Investigating solid-waste management in the Cariri Oeste Region using the Updated Waste Management Condition Index – ICGRA

Investigando a gestão de resíduos sólidos na Região do Cariri Oeste por meio do Índice Atualizado de Condição de Gestão de Resíduos – ICGRA

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ABSTRACT
The northeast region of Brazil has poor waste management and lags in compliance with the National Solid-Waste Policy. The use of indicators is a promising alternative for the specific assessment of solid-waste management conditions. This study investigated the solid-waste management system of...
municipalities in the Cariri Oeste region (CE) through the characterization of management services and application of the Updated Waste Management Condition Index (ICGRA) method. In ICGRA, indicators are grouped into four categories, namely the characteristics of the management system, Management System Planning, Operational Conditions of the Management System, and specific indicators of the PNRS and new technologies. Data and information regarding the indicators were obtained from websites, academic literature, plans and studies relevant to the subject, field visits, contact with municipal managers, and photographic records. After applying the data diagnosed in the ICGRA method, an inadequate management scenario was determined for all the evaluated municipalities. This result, linked to field observations, complemented the diagnosis, which reflected the status of municipalities. The most fragile points observed in the ICGRA results concern the management compliance with the provisions of PNRS and new technologies. ICGRA proved to be effective in evaluating the management of municipal solid waste in the CE region.

**Keywords:** indicators, municipal management, updated waste management condition index, solid waste consortium.

**RESUMO**
A região Nordeste do Brasil apresenta má gestão de resíduos e está atrasada no cumprimento da Política Nacional de Resíduos Sólidos. A utilização de indicadores é uma alternativa promissora para a avaliação específica das condições de gestão de resíduos sólidos. Este estudo investigou o sistema de gestão de resíduos sólidos de municípios da região do Cariri Oeste (CE) por meio da caracterização dos serviços de gestão e aplicação do método Índice de Condição de Gestão de Resíduos Atualizado (ICGRA). No ICGRA, os indicadores são agrupados em quatro categorias, a saber, as características do sistema de gestão, Planejamento do Sistema de Gestão, Condições Operacionais do Sistema de Gestão e indicadores específicos da PNRS e novas tecnologias. Os dados e informações referentes aos indicadores foram obtidos em sites, literatura acadêmica, planos e estudos pertinentes ao tema, visitas de campo, contato com gestores municipais e registros fotográficos. Após a aplicação dos dados diagnosticados no método ICGRA, foi obtido um cenário de gestão inadequado para todos os municípios avaliados. Este resultado, aliado às observações de campo, complementou o diagnóstico, que refletiu a situação dos municípios. Os pontos mais frágeis observados nos resultados do ICGRA dizem respeito à conformidade da gestão com as disposições da PNRS e das novas tecnologias. O ICGRA mostrou-se eficaz na avaliação da gestão de resíduos sólidos urbanos nessa região do Ceará.

**Palavras-chave:** indicadores, gestão municipal, índice de condição de gestão de resíduos atualizado, consórcio de resíduos sólidos.
1 INTRODUCTION

The growth of cities, expansion of urban areas, and poor public management have contributed to negative environmental impacts. The excessive generation and final disposal of solid waste (FORTE, 2020), in particular, the frequent consumption of industrialized products, is responsible for the continuous production of waste in cities. To effectively manage a city, it is essential to consider the problems caused by solid waste (MUCELIN; BELLINI, 2008).

The improper handling and disposal of urban solid waste (MSW) has adverse effects on groundwater, surface water, and soil because of the percolation of liquids from the decomposition of waste. Furthermore, the release of noxious gases from the biodecomposition of organic materials, such as methane adversely affects the atmosphere.

However, according to Dantas (2008), efficient waste management remains a challenge in Brazil, as most public city managers do not address this problem with relevance, urgency, and appropriate sensitivity.

Thus, according to the Federal Constitution of 1988, the management of MSW belongs to municipal and district units under legal jurisdiction. Therefore, the correct provision and collection of this type of service fall on political entities. In this context, the National Solid-Waste Policy (PNRS), established by Law No. 12305/2010, in its Article 10, and the municipalities and the federal district are responsible for managing MSW (BRASIL, 2010). The implementation of this responsibility is challenging for public authorities (ROCHA, 2020).

