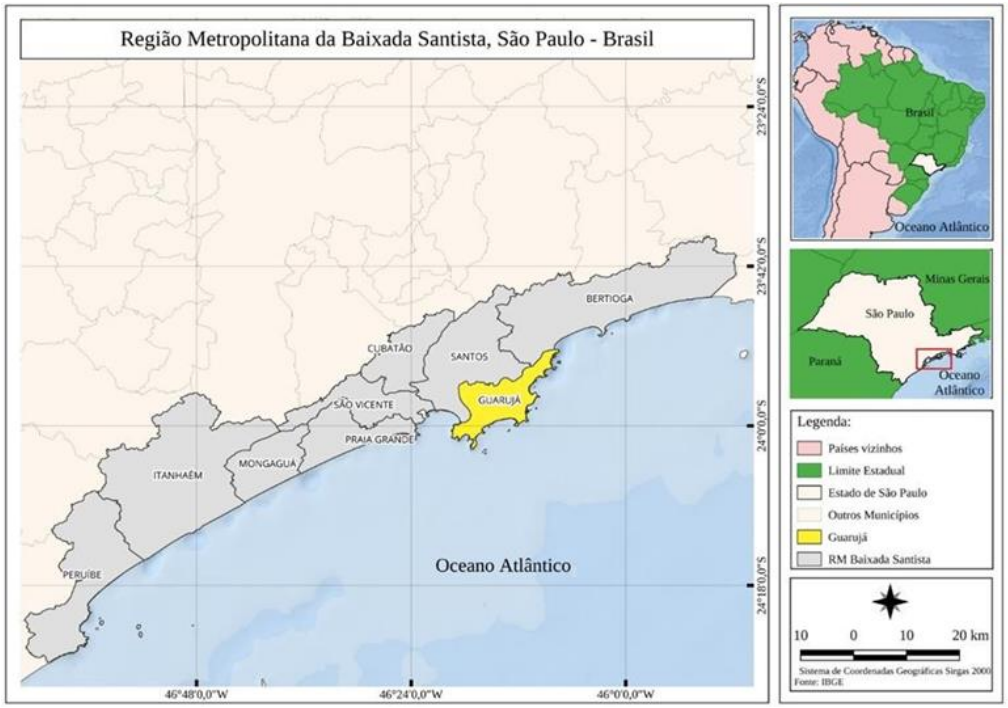
It is also important to note that the Metropolitan Region of Santos Area Lowlands (RMBS) has an increase of around 56.5% in its floating population during the summer period (December, January and February). While the municipality of Guarujá received 173,975 vacationers in 2020, thus having a significant impact on waste generation (IPT, 2018, pp. 42-43).

Although this scenario of a fluctuating population has changed during the COVID-19 pandemic, it is a factor that cannot be disregarded, as it has direct implications for the municipality's revenue and the generation of urban waste.

The Blue Green Municipality Program (PMVA) takes on a prominent role as a key parameter for assessing environmental management in municipalities located in São Paulo state. It comprises ten crucial environmental guidelines, the tenth of these focuses on the assessment of solid waste management. This parameter covers a range of eight indicators, ranging from the ongoing implementation of the Municipal Plan to the evaluation of the Landfill Quality Index (IQR). In this way, the PMVA stands not just as an indicator, but also as a comprehensive instrument that allows for detailed and systematic analysis of the efficiency and sustainability of waste management practices at municipal level. By emphasizing the importance of the program's tenth guideline, it becomes clear that the evaluation of solid waste is not just a component, but an essential sign of the municipality's ability to promote a responsible and effective environmental management.

Figure 1

Location map of the municipality of Guarujá



Source: Authors, 2023 - from Q-Gis 3.14

In this sense, the concern with waste management is embodied in important documents, where the effective participation of organized civil society is evident. Agenda 21 is a clear example of this purpose, for since the beginning of its construction in 2006 until its effective deployment in 2012, good waste management has been kept as a goal to be achieved, especially in the territorial environmental dimension, as sub-actions under Environmental Conservation. Later, in 2019, Agenda 21 was revised and the commitments to good waste management were reaffirmed (PM-GUARUJÁ, 2019).

