



**Health services waste management:
an analysis of the performance of the states of the Northeast**

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ABSTRACT

The objective of this article was to analyze the performance of the states of the Brazilian Northeast in the final treatment of Health Services Waste (HSW). For this purpose, an exploratory and documentary research was developed, in which data from the National Sanitation Information System (SNIS) were analyzed. Solid waste management has been the subject of debates over time, the discussion lies in the high level of environmental degradation that this material represents, such a situation is reinforced when it comes to HSW. In addition to the degradation factor, they accumulate the potential for contamination and spread of diseases, in case they do not receive adequate treatment. Proper management of HSW will produce healthier cities. The data indicate that the use of dumps is present in all states, even though this is an improper destination. However, some states such as Bahia and Ceará are already leading the migration process towards optimized destinations, such as sanitary landfills and decontamination units, essential for the treatment of HSW. Finally, the results allowed the construction of a ranking among the northeastern states, with the states that have the greatest capacity to provide adequate final destination for HSW appearing in the first places, as well as showing the inaccuracy of the SNIS in not segregating HSW by category. Compiling the data made it possible to clarify the specificities of the HSW and will enable the other states to follow the traced path of evolution.

KEYWORDS: HSW. Performance. Destination.

1 INTRODUCTION

Several problems afflict humanity, however, in the environmental sphere, the production of solid waste stands out, corresponding to one of the most representative forms of aggression to the environment (BARROS *et al.*, 2020). Like people, companies, regardless of their size, also contribute to environmental degradation, with the emission of waste in the form of gas, liquid and solids, therefore, they must issue reports on the environmental effects of their operations (ACAR; TEMIZ, 2020). Such reports are useful in measuring the volume of waste and support the strategic planning for the destination of declared quantities and types of waste.

The amount of solid waste generated has progressively advanced with the development of large centers and changes in society's consumption pattern, as evidenced by data from the Brazilian Institute of Geography and Statistics (IBGE, 2017) when it reports that in 1989 a total of 96,287.0 tons per day of solid waste was collected, while in the year 2000 this amount per day rose to 157,708.1 tons, lower values than the data for 2008, when the amount of garbage collected was 259,548.8 tons per day.

Complementing this information, the Brazilian Association of Public Cleaning and Special Waste (ABRELPE, 2020) points out that in 2020 there was a collection of urban solid waste of 82,477,300 t/year, 24.7% of this amount, collected in the Northeast region. This exponential increase in the production of solid waste causes a need to increase investments for its correct disposal, which makes it difficult for small towns to implement it, and the case is even worse when analyzing the management of Health Services Waste (HSW), as it is a contaminating material that poses a risk to society, requires more care and higher investments, as explained by Oliveira (2020). Therefore, the management of solid waste incorporates a significant role for the company, “not only from an organizational perspective, but, above all, socio-environmental perspective” (CHAGAS *et al.*, 2019, p. 3).

The HSW are those that require specific treatment in their handling and that may

require care before their final destination, as classified by CONAMA Resolution n. 358, of 04/29/2005 (BRASIL, 2005). That is, such waste should not be disposed of anywhere, because it contains an imminent risk of contamination for the planet and for the people who handle it. Oliveira (2017) warns of the uniqueness of hospital waste, which can present, among others, chemical, biological and radioactive risks; therefore, they represent a great risk of environmental contamination if there is no well-defined waste management policy, a situation detected in most Brazilian municipalities.

HSW are grouped according to their nature and the risks they pose to the environment and to the health of the individual (LUCCHESI; SOUZA; MACHADO, 2018). The risk of contamination of the environment and society is attributed to the high level of material diversification (PEREIRA, 2012). Motta *et al.* (2018) report that infections associated with health care represent a substantial number of deaths and an increase in morbidities, to minimize the risks of environmental contamination, hygiene protocols, protection barriers, etc. are considered.

In view of the many risks inherent in the handling of this waste, its correct destination is essential. The costs of disposing of health services waste are calculated by the weight of the material, so Boreli, Godoy and Kozusny-Andreani (2018) highlight the importance of paying attention to the initial phase of the waste generation cycle, the disposal, a stage where care must be taken to segregate the materials, preventing contaminated items from infecting non-contaminated materials, avoiding the increase of their quantity and the cost of their specific disposal. It should be borne in mind that disrespect for the rules of the National Policy on Solid Waste burdens the waste management processes of health services, as Oliveira (2020) informs.