One of the justifications by public authorities regarding the fragility of solid-waste management is the lack of financial resources for its correct management, which compromises system functioning. Therefore, because of this lack of resources, many Brazilian municipalities cannot landfills stipulated by the PNRS, which had set a deadline for the task as of 2014 (BRASIL, 2010a). However, this objective has yet to be implemented throughout the Brazilian territory.

To allow the adaptation of this environmental requirement, according to the New Basic Sanitation Framework (Law no. 14024/2020), municipalities with a population of less than 50,000 inhabitants, which have developed an inter-municipal solid-waste plan or municipal plan of integrated solid-waste
management and have charging mechanisms that guarantee their economic and financial sustainability, have a deadline to close their landfills by 2024.

In addition to factors related to financial deficiencies and compliance with legal provisions, Souto and Lopes (2019) revealed that the lack of specialized professionals and technical knowledge on the subject hinders solid-waste management, rendering the implementation of public policies for the sector difficult.

However, inadequate disposal is a key factor in solid-waste management. According to the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE, 2022), 39.0% of the waste collected in Brazil in 2021 was destined for inappropriate final disposal by 2,868 municipalities. Of these, 1,279 municipalities are located in the northeast region. The State of Ceará is no different, as the majority of municipalities in Ceará send their waste to approximately 300 landfills in the State (CEARÁ, 2019).

However, among the numerous challenges involving municipal solid-waste management, municipalities lack the implementation of specific actions for the adequate management of this waste, as well as the absence of clearly defined models, objectives, and targets for evaluating this management.

Mendez and Mahler (2018) attributed the difficulties in evaluating the inadequate establishment of indicators that reflect the conditions and performance of an integrated solid-waste management system. According to Martins (2005), the introduction of indicators is crucial for the analysis of current development processes in addition to providing essential elements for the elaboration of projects and public policies.

Thus, the use of indicators is a crucial mechanism for corrective decisions in municipal solid-waste management, enabling continuous processes improvement. The relevance of using tools that promote analysis and diagnosis, such as those that employ specific indicators, including the updated waste management control index (ICGRA), to assist administrative management in identifying compliance with or deficiencies in solid-waste management services should be considered.

Therefore, the objective of this work was to determine the ICGRA within the municipalities that make up the Public Solid-Waste Management Consortium
of the Cariri Oeste region (CONCESTE) in Ceará, Brazil as a diagnostic tool for waste management services to identify weaknesses and propose opportunities to improve these services.

2 METHODOLOGY

The CE region in the Southwest of the State of Ceará, Brazil, comprises seven municipalities, namely Antonina do Norte, Araripe, Assaré, Campos Sales, Potengi, Salitre, and Tarrafas (Figure 1).

This study was conducted in an exploratory and descriptive manner and outlined through bibliographical research, consultation with city hall representatives, and on-site observations from field research.

Data collection began with research on official websites of the Federal Government, such as SNIS and SINIR, as well as on the Ceará State Department of the Environment; on environmental agencies; on the websites of municipal governments; and on state, regional, and municipal solid-waste management, in addition to other studies related to the topic. This approach facilitated the filling of spreadsheets. Subsequently, visits were performed to collect additional
information and data related to the indicators, and photographic records were obtained to document the services related to solid-waste management in the municipalities. The data were collected from April to July 2023.

To determine the municipal waste management condition index, the ICGRA spreadsheet was developed by Mendez (2017), based on Dantas (2008). The composition of ICGRA considers 40 indicators related to system characteristics, operational conditions, and system planning, in addition to 22 indicators related to the guidelines and instruments proposed by the PNRS as well as new technologies. The ICGRA is calculated on a spreadsheet, and a specific value is allocated to each municipality. This value is classified as inadequate or adequate, based on this index.

3 RESULTS AND DISCUSSION
3.1 GENERAL ASPECTS ABOUT MUNICIPAL SOLID-WASTE MANAGEMENT

The investigation revealed that the provision of collection, transportation, curb painting, sweeping, weeding, pruning, land cleaning, construction waste collection (RCC), and disposal of urban solid-waste services, including household and commercial waste, urban cleaning, and the collection and final disposal of healthcare waste, is performed by outsourced companies in all municipalities. The inspection of services is the responsibility of the Secretariats of Infrastructure, Works and Urban Services, with the exception of the Municipality of Salitre, where supervision is performed by the Secretariat of Urbanism and Environment.