It is important to note that in 2012, together with Agenda 21, Guarujá built its first Municipal Plan for Integrated Solid Waste Management (PMGIRS), formalized by Municipal Bill 9.505/2012. The document was drawn up by a Multidisciplinary Working Group, which included technicians from various departments under COMDEMA (Municipal Council for the Defense of the Environment) and the Agenda 21 Permanent Forum (PM-GUARUJÁ, 2012).

In 2015, a review of the previous plan began, leading in 2016 to Municipal Bill 4367/2016, which sets out the objectives, instruments, principles and guidelines for integrated solid waste management (SEMAM-GUARUJÁ, 2022).

Guarujá Municipality, through SEMAM, has systematically sought to promote initiatives to improve waste management based on scientific research and best practices. To this end, it has forged productive partnerships with prestigious universities and companies with certified track records and activities that are demonstrably relevant to the sustainability of the

municipality (SEMAM- GUARUJÁ, 2022).

In this way, it is worth noting that a retrospective analysis of the period between 2017 and 2021 will not only allow tangible progress to be identified, but also the detection of trends and patterns that can provide valuable insights to guide future initiatives in solid waste management in Guarujá.

Methodology

The research for the article was carried out through a bibliographic review of the indexed databases Scopus, Web of Science, and open data from the Guarujá Municipality (Tranfield, Denyer, & Smart, 2003).

To develop the article, an exploratory documentary research with a qualitative approach was conducted based on documents and secondary data made available by the IPT and SEMAM of Guarujá (Kuss, Carlan, Behling, & Gil, 2015).

The data was analyzed using a qualitative approach and presented as a case study taking into account specific actions to achieve the goals of the Municipal Plan for Integrated Solid Waste Management between the years 2017 and 2021 (Yin, 2010; Rabinovici, Barros-Freire, Goldberg, & Neiman, 2021).

The data collected from SEMAM Guarujá was obtained through email responses, open documents from the Guarujá Municipality website, and IPT reports. After reading and sorting, the data was tabulated, identifying the action taken, the year it began and the current situation. The analysis and discussion were based on the literature review and presented as a case study (Yin, 2010).

This research takes an original approach, since it analyzes solid waste management in Guarujá from the perspective of the Regional Plan, pointing out the need for integrated management and highlighting the importance of reviewing the strategies adopted by the city government. It also identifies flaws in the legislation and highlights the importance of creating Regional Solid Waste Units for the effectiveness of regional plans. Therefore, the results of this study contribute to the promotion of more effective and sustainable public policies in solid waste management.

This research presents an original approach, as it analyzes solid waste management in Guarujá from the perspective of the Regional Plan, indicating the need for integrated management and emphasizes the importance of reviewing the strategies adopted by the municipality. It also identifies flaws in the legislation and highlights the significance of creating Regional Solid Waste Units for the effectiveness of regional plans. Therefore, the results of this study contribute to the promotion of more effective and sustainable public policies in solid waste management.

The relevance of this research is underlined by the urgency of the issue for improving living conditions in the territory and its alignment with the UN Sustainable Development Goals.

Data analysis

The analysis of the data presented in this research was conducted based on information acquired from three essential sources for understanding the current situation of waste management in Guarujá: the reports from the Solid Waste Management Modernization Program (PMVA), data from the Municipal Integrated Solid Waste Management Plan (PMGIRS) and, finally, the Guarujá Waste Management Plan.

The PMVA Program expresses an important milestone in the search for efficiency and modernization in solid waste management. Through detailed analysis of the reports generated by this program, it was possible to obtain a comprehensive view of the initiatives implemented, their quantitative and qualitative impacts, as well as identifying areas of opportunity for future improvements.