CONAMA Resolution n. 358, of 04/29/2005 (BRASIL, 2005), in its 4th article, provides that it is the responsibility of health waste generators to prepare and execute a Health Services Waste Management Plan (HSWMP). Therefore, it must be considered that in addition to meeting the general standards, each plan will bring the specificities and realities applied to each managing body, as well as the details of the treatment for each category of waste. In addition to this, Law no. 12,305, of 08/02/2010 (BRASIL, 2010), that is, the National Solid Waste Policy (NSWP) also assigns to the generator the responsibility for the correct disposal of the waste produced.

Notably, the society-nature relationship has caused enormous damage to the environment and this fact needs reflection, in the sense of implementing actions to minimize these damages, as Pereira (2012) points out, and he continues that local problems are not isolated, on the contrary, they have global repercussions, which is why it is important to study cities as the starting point of degradation. Municipal public agents have spent a lot of attention on environmental policies, especially after CONAMA Resolution n. 237 (BRASIL, 1997), which removed responsibility for these residues from the federal and state spheres and placed it on the municipalities. These must balance public accounts with environmental policies, via orderly and constant monitoring (REZENDE; DALMÁCIO; SANT'ANNA, 2019).

In this sense, this article analyzes the management of HSW in the nine states of Northeast Brazil between the years 2016 to 2020, given its significant population, being

characterized by IBGE data (2022) as the second most populous geographic region in Brazil and the one that covers the largest number of states, it is important to understand the degree of maturity of this conglomerate in relation to the HSW allocation routines. Therefore, we seek to identify how the final destination of HSW is being carried out in the states of the Brazilian Northeast.

2 LITERATURE REVIEW

2.1 Environmental performance

The understanding of the need to adopt attitudes to protect the environment should guide the perspective of the future of each individual, being assigned responsibility for the environment they inhabit. In this sense, organizations need to assume their responsibilities regarding the unrestricted use of material resources and must incorporate new, environmentally appropriate attitudes (VEGINI *et al.*, 2012). In the long term, as highlighted by Khan *et al.* (2020) low environmental performance will culminate in increased health spending, which is why African and European countries have developed intense research on the relationship between economic growth and health spending. The reflection of this relationship will be the degradation of the environment that human beings inhabit, as the amount of waste increases proportionally to population growth.

According to Morioka *et al.* (2018), science already proves the need to combine sustainability with business, so it must be considered that sustainability is not the responsibility of a specific sector, but of everyone, each employee in his job.

The repercussion of the disclosure of environmental information on financial performance is relevant for both shareholders and other stakeholders, based on this, many studies are carried out to try to measure the level of significance of these environmental disclosures (ACAR; TEMIZ, 2020). Chagas *et al.* (2019) in their research, found, through the interviewees' reports, that the actions for the destination of hospital waste represent an increase in revenue, through recycling for reuse, and the reduction of costs, also related to materials that can be recycled.

In their study, Lucchese, Souza and Machado (2018) detected that costs linked to environmental demands are included in other operating costs, which makes it impossible to analyze the amount and the way in which environmental costs occur. Contrasting these findings, Kraemer (2011) shows that environmental accounting must segregate environmental data from financial statements and therefore its use depends on an accounting policy that considers the separation of topics related to the environmental impact of the organization's actions on the environment. Environmental accounting is the term that defines the interaction between the environmental management area and the accounting record area (LUCCHESI; SOUZA; MACHADO, 2018).

The improvement in the levels of environmental performance of organizations reduces health expenses and enhances economic activities, in addition to attracting investors, by

improving the country's image worldwide (KHAN *et al.*, 2020). Acar and Temiz (2020) indicate that in recent years, shareholders have become more attentive and sensitive to environmental issues, as they demand more from organizations to adopt sustainable postures, as well as environmental disclosures. The more the country demonstrates its concern with environmental issues and exposes its actions, the more attractive it becomes, receiving the attention of world organizations and institutions.

When segregated in an irregular manner, hospital waste represents an increase in incineration costs, since such an asset is accounted for considering its volume (PEREIRA, 2012). That is, incineration is a sophisticated and costly procedure, but necessary; therefore, it must be used strictly in materials that need this destination. Although incineration is an appropriate destination, it is also harmful to the environment, because the gases produced from this activity are potentially contaminating vectors and pose risks to communities (CHAGAS *et al.*, 2019). Therefore, what needs incineration should be incinerated, avoiding as much as possible the spread of contamination and unnecessarily increasing the amount of incinerated waste.