The operationalization of home collection is performed in the districts, towns, and in the nucleus of the municipalities (Headquarters) on a door-to-door system with a daily frequency from Monday to Saturday for the Municipality Headquarters (except for the Municipality of Tarrafas, which collects three days a week). For districts and towns, the frequency varied from municipality to municipality.

The average waste generation estimate for 2022 was 104.14 tons per day, with the lowest generation rate occurring in the municipality of Antonina do Norte (6.61 t/day) and the highest in the municipality of Campos Sales (24.08 t/day).
One difficulty in obtaining accurate data is that waste collection is joint, especially with regard to waste collected by large generators and commercial waste. Therefore, it is difficult to accurately determine the amount of household waste.

The collection coverage in the municipalities of Araripe, Assaré, Antonina do Norte, Campos Sales, Potengi, and Tarrafas is greater than 90%, whereas that in the Municipality of Salitre is less than 75% (SNIS, 2022). Furthermore, sweeping services are performed daily in the morning and afternoon shifts on the roads at the municipal headquarters and weekly in the districts.

Only the municipalities of Araripe and Salitre currently dispose of waste in a private landfill located in the Municipality of Salitre, CE. Other municipalities still use landfills for the final disposal of waste. Thus, the region has five landfills in operation: Antonina do Norte, with an area of approximately 2.91 hectares; Assaré, with an area of 4.03 hectares; Campos Sales, with an area of 15 hectares; Potengi, with an area of 1.1 hectares; and Tarrafas, with an area of 0.71 hectares. Furthermore, four deactivated areas have yet to receive any type of environmental recovery (Araripe, Salitre, Potengi, and Tarrafas).

3.2 THE ICGRA OF THE EVALUATED MUNICIPALITIES

The survey of the general characteristics of the waste management systems of the evaluated municipalities complements the evaluation of the ICGRA indicators and, thus, helps understand the situation in which the municipalities find themselves. To obtain the final evaluation and determine ICGRA, indicators related to Management System Characteristics (B1) were considered. Furthermore, Management System Planning (B2), Operational Conditions of the Management System (B3), and specific indicators of the PNRS and new technologies (B4) were considered.

The highest ICGRA score was achieved by the municipality of Araripe, with a value of 5.57, whereas the other municipalities obtained scores below 5.3. The municipalities are classified in descending order as follows: Araripe, Salitre, Tarrafas, Antonina do Norte, Assaré, Potengi, and Campos Sales (Figure 2). Regarding the final ICGRA score, all municipalities were classified as inadequate in
terms of management, which reflects the deficiencies identified during the research and is not directly related to the GDP of each municipality.

The results revealed a common problem in the country regarding the deficiency in solid-waste management, consistent with those obtained by Mendez and Mahler (2018), who evaluated the municipalities of Rio de Janeiro, Souto and Lopes (2019) in the municipalities of Seridó Potiguar, and Silva and Brito (2021) in the municipalities of the Central South region of Ceará. These authors found that the management conditions were inadequate.

When performing individual assessments of the results obtained by the municipalities, the worst performance was recorded for the specific indicators related to the PNRS and new technologies (B4), followed by the Management System Operational Conditions (B3) and Management System Planning. Management (B2), except for the municipalities of Araripe, Assaré, Salitre, and Tarrafas. Finally, the Management System Characteristics (B1) performed better. Table 1 summarizes the results obtained using the ICGRA method for the seven municipalities.
In the B1 block (characteristics of the management system), only the municipalities of Assaré and Potengi obtained scores below 80%, and the highest score was obtained by the Municipality of Tarrafas (87.5%), with scores ranging from 25 to 28 points, as illustrated in Figure 3. The municipalities of Assaré and Potengi obtained lower scores in relation to the block’s total score because they did not perform selective collection. In contrast, the highest score for the Municipality of Tarrafas was justified by the fact that it scored in almost all indicators evaluated by the block, with the exception of the indicator relating to tire collection.