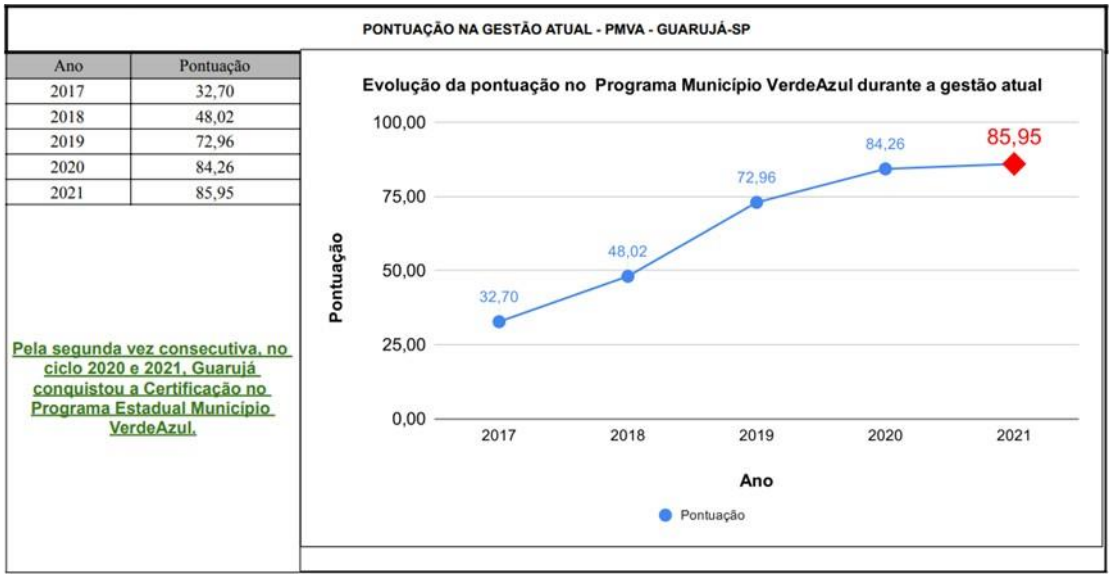
The PMGIRS, in turn, constitutes a strategic plan designed to lead municipal actions in integrated solid waste management. By analyzing these guidelines, we were able to assess the coherence of the proposed strategies with the observed reality. Moreover, the comparison between the targets set and the results obtained provided a critical basis for assessing the progress made to date.

Guarujá's Waste Management Plan is a fundamental piece of work, for it provides an in-depth overview of the specific policies and procedures adopted by the municipality with regard to waste management. Through its analysis, it was possible to gain a detailed understanding of the operational strategies, regulations and programs in place, as well as to identify any gaps or areas for potential optimization.

The integration of these three sources of information allowed for a holistic approach to assessing waste management in Guarujá. Through this combined analysis, it was possible to extract valuable insights that will serve as a basis for future recommendations and improvement strategies.

Figure 2

PMVA score evolution



Source: Guarujá Municipality (2022)

Figure 2 shows the evolution of Guarujá since 2017, showing the increase in the city's score by more than 150%, also recording the first time that Guarujá achieved certification/approval in 2020.

The Green and Blue Municipality Program (PMVA) is an environmental agenda determined by the São Paulo State Government for municipalities. SIMA (Secretariat for Infrastructure and Environment) audits the targets and assigns the scores; therefore is one of the main indicators that assesses environmental management in each municipality, certifying or approving management in cases of scores above 80 points.

It is important to make light on these actions because one of the PMVA guidelines is to assess good solid waste management in the city, so this scenario shows that the municipality of Guarujá has made progress on solid waste management.

In consequence, it is worth noting that the tenth guideline of the PMVA deals with waste management, as this guideline contains eight items that are measured in terms of their execution, year after year, from selective collection to composting. In 2021 it not only maintained certification and approval, but also increased its performance.

Discussion

The PMGIRS in the Santos Area Lowlands indicates strategic actions whereas goals are classified into short, medium and long term, considering short term a period of up to 5 years, medium term a period between 5 and 10 years and long term a period of more than 10 years.

Although the PMGIRS was drawn up from the internal perspective of the municipality, from 2017 onwards it has been concerned with inter-municipal relations, such as the fact that 40% of the Port of Santos is located in the municipality of Guarujá and there is a direct integration with the petrochemical hub of Cubatão, among other factors.

The panorama of the efficiency of these strategies in relation to compliance with the PMGIRS is categorized in figure 3 in the "Status" column, in which there are the following categories: In progress; In continuity; Completed; Not completed and Not carried out.

The result of this analysis is important to allow verifying whether the actions are producing the expected result or whether there is a need to adjust and change part of these strategies so that they have the desired effect (Ferraz, 2008).

In the present study, the actions implemented by the Municipality of Guarujá were analysed, based on its own public data. In this way, the result of this work can serve as a support so that public management can outline new horizons for the municipality and contribute to the PRGIRS/BS (Picchiai & Senigalia, 2019).

The analyses were carried out based on the PMGIRS. Nevertheless, the analysis of the actions was conducted under the focus of the Regional Plan, according to the guidelines listed in Figure 2, as well as the fundamental principle of article 2, item XIV of Law 14.026/2020.