2.2 Health Services Waste

It is only recently that the issue of HSW has been addressed more deeply and that the first concerns with the destination of these materials have arisen, however, care with the proper separation of waste was not yet perceptible, since the waste generated by health institutions has varied contamination potential (PEREIRA, 2012). This perspective is reinforced by Magalhães *et al.* (2022) when they describe the concern with the disposal of HSW as a current issue, primarily considering the environmental damage that this type of material can cause. Barros *et al.* (2020) and Motta *et al.* (2018) go further, emphasizing the fact that this type of waste poses a threat to both the environment and human health if it is discarded incorrectly.

Access to health services has increased in developing countries, when compared to developed countries, allowing an ever-increasing number of people to consume health services (ASARI *et al.*, 2019). To ensure the safety of users, the use of disposables increases considerably, and this trend has a direct impact on the generation of hospital waste (ASARI *et al.*, 2019). That is, more demand for health services generates more HSW, proportionally.

Considering that some organizations are not responsible for waste management, public management takes responsibility for itself, assuming the share of collecting, transporting and even the final destination of HSW, so some city halls have a specific collection system for these wastes, however, they still fail to raise the awareness of professionals who handle HSW within the company, as emphasized by Pereira (2012).

These professionals are agents of change and need to be aware that the random disposal of waste contaminated with non-contaminated waste generates an increase in disposal costs and makes it impossible to dispose of and recycle viable materials, since not all the waste generated in health services have potential for contamination. As it is possible to identify in the classification of CONAMA Resolution n. 358 (BRASIL, 2005), contained in Chart 1, health services generate both potentially contaminating waste and common waste, subject to recycling.

Chart 1 - Classification of health services waste

Group	Definition
A	Waste with the possible presence of biological agents, with risks of infection due to its greater virulence or concentration. Ex.: laboratory sample leftovers, transfusion bags with residual volume, etc.
B	Waste containing chemical substances that pose a risk to public health or the environment, and may be flammable, corrosive, reactive or toxic. Ex.: Hormonal products, sanitizing products, etc.
C	Any materials resulting from human activity that contain radionuclides in quantities greater than the disposal limits described in the rules of the National Nuclear Energy Commission (CNEN) and for which reuse is inappropriate or not determined
D	Waste that does not present biological or radiological risks to health or the environment, and can be compared to household waste.
E	Sharp or scarifying materials. Eg: glass ampoules, coverslips.

Source: CONAMA Resolution n. 358 (BRASIL, 2005).

When the materials are properly segregated, according to the classification shown in Chart 1, the problems go from being constant to occasional, in the processes of handling, storage, displacement, treatment and final disposal (VEGINI, 2012). Thus, there is an optimized waste cycle, saving resources and reducing environmental damage.

To achieve this objective, the role of municipalities in environmental management is considered. In the words of Rezende, Dalmácio and Sant'Anna (2019, p. 3), “it is up to the municipalities to regulate and supervise the private and collective property rights regarding natural resources”. Wishing to achieve efficiency in environmental management, the municipalities brought laws and regulations to try to establish an alignment of conduct.

3 METODOLOGY

The research developed is characterized from the point of view of its objectives as exploratory, they are researches that seek to promote more understanding about the theme worked (PRODANOV; FREITAS, 2013).

In addition to being exploratory, this research proposes to carry out a documental analysis of the reports issued by cities in the Northeast in the monitoring of the destination of HSW. This typology, in the description by Gil (2002) and Severino (2013), focuses on the analysis of documents that have not yet been analytically treated, which are in their raw state as raw material to support the researcher's analyses.

The data used come from the database of the National Sanitation Information System (SNIS), in its historical series, the system is fed by the municipalities that receive the HSW (BRASIL, 2022). Although the data have been compiled by the system, they still require analysis in order to transform them into information. The research analyzed the universe of 223 cities, from the nine states of the Northeast, which reported having received some amount of HSW, in the period of five years, from 2016 to 2020.

The aim is to analyze the performance of states in the Northeast regarding the treatment of HSW. It should be noted that, although there is a classification of HSW in groups A, B, C, D and E, the SNIS does not provide data segregated by group, therefore, it is not possible

to identify the proportion of each group contained in the quantity declared by the system. For this reason, the entire amount of HSW received at the processing unit will be considered a contaminating waste that must be treated separately from other types of solid waste.