Table 1 – ICGRA assessment result

<table>
<thead>
<tr>
<th>Municipality</th>
<th>B1 (score)</th>
<th>B1 (%)</th>
<th>B2 (score)</th>
<th>B2 (%)</th>
<th>B3 (score)</th>
<th>B3 (%)</th>
<th>B4 (score)</th>
<th>B4 (%)</th>
<th>ICGRA</th>
<th>Condition of Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Araripe</td>
<td>26</td>
<td>81.2</td>
<td>29</td>
<td>76.3</td>
<td>39</td>
<td>65.0</td>
<td>19</td>
<td>26.0</td>
<td>5.6</td>
<td>Inadequate</td>
</tr>
<tr>
<td>Antonina do Norte</td>
<td>26</td>
<td>81.2</td>
<td>25</td>
<td>65.8</td>
<td>36</td>
<td>60.0</td>
<td>14</td>
<td>19.2</td>
<td>5.0</td>
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</tr>
<tr>
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<td>27</td>
<td>71.1</td>
<td>33</td>
<td>55.0</td>
<td>14</td>
<td>19.2</td>
<td>4.9</td>
<td>Inadequate</td>
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<tr>
<td>Campos Sales</td>
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<td>81.2</td>
<td>26</td>
<td>68.4</td>
<td>27</td>
<td>45.0</td>
<td>13</td>
<td>17.8</td>
<td>4.5</td>
<td>Inadequate</td>
</tr>
<tr>
<td>Potengi</td>
<td>25</td>
<td>78.1</td>
<td>25</td>
<td>65.8</td>
<td>29</td>
<td>48.3</td>
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<tr>
<td>Tarrafas</td>
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<td>27</td>
<td>71.1</td>
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<tr>
<td>Average</td>
<td>25.4</td>
<td>79.5</td>
<td>26.6</td>
<td>69.9</td>
<td>34.7</td>
<td>57.1</td>
<td>14.6</td>
<td>20.0</td>
<td>5.0</td>
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</tbody>
</table>

Inadequate

- Average Maximum Score
<table>
<thead>
<tr>
<th>Municipality</th>
<th>B1 (score)</th>
<th>B1 (%)</th>
<th>B2 (score)</th>
<th>B2 (%)</th>
<th>B3 (score)</th>
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Inadequate

- Average Maximum Score

Source: Authors (2023).

Figure 3 – Geographic map with the values of B1 for each municipality studied

Source: Authors, (2023)
In relation to B2 block (Management System Planning), the municipalities of Araripe, Assaré, Salitre, and Tarrafas presented percentages above the general average for the block. However, the municipality of Araripe exhibited the highest score, as it was the only municipality to plan weeding, mowing, and pruning. The municipalities of Antonina do Norte and Potengi had the lowest percentage with 65.8%, in which actions to implement the Environmental Education and Awareness Program occurred late in relation to the other municipalities, followed by Campos Sales with 68.4%. The scores obtained by the municipalities ranged from 25 to 29 points (Figure 4).

![Figure 4 – Geographic map with the values of B2 for each municipality studied](source: Authors (2023)).

In B2, the desired results were identified in all municipalities, especially in indicators associated with the Integrated RCC Management Plan, RCC management planning, and financial and economic sustainability. A highlight common to all municipalities is the indicator related to financial and economic sustainability, for which no score was recorded. This indicator has a direct effect on service provision. In this context, as highlighted by EY (2020), the implementation of collection mechanisms linked to the execution of services not
only generated the revenue necessary to cover expenses but also encouraged society to recognize the importance of reducing and preserving natural resources.

However, the large difference in B2 is an indicator related to the Existence of a Management Plan, in which all municipalities obtained the maximum score. The same applies to the Environmental Education and Awareness Program, as all municipalities have a Regionalized Environmental Education Plan with an emphasis on solid-waste management. Furthermore, positive performance stood out in the indicators related to support for participatory management and consortia as well as in the indicator related to Waste Picker Inclusion Programs in the system.

Environmental education is an important instrument of Brazilian environmental policy, as it imparts the population with knowledge and individual and collective awareness of socioenvironmental phenomena. However, policies aimed at environmental education should be encouraged to raise awareness about the importance of selective collection and recycling (SILVA and CAPANEMA, 2019; EL-DEIR, AGUIAR and PINEIRO, 2016).

With regard to the inclusion of collectors, the organization of collectors in associations in the municipalities of Araripe, Antonina do Norte, Campos Sales, Salitre, and Tarrafas creates favorable conditions for the implementation of selective collection, even if only partially. However, collectors are yet to enjoy the benefits of selective collection, such as satisfying the needs and deficiencies persisting in all municipalities regarding the implementation of inclusion programs. Despite these programs, this scenario remains vulnerable.