It is important to point out that, at this first moment, the analyses are subordinated to the objectives listed in item 2 of Guarujá's PMGIRS (pages 11 and 12), which, briefly, point out: reducing generation; encouraging research; promoting development and implementation, in partnership with educational and research institutions; guaranteeing regularity, continuity and quality in the systems; stimulating pollution prevention practices; eradicating landfill, dumps; intensifying sensitization and awareness programs; integration between public authorities and organized civil society and the population.

As the reduction of MSW (Municipal Solid Waste) is it is the cornerstone of any plan, it is delimited in item II of article 7 of Law 12.305/2010. The objective was duly achieved. Considering Guideline 1 connected to the reduction of household solid waste, it is possible to consider that the objective has been correctly achieved, looking at the following data (Figure 4). Of course, the pandemic period (COVID-19) deserves a specific study, because according to data provided by the Department of Urban Services (SEURB), there was an increase in generation from 2019 to 2020 (the year the pandemic began), in the order of 3.86%, followed by a reduction in 2021 in the order of 13.24%, based on 2019 (the year before the pandemic).

Figure 3

Comparison of waste generation per Kg/day/inhabitant

Source	Yer	Index kg/day/resident
Agenda 21	2012	1,66
PRGIRS/BS	2016	1,3
Update PRGIRS/BS	2017	1,24
Update PRGIRS/BS	2018	1,34
Update PRGIRS/BS	2019	1,18
Update PRGIRS/BS	2020	1,21

Source: Data tabulated by the authors, 2023

In terms of encouraging research, numerous actions include support and effective interventions by renowned research centers in Brazil, with regard to execution of various research projects in Guarujá. Most noteworthy is the contracting of the IPT (São Paulo Institute of Technological Research) to define the technological route for Guarujá's future Solid Waste Management Center (SEMAM-GUARUJÁ, 2022).

To strengthen the objective set out in the PMGRIS, regarding regional actions, we highlight the project funded by the Federal Public Prosecutor's Office, in the Praia Branca Traditional Community, to set up six biodigesters to recover the wet fraction of MSW and convert it into biogas. This research, carried out between Guarujá City Hall and the Vanzolini Foundation, is especially important because it is a region that has no land access (by car).

The objective of developing a partnership with an educational institution, not only includes the items above, but also the studies for monitoring waste from the Port of Santos, particulate matter control and the analysis of degraded areas, carried out with CEPEMA, USP's Advanced Research Laboratory and UNOESTE.

Considering the "technological route" studies, there are plans to build two sheds for the cooperatives with complete equipment and a composting plant for pruning waste. On the other hand, the municipality has contracted two Waste Picker Cooperatives (*Mundo Novo* and *Recicla Mais*), by donating them trucks, increasing the municipalities' coverage area in door-to-door selective collection, according to the SNIR, from 16% coverage in the city in 2016 to 28.1% coverage in 2019, therefore within the average recycling of the total mass of 1.6% as indicated in the Regional Plan for Integrated Solid Waste Management in the Santos Area Lowlands (PRGIRS-BS).

SEMAM Guarujá, through the PRADs (Degraded Areas Recovery Plan), is recovering four areas, namely Jardim Esplanada, Jardim Brasil I and II, Área Verde I and II (Granville), and the remaining area of the Municipal Stadium. These projects have been duly approved by the São Paulo State Environmental agency *Centro Técnico Regional de Santos* (Santos

Regional Technical Center), which is connected to SIMA (State Department for Infrastructure and Environment). Another issue under discussion is the possibility of a church taking over the recovery of the area; and finally, the fundraising phase. On the other hand, three studies of contaminated areas are being carried out: Canta Galo, Truck Yard and Cemeteries.

All the waste management projects developed by Guarujá Municipality aim at expanding Selective Collection in the city and raising residents' awareness of the importance of active participation in these actions. The new Management Center will be delivered with two large sheds equipped for Cooperatives. Also *Recicla Guarujá* projects made possible by Municipal Bill 5,014 and the "Our Seas" Project to combat waste at sea will be expanded. In this vein, Municipal Bill 4.291/21 was issued, establishing the Municipal Payment Program for Environmental Services, a fundamental tool for expanding Selective Collection (SEMAM-GUARUJÁ, 2022).