Taking into account that group B waste presents a chemical risk, it requires treatment by incineration, according to the HSW manual of the Virtual Health Library of the Ministry of Health. Group D waste can be treated as household waste and can be sent directly to urban solid waste landfills, when recycling is not possible, as per Resolution n. 222 (BRASIL, 2018) of the National Health Surveillance Agency (ANVISA). Waste from group C must go through the decay process and that waste from groups A and E must be treated according to the type of infectious risk they present.

Therefore, as the various types of waste produced require specific destination, according to their uniqueness, and considering that the SNIS does not distinguish the characteristics of waste, for research purposes, the best performance will be considered the states that have more types of destination units in use.

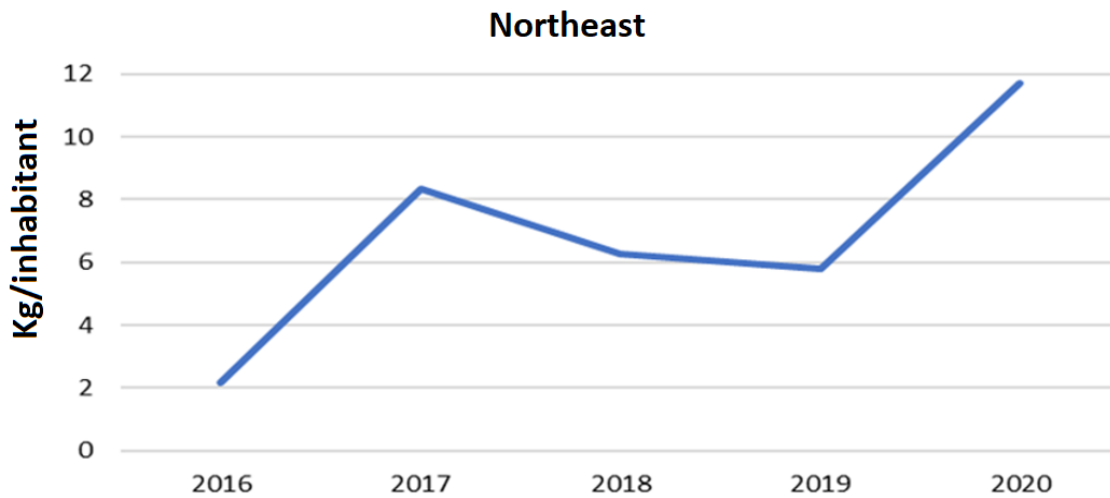
Thus, the states that have the greatest variety of destinations available can be more effective in the segregation and final disposal, according to the needs of each waste. However, it is necessary to point out that regardless of the waste group, disposal in dumps is always disapproved, being classified as the most inappropriate destination.

4 RESULTS ANALYSIS

Providers must feed the SNIS system (BRASIL, 2022) annually with the total amount of solid waste treated in the period, the values are separated into subcategories by type of waste, such as construction waste, pruning waste, among others. Therefore, it was necessary to apply a filter to the data, so that only the amounts related to RSS were accounted for the analysis of this research, thus excluding other declared solid waste.

The result of crossing the data obtained from the SNIS – Série Histórica (BRASIL, 2022) with the population expectation issued by the IBGE (2022), for the analyzed years, allowed tracing the average *per capita* amount of HSW collected in the 9 northeastern states.

Figure 1 – Annual *per capita* quantity, in tons, of HSW produced in the Northeast.



Source: Own elaboration.

Figure 1 shows that the amount of declared HSW follows an increasing projection, accompanying the predicted population increase for the respective years. This finding is with expectations for the relationship between HSW generation and population growth. As also noted by Sodr e and Lemos (2017), the demand for health services increases as the population increases, therefore, a proportional increase in the amount of waste generated and discarded is expected.

In addition to the subcategories of solid waste present in the SNIS, of which only RSS will be analyzed, the system also segments the amount by destination, in the case of HSW, the database provides six possible destinations, namely: dump, controlled landfill, sanitary landfill, specific HSW trench, incineration treatment unit and microwave or autoclave treatment unit

According to the Ministry of Health's HSW manual (BRASIL, 2001), the final HSR procedures can be divided into partial and complete. The complete is the destination, the closure of the waste cycle, the way it will be disposed in nature, while the partial is an intermediate phase, that is, a necessary procedure before the final disposal. Microwave and autoclave treatment units, classified as sterilization units, are included in the partial allocation.