In relation to B3 block (Operational Conditions of the Management System), the scores obtained in the municipalities ranged from 27 to 41 points (Figure 5). Generally, the lowest scores were obtained by the municipalities of Assaré, Campos Sales, and Potengi.
The indicators that contributed the most to the low score in B3 were the financial control of the system, performance control, and critical evaluation, the introduction of objectives and targets, operation of the recycling unit, reuse of organic waste, and control of work accidents. Regarding the financial control of the system, municipalities do not take ownership of the costs of urban cleaning and solid-waste management services in a way that allows each activity to be analyzed separately (CEARÁ, 2019). Thus, financial control is performed only in terms of the amount to be paid, as with any other service provided in the municipality.

The majority of organic waste is discarded through public collection without any separation, and the practice of using organic waste for animal feed is recurrently pursued as a way of disposing waste in all municipalities. Another pertinent concern is the safety of workers. As waste disposal is a service with a high level of accident risk, municipalities do not have a mechanism to control workplace accidents. However, safe work is extremely important and essential for the proper functioning of services. For the safety of work teams, identifying risk identification and control measures to mitigate possible work accidents and performing training and qualifications with work teams regarding risk control measures inherent to the activities is essential.
Safety in the workplace and accident control play a crucial role in minimizing accidents in routine work, particularly because of the risks inherent in performing tasks. This requires the implementation of several actions to preserve the health and safety of professionals responsible for performing the activities (SILVA et al., 2016; BUTUHY and MELO, 2018).

Regarding the B4 block (specific indicators related to PNRS and new technologies), all municipalities achieved significantly lower scores than the maximum score of 73 points established for this block. The scores ranged from 13 to 19 points (Figure 6), not even a third of the block’s total score, which demonstrated limited adherence to the innovations from the PNRS.

The only indicators in this block were attributed to the completion of data related to the SNIS, reuse of RCC for landfilling and maintenance of public roads, removal of unusable materials, alternative collection times, and the availability of public collectors in some neighborhoods for waste segregation. The low scores obtained in the block were the result of the lack of adherence to reverse logistics regulations, inadequate environmental monitoring, failure to use biogas, lack of implementation of an environmental management system, absence of a fleet control system for vehicles, and use of special vehicles in difficult-to-access areas.

Figure 6 – Geographic map with the values of B4 for each municipality

Source: Authors (2023).
Regarding indicators for the collection and/or use of biogas generated in areas of final waste disposal, contracts for geotechnical and environmental monitoring of landfills, as well as geotechnical and environmental monitoring of deactivated areas of irregular waste disposal, none of the municipalities managed to score in the three indicators, as none of them monitored and controlled mechanisms for final disposal areas. The Municipality of Salitre has a private sanitary landfill. However, there are no effective control mechanisms for the operation and monitoring of this landfill.

Although the municipalities of Araripe, Salitre, Potengi, and Tarrafas have deactivated landfills, they do not perform geotechnical or environmental monitoring in these areas. The municipalities of Potengi and Tarrafas have two landfill areas, one currently in use and the other deactivated. The areas deactivated by the municipalities do not have a plan for the recovery of degraded areas, monitoring, and inspection, and no study has been conducted for the deactivation, monitoring, and recovery of these areas.

However, the performance of the municipality of Araripe obtained the best score in the block as a result of meeting the indicators related to the information system on waste management on a specific website or page and incentives for economic and/or tax for nongeneration, reduction, reuse, and recycling actions.

The municipality of Campos Sales obtained the lowest score in the block, 13 out of a total of 73 points, revealing a poor scenario in terms of compliance with the implementation of the PNRS and its municipal technologies. The results highlight the ineffectiveness of planning and executing actions to support compliance with the objectives, principles, instruments, and guidelines established in the PNRS as well as the adoption of new technologies applicable to waste management.

Therefore, the low performance in satisfying the indicators is not isolated from the municipalities evaluated here, but rather a reflection of the reality experienced by a large part of the Brazilian regions. Queiroz and Filho (2022) revealed that Brazilian municipalities are yet to come to the mark, especially for people with a population of less than 50,000 inhabitants, due to the lack of
financial support, technological resources, qualified human resources for MSW management actions, and support for PNRS.