The projects mentioned above were strengthened by the training of Environmental Agents, by the elaboration of the Municipal Environmental Education Plan, as well as by an intense Environmental Inspection Program. Over the last six years, several operations have been raided, culminating in the interdiction of companies and sites used by dumpers, as well as in constant incursions on companies operating in the port region, both by land and by sea. Environmental Inspection Program also resulted in several enforcement operations on grain unload from the export corridor that passes through Guarujá. There is also a project to create four recycling stations for RCC (Construction Waste), but so far there are no resources for this (SEMAM-GUARUJÁ, 2022).

The mainstays of Environmental Governance are rigorously adopted by SEMAM Guarujá, which results were followed by awards and by the publication of scientific papers (SEMAM-GUARUJÁ, 2022). The Management Council of APA Serra do Guaruru, a Municipal Conservation Unit, was recognized by ICLEI as an example in Brazil. Eventually the Panorama Program linked to the IUCN elevated APA Serra do Guaruru as an inspiring model for the world. On the other hand, the research "Environmental Governance: COMDEMA's Role as a Mediator of Environmental Conflicts in the Municipality of Guarujá/SP" is available in the Virtual Environmental Library (Aranha, 2020).

Therefore, figure 6 sums up the analysis of the actions carried out between 2017 and 2021 in the municipality of Guarujá in terms of waste management.

Figure 4

Summary of actions carried out between 2017 and 2021 in Guarujá

SITUATION	QUANTITY	PERCENTAGE
Completed	2	8,70%
Completed with encouragement for continuation	1	4,35%
In progress	7	30,43%
Continuous / Perennial	5	21,74%
Unfinished	6	26,09%
Not carried out	2	8,70%
Total	**23**	**100,00%**

Source: Guarujá Department of the Environment (2022) - adapted by the authors, 2023

The summary of the actions' analysis indicates that less than 10% of the actions have been completed. However, it is possible to see that there are more than 50% of actions in continuity and perennial activity. This means that there is mobilization and interest from the municipal management in acting significantly to develop this agenda, as highlighted above, in local action, aiming to regional relations.

The Solid Waste Management Center was conceived to cope with a demand from the municipality of Guarujá. However, the partnership between municipality and IPT has already brought a vision of a regionalized solution. In this sense, Guarujá has extended the area earmarked for reverse logistics with a view to the possibility of receiving waste from Bertioga (SEMAM-GUARUJÁ, 2022).

Furthermore, there is an important theoretical gap to be filled, for that there is a need to apply similar studies to the other municipalities of the Santos Area Lowlands.

Considerations

The Municipal Plan for Integrated Solid Waste Management (PMGIRS) in the Santos Area Lowlands, especially in the municipality of Guarujá, demonstrates a comprehensive strategic approach with goals set for the short, medium and long terms. The consideration of inter-municipal relations, such as the significant participation of the Port of Santos in the territory of Guarujá, shows an integrated vision that is coherent with regional demands.

The analysis of the efficiency of the strategies, categorized as "Situation", provides a valuable overview for evaluating the achievement of the established objectives. This reflects the maturity of the monitoring and evaluation process, which is essential for adapting and optimizing innovative actions. Collaboration with renowned research centers, such as the IPT, illustrates Guarujá's commitment to advancing knowledge and implementing innovative solutions. Moreover, the partnership with teaching and research institutions, such as USP and

UNOESTE, highlights the collaborative approach and the search for external expertise.

The reduction of Municipal Solid Waste (MSW) is paramount to the plan, and the data presented indicates notable progress, despite the challenges posed by the COVID-19 pandemic. The expansion of Selective Collection, the installation of Voluntary Delivery Centers (PEVs) and the recovery of degraded areas show a permanent commitment to responsible environmental management. The creation of the Municipal Payment Program for Environmental Services is an innovative strategy that promotes the active participation of the community.

The global analysis of actions between 2017 and 2021 denotes that although there is a relatively low number of completed actions, the majority are stay or in perennial activity. This underscores the long-standing commitment of municipal management to sustainable development, both locally and in regional relations.

The authors recommend that similar studies be extended to other municipalities in Santos Area Lowlands, filling an important theoretical gap and contributing to a comprehensive and coordinated view of waste management in the region. This collaborative approach and sharing of good practices between municipalities could be key to promoting more effective and sustainable solutions in the long term.

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