Santos *et al.* (2022) describe that, after waste is treated in sterilization units, it loses its contaminating potential and thus can be discarded as household waste. Regarding the existence of a microwave or autoclave treatment unit, such a unit is present in Bahia, as of 2018, its use being constant in subsequent years. In addition, the data report a single use of such a unit in the state of Para ba in 2019, however there were no subsequent notes sent to this unit.

Therefore, considering the polluting and contaminating potential of HSW, it is ideal for the states to have incineration units, characterized as a complete procedure, or units for microwave treatment, or autoclave, characterized as a partial procedure, as they are suitable destinations to neutralize the risks inherent in the material. Analyzing the nine states of the Brazilian Northeast, only 5 of them have one or more of these destination units.

From Table 1, it is possible to identify that the state of Ceará (CE) stands out for having a continuity in the use of such destinations, registering annually the sending of quantities of HSW to the incineration treatment units located in the cities of Fortaleza and Juazeiro do Norte. It is still possible to see that neutralizing destinations began to be used in Bahia in 2016, neglected in 2017, but continuing their use in 2018 and from then on keeping shipments constant, although in small quantities. In Pernambuco, this type of destination started to be reported in 2020. The state of Alagoas, for the period studied, did not report any use of incineration units, autoclaves or microwave units.

Table 1 - Quantity, in tons, of RSS sent to incineration, autoclave, or microwave unit

Tonne of HSW sent to incineration, autoclave or microwave unit					
	2016	2017	2018	2019	2020
Alagoas	0,0	0,0	0,0	0,0	0,0
Bahia	85,0	0,0	180,0	440,0	412,1
Ceará	5229,5	5697,7	5090,0	5531,1	6471,5
Maranhão	0,0	0,0	0,0	0,0	0,0
Paraíba	0,0	0,0	0,0	689,4	0,0
Pernambuco	0,0	0,0	0,0	0,0	3120,3
Piauí	0,0	0,0	0,0	0,0	0,0
Rio Grande do norte	0,0	0,0	0,0	0,0	0,0
Sergipe	0,3	0,0	0,0	1023,8	1,0

Source: Own elaboration.

The next destination, and the least indicated, is the landfill, although in 2010 Federal Law n. 12,305 (BRASIL, 2010) has already determined the elimination and recovery of landfill areas, the data still portray the sending of part of the HSW for this destination. According to Ferreira (2017), dumps inadequately receive all waste without any type of segregation, making the negative impact of dumps evident. Therefore, it is an ecologically inappropriate finalization.

Reinforcing this definition, Silva *et al.* (2020) report that dumps are places where tailings of all kinds are openly deposited, without any prior treatment of the land. The same authors also relate the frequency of use of this destination with the economic power of the region, in the study the northeast region is among those with the highest percentage of use of dumps, which is the destination of 60% to 70% of all solid waste produced .

Table 2 displays the total amount in tons of HSW that were deposited in dumps over the 5 years studied. Ceará and Bahia were the states that sent the largest amount of HSW to dumps in 2019 and 2020, respectively, however, they are two of the three most populous states in the Northeast, covering, together with Pernambuco, 60% of the regional population. The highlight is given to the state of Maranhão, which sent 100% of its waste to dumps in 3 of the 5 years analyzed, and Alagoas, which sent all its waste to dumps in 2016 and 2017.

Table 2 - Amount, in tons, of HSW sent to Dumps in the 5 years analyzed

	Tons of HSW sent to Dumps				
	2016	2017	2018	2019	2020
Alagoas	184,1	1818,0	0,0	0,0	0,0
Bahia	1486,5	5435,1	1066,5	3385,9	82315,3
Ceará	357,9	367,8	1456,3	13997,0	211,4
Maranhão	767,9	845,7	772,4	554,6	9015,1
Paraíba	1279,8	2988,1	114,7	206,2	49,0
Pernambuco	75,0	34,9	128,6	40,0	5456,6
Piauí	213,5	97,8	83,1	133,1	344,7
Rio Grande do norte	89,0	1301,0	3737,0	1556,3	2570,5
Sergipe	52,7	5962,4	13,0	21,1	41,2

Source: Own elaboration.

In 2016, the State of Alagoas had 33 municipalities that received waste of the most diverse types, however, only 8 of these cities received HSW and all of them had the dumps as final destination, that is, these municipalities did not indicate any treatment or specific destination, necessary for the type of waste reported. Although ANVISA Resolution n. 306 (BRASIL, 2004) already foresees that the HSW groups must be destined according to their specificities and singularities, the state did not indicate that it has an adequate final destination, nor the realization of all phases of the life cycle of the waste.