3.3 IMPROVEMENT PROPOSALS

After an assessment was performed by block, the importance of using ICRGA in management assessment became evident, as the methodology highlighted the key points of greatest relevance for the analysis. Highlighting the aspects that deserve greater attention in each block is essential.

- The large difference in the B1 block corresponded to the indicators relating to the selective collection of recyclable waste and regular household and commercial coverage, as both indicators are extremely important in the assessment of solid-waste management.
- Regarding B2, the indicators related to the existence of a regional solid-waste management plan, as well as the municipal solid-waste management plans in the municipalities of Araripe and Salitre. These aspects are in accordance with the guidelines established in the National Solid-Waste Policy (PNRS) and are essential for the implementation of this policy, along with the mechanisms for the inclusion of collectors, support for participatory management, and participation in consortia.
- In B3, the key point is related to the operation of public cleaning services, which gives this block significant importance, as it differentiates the score between municipalities based on the way services are performed and are classified as satisfactory or unsatisfactory.
- Finally, in relation to the indicators referring to B4, the biggest deficiencies in the evaluation were related to the failure to meet the block indicators in general.

To improve solid-waste management in the municipalities studied, strategies and actions were proposed based on the results obtained with the application of ICGRA to strengthen the management and planning of issues of local interest. Therefore, the following were suggested: i) implement appropriate legislation with the participation of legislative and executive powers to allow the MSW management system to function; ii) prioritize ongoing environmental
education and population awareness activities; iii) emphasize the implementation and expansion of selective collection; and iv) encourage research focused on technologies applicable to solid waste.

The deficiencies identified through the characterization of the municipalities and the IGCRA results arise from the lack of planning and monitoring of services, as well as insufficient provision of these services. Thus, strategic planning is a valuable tool for identifying gaps, supporting decision-making in waste management, and optimizing operational, financial, and human resources.

Figure 7 displays actions that can be used to seek improvements in the municipalities’ management systems, in particular, from the perspective of strategic planning as a starting point for improving and correcting deficiencies identified in the process. These actions guide management in defining the goals and objectives to be achieved.

![Figure 7 – Actions to improve the municipal management system](chart)

Source: Authors, (2023)

Therefore, the solution for efficient management is the development of sustainable and integrated models that cover the entire waste cycle from generation to final disposal. This development must be in accordance with the order of priorities for waste management. The implementation of such sustainable and integrated models in the evaluated municipalities involves short-
medium-, and long-term actions that aim at improving services, reducing environmental impacts, optimizing waste management, and improving the quality of life of the population.

In this context, the implementation of actions for environmental education in municipalities plays a crucial role in the transformation of waste management, especially with regard to the awareness of inappropriate disposal and waste generation. These actions can raise awareness among both public authorities and the population, highlighting that the environmental impacts of poor waste management can have direct repercussions on health, the environment, and the economy.

Despite the numerous challenges that municipal managers face, improvement actions were proposed considering the small municipalities in relation to the implementation of measures for solid-waste management and the interaction between various actors in society.

4 FINAL REMARKS

Based on the characterization of municipal management and the assessment by ICGRA, this study investigated the solid-waste management scenario in seven municipalities in the Cariri Oeste region in the State of Ceará. The results provided a comprehensive understanding of the reality of solid-waste management in municipalities, addressing various aspects and highlighting vulnerable areas as well as areas with the most positive management performance. In all municipalities, the lack of implementation of aspects related to the National Solid-Waste Policy (PNRS) and new technologies applicable to the sector was evident.

Inadequate management of the final waste disposal and the absence of charges for waste management services in municipalities were identified as crucial drawbacks of waste management. Positive points include the broad scope of the provision of regular collection services for household, commercial, and health waste, demonstrating the commitment to providing essential public services to the population.

This study obtained information on the conditions of the municipalities’ management systems using the ICGRA method, which resulted in the
classification of all municipalities as having inadequate management. With scores from 5.6 to 4.5, the municipalities of Araripe, Salitre, Tarrafas, Antonina do Norte, Assaré, Potengi, and Campos Sales are mentioned in descending order. The ICGRA method proved to be effective in evaluating municipalities in the context of solid-waste management and can be applied as an evaluation tool in other regions. Furthermore, the methodology proved to be easy to apply, interpret, and measure results, as long as the analyst could access the data and information necessary for the method.
REFERENCES


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