The next destination addressed is the controlled landfill, this presents itself as an evolution of the dump, however, soil preparation and effluent treatment is absent. This stage differs from the dump because there is no deposit of waste on the land, in the controlled landfill the land is excavated, the waste is deposited and is later covered by a layer of soil.

Loureiro *et al.* (2019), identify that the use of controlled landfills softens the release of odors, reducing the attraction of animals and providing a certain visual comfort, however the lack of any waterproofing makes it a non-optimized alternative.

According to SNIS data collected for this research. The states of Ceará and Paraíba were the states that sent the most HSW to the controlled landfill unit, on the other hand, the states of Alagoas and Sergipe did not send any HSW to controlled landfills. The amounts in tons destined for landfill by each state, over the 5 years analyzed, are shown in Table 3.

Table 3 – Quantity of HSW, in tons, sent to controlled landfills in the 5 years analyzed.

	Tons of HSW sent to controlled landfill				
	2016	2017	2018	2019	2020
Alagoas	0,0	0,0	0,0	0,0	0,0
Bahia	20,0	82,8	117,6	104,0	470,1
Ceará	133,0	960,5	17500,0	9500,0	12073,0
Maranhão	0,0	0,0	12,0	0,0	250,0
Paraíba	0,0	8702,0	4,0	4,0	4,0
Pernambuco	454,0	0,0	768,0	0,0	0,0
Piauí	0,0	2,0	21,0	13,4	2,1
Rio Grande do norte	0,0	13,3	28,0	0,0	9,3
Sergipe	0,0	0,0	0,0	0,0	0,0

Source: Own elaboration.

Finally, there is the last destination, appearing as an ecologically appropriate destination, which are sanitary landfills, in the complete procedure category. In the definition by Silva and Tagliaferro (2021) they are systematically prepared constructions to allow the protected disposal of solid waste, their composition is the result of the integration of aspects of civil engineering, environmental engineering and sanitary engineering to provide a safe final destination.

Additionally, the SNIS brings the possibility of disposing of HSW in a specific ditch for HSW, this ditch is used by the state of Bahia in all the years analyzed, this trend was followed by Piauí, which started to allocate waste to specific ditches for HSW in the year of 2018 and more recently, Ceará reported the use of such a unit, allocating a total of 22.1 Tons of HSW in the year 2020 alone.

According to the Support Center for Environment and Urban Planning (CEAMA) of the Public Ministry of the State of Bahia, the specific ditch for HSW is a part of the sanitary landfill intended only for the disposal of this waste (BAHIA, 2022). It is concluded that, as the trench is a portion of the sanitary landfill, it can be equated to its characteristics. Therefore, the quantities of HSW destined for sanitary landfills and specific trenches for HSW were counted together and referred to only as landfills.

The amounts, in tons, sent to the sanitary landfill are shown in Table 4. It is possible to identify the annual progression of the state of Ceará, where the use of the landfill remained continuous throughout the period. In the case of Bahia, it already had a constant use of the landfill, however in 2020 the amount of waste increased exponentially. Another detail is the state of Paraíba, which presented a peak of HSW in landfills in 2018 and later the flow returned to normal. Finally, there are the states of Rio Grande do Norte and Sergipe that did not register any HSW sent to this destination in the five years analyzed.

Table 4 - Quantity, in tons, of RSS sent to sanitary landfill

	Tons of HSW sent to sanitary landfill				
	2016	2017	2018	2019	2020
Alagoas	0,0	0,0	0,0	0,0	0,0
Bahia	710,2	499,6	87,6	516,9	4204,3
Ceará	5993,3	5172,9	6545,9	5604,7	6613,1
Maranhão	0,0	0,0	0,0	0,0	0,0
Paraíba	50,0	53,0	4850,0	50,0	40,8
Pernambuco	0,0	110,7	2163,8	6,0	8,1
Piauí	0,0	0,0	0,0	5,0	1,0
Rio Grande do norte	0,0	0,0	0,0	0,0	0,0
Sergipe	0,0	0,0	0,0	0,0	0,0

Source: Own elaboration.

In order to rank the states according to the destination of the HSW, a 5-level classification was developed, a score was also arbitrated for the use of each unit, considering partial and complete final procedures, as shown in Chart 2.

Chart 2 – Score awarded for the efficiency of each destination

Finalistic unit	Punctuation
Dump	0
Controlled landfill	1
Sanitary landfill	2
Incineration	3
Autoclave or microwave	4

Source: Own elaboration.

No punctuation was attributed to the dump, this happened because this was a totally inappropriate destination for any type of waste. The controlled landfill was assigned punctuation 1, as it represents an improvement in waste treatment compared to the dump. The sanitary landfill, which is an environmentally appropriate destination, received punctuation 2, as it takes care of the soil, avoiding contamination and odors, however it did not receive the maximum punctuation due to the prior need for decontamination inherent to HSW.

The greatest punctuations refer to the incineration units, punctuation 3, and autoclave or microwave, with punctuation 4, this happens because they are the destinations capable of carrying out the decontamination of HSW, a necessary procedure to remove the risk of spreading disease through contact with contaminated HSW.

By this methodology, the state that presents some amount of HSW destined for the autoclave unit will receive punctuation 4 and if that same state, in the same analyzed year, also registers the sending of HSW to the sanitary landfill, the score will be added 2. Consequently, the final punctuation of the analyzed state, in the chosen year, will be 6, that is, the sum of 4, referring to the autoclave unit, and 2, referring to the sanitary landfill.

The punctuation, present in Table 5, was assigned annually to the states that declared sending, some amount of HSW for the existing final units, according to the punctuation in Chart 2. After calculating the score of each state in each year, it was the general average of all years, by state, is taken out.

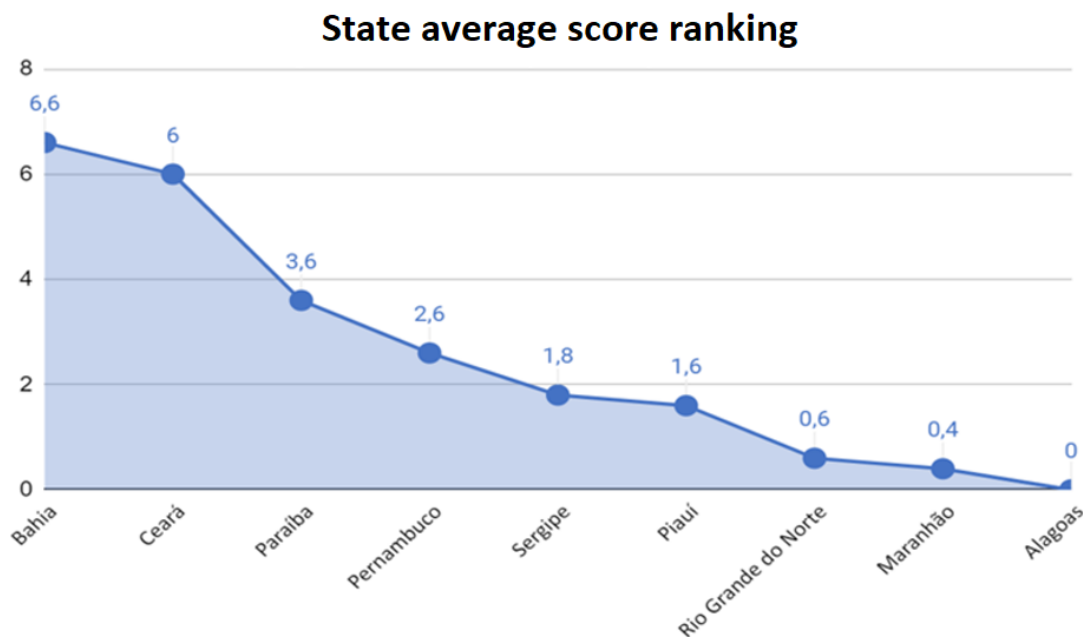
Table 5 - Annual final punctuation

	State final punctuation				
	2016	2017	2018	2019	2020
Alagoas	0	0	0	0	0
Bahia	6	3	7	7	10
Ceará	6	6	6	6	6
Maranhão	0	0	1	0	1
Paraíba	2	3	3	7	3
Pernambuco	1	2	3	2	5
Piauí	0	1	1	3	3
Rio Grande do norte	0	1	1	0	1
Sergipe	3	0	0	3	3

Source: Own elaboration.

Therefore, it is considered that the state that has more types of destinations will be able to reduce the environmental damage and costs, as it will treat each HSW according to its strict need. From this score, based on SNIS data provided by the states themselves, the state performance ranking was created, shown in Figure 2.

Figure 2 – Score attributed by destination options present in each state



Source: Own elaboration.

The observation of the data and the accounting of the score made it possible to trace groups of states by similarity. Group 1, composed of the states of Bahia and Ceará, were thus segregated because the states report, in the period studied, the use of four forms of disposal, thus having a profile capable of further optimizing the final disposal of HSW, although they still make use of dumps, a gradual migration to environmentally appropriate forms of disposal can be seen.

Bahia stands out, in the treatment of HSW, for having a partial microwave or autoclave treatment unit installed in the municipality of Feira de Santana, its use has been reported since 2018 and this unit is used to make the contaminating potential of the waste inert. That is, Bahia has the resources to decontaminate HSW and uses sanitary landfills as the ideal destination for materials that are not contaminated or that have already gone through the decontamination process, formatting the ideal scenario for the HSW cycle. On the other hand, Ceará reported the use of the incineration unit in all the years studied, although it is a more expensive destination, it also manages to disinfect the material.

Group 2 was formed by the states of Paraíba, Pernambuco, Sergipe and Piauí. This group is made up of states that demonstrate progress in the process of treating HSW, as they already use three of the five possible treatments, which already allows them to give a reasonably adequate treatment to HSW. While Sergipe alternates sending its HSW to dumps and incineration units, Paraíba and Pernambuco have been using sanitary landfills since 2017 and Piauí started recording HSW sent to sanitary landfill in 2019. The improvement is noticeable with the registration of an autoclave or microwave unit in Paraíba in the year 2019.

Finally, group 3 consisted of the states of Rio Grande do Norte, Maranhão and Alagoas. In Rio Grande do Norte and Maranhão, all HSW is sent to dumps or controlled landfills, which

are two relatively inappropriate destinations. However, the most alarming picture is presented in Alagoas with 100% of HSW deposited in dumps. A worrying picture, due to the fact that dumping should have already been discontinued in view of current legislation, and concerns about the potential contaminant present in HSW, when they are discarded without any additional care.

5 CONCLUSION

The final disposal of HSW is a public health and utility problem, since, in addition to the power of environmental contamination, there is a high risk of disease proliferation through infected waste. It is noticed that there is still a large-scale use of dumps, as this destination is present in all states in all years analyzed. However, some states, such as Ceará, Bahia and Paraíba, already demonstrate the capacity for improvement, including more advanced HSW treatment techniques and progressively migrating to the use of sanitary landfill.

Therefore, the general level is that the performance of the nine northeastern states continues to be below ideal, because the use of non-ecologically correct destinations is still very present. Improvement must be subsidized by time, financial resources and scientific studies, as the active debate of such themes is capable of encouraging increments and envisioning new possibilities.

The state of Bahia is highlighted and has the best performance, as it presents continuity in data recording, demonstrating an evolution in terms of HSW treatment, expanding its possibilities of destination and reducing the amount destined for dumps, being, therefore, a guide for the other states to follow. Ceará is also highlighted for having a well-established incineration unit and sanitary landfill, throughout the reports, lacking only a partial treatment unit, as incineration is a costly process and should be used only in specific cases. Paraíba is also distinguished by including a partial treatment unit in its network, responsible for decontaminating HSW, and making use of sanitary landfills.

The SNIS still has some weaknesses, such as the fact that it does not present the HSW classification, and even though it is a database that should be fed annually, there is a delay and in some cases the absence of data, since the most recent information on the platform is from 2020. However, the existence of this database is appreciable and can be compared with existing databases in Europe and England, as reported by the Ministry of Regional Development. The agglutination of this information should be valued, as it allows the use of different methodologies, providing a lot of data for future research. The Ministry of Regional Development seeks to encourage municipalities to consolidate the database using the information contained in the SNIS as a selection criterion and hierarchy and allocation of financial resources by the federal government.

As a limitation of this research, there is the fact that the types of HSW were not considered, whether type A, B, C, D or E, which were destined for each unit, only the report of sending and use of each destination foreseen in the system was analyzed, that is, the study focused on the presence of the final units and not on the type of HSW intended for each unit.

For future research, it is suggested to analyze the influence of the effective amount destined for each unit in the state performance, as well as that the data be expanded, analyzing

the performance in other geographic regions, allowing the development of a national level. It is still recommended to analyze the other categories of solid waste in the other aspects that the SNIS provides.

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