Management of Port Solid Waste Framework

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Abstract- One of contemporary environmental issues refers to progressive and diverse generation of solid waste in urban areas or specific, and requires solutions because the traditional methods of treatment and disposal are becoming unviable over the years and, consequently, a significant contingent of these wastes presents final destination inappropriate. The diversity of solid waste generated as a result of human activities must have the appropriate allocation to specific legislation in force, such as landfill, incineration, among other procedures established by the competent bodies. Thus, also the waste generated in port activities or proceeding vessels require classification and segregation for proper disposal later. This article aims at presenting a methodology for the collection, transportation, treatment and disposal of solid waste port and also application of automation technology that makes possible the implementation of the same.

Keywords- automation technology, management, segregation, solid waste port, sustainability.

I Introduction

The environmental and social impacts due to improper disposal of solid waste are growing increasingly both in developed and developing countries and according to Schenato et al. in Brazil, the inadequate disposal of solid waste on soil and surface is recognized as one of the serious problems of our times [1].
According to Gissen apud Aktas, the big question of this century consists of a conflict between the increased quality of life and a decrease in overall consumption of natural resources. It is estimated that the world's population, currently around 6.2 billion by 2025 to spend 8-10 billion, and so, consequently, will increase both the demand for resources and the generation of environmental impact due of human activities. Therefore, as the earth is a closed ecosystem, you can not sustain this increasing population in traditional economic models targeted for growth [2].
The steady increase in the generation of solid waste leads to management problems in addition to the environmental impacts. With economic development and consequent increase in production and consuming, the problem of waste management concerns developed countries and also the least developed. The Environmental legislation exercises a constant pressure for solutions economically advantageous and environmentally sustainable, so that the effects can be minimized [3]-[4]-[5]. Acoording to Ramlee et al. in Malaysia, integrated solid waste management is a modern and rational approach for planning and implementing solid waste program in Local authorities [6].
Waste management is becoming one of the most important issues for the municipalities of modern society due to their social, political and economic, mainly because of rising public concern with environmental preservation [7].
According to El-Fadel et al. in Domingo e Nadal, because of the ease of operation and lower economic costs, the landfill has been used for disposal of municipal solid waste. About 95% of the municipal solid waste generated worldwide, until recently, were destined for landfills [8]
According to EC (2004) in Mari et al., the European Union (EU) produces 1.3 billion tons of waste annually. They are waste from household, and commercial and industrial activities, which need to be managed properly to minimize potential impacts to the environment and human health. The European Union has guidelines for waste management based on reducing the generation, recycling, reuse and improvement of the final disposal [9].
According to Domingo and Nadal, the waste sorting and recycling of municipal solid waste are critical to the effective management of municipal solid waste. For Sykes et al. in Domingo and Nadal, the deviation of organic waste from landfill is essential for the sustainability of waste disposal [8].
The problem of solid waste in the cities that have ports is even greater, because in addition to waste generated in their own ports complex there is also a huge contingent of waste brought by ships and boats.
The lack, in some cases, the efficient structure in the ports to address issues relating to the management of solid waste, adversely affects the quality of life in port cities and even the surrounding region. As demonstrated by the data presented in Gissen [2], El-Fadel et al. [8], Domingo and Nadal [8], EC [8], Mari et al. [6], Ghiani et al [7] and Sykes et al. [8], further urgency to the development of automatic control and monitoring systems so that the collection policies more efficient, segregation, disposal and recycling can be implemented for solid waste will be generated by a municipality or by the ports.
Therefore, investment in appropriate procedures of classification, collection, treatment and proper disposal of solid waste is essential to minimize their negative effects and mitigate potential environmental impacts.

II Analysis of Solid Waste Generation in Port of Santos and the Municipality of Santos

2.1 Generation of solid waste in the Port of Santos
The Port of Santos is located in the city of Santos, in the state of São Paulo, Brazil. It is the Latin America's largest port, both in volume of freight handled as well as in trading volume. According Tseng and Lin in TAIWAN, the living consumption causes the generation of a lot of solid wastes that create environmental impact and health risks [5].
The Port of Santos is responsible for approximately one quarter of participation in the Brazilian Trade Balance in values, and handled in 2010 $ 96.2 billion of the Brazilian international tradet [10].
The identification of sources of solid waste generation in port areas is critical to the development of a management plan for this waste [11].
The main sources of port solid waste are:

a. vessels - various types of solid waste are generated according to the administrative, support, maintenance and operation activities of a vessel. However, the volume of waste generated depends on the size and capacity of the vessel, the number of crew members and the kind of freight, as well as the characteristics of the equipment used in the operation.

b. the various port activities on land such as operations of terminals, canteens and kitchens, maintenance and support sectors, among others.

For this study a survey was conducted with the Management of Environment of Codesp (Dock Company of São Paulo), and also with the company Marim Gerenciamento de Resíduos Ltda. ME and the shipping company CMA CGM do Brasil Agência Marítima Ltda.
According to Hřebíček et al. in Czech Republic, the social dimension of corporate sustainability concerns the impacts the given organization has on the social systems within which it operates [12].

Fig.1 and Table I presents an estimation by extrapolation of the amount of solid waste generated, taking into account only the average of long-haul vessels berthed for a month at the Port of Santos.

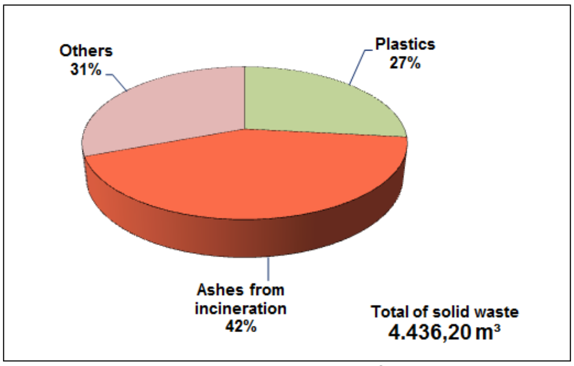

Fig. 1 - The estimated percentage of waste generated by long-haul vessels berthed for a month at the Port of Santos.

Table I - Estimated average monthly of generation of solid waste by long-haul vessels.

Solid waste	Estimated average per vessel (m³)	Monthly total with apparently 411 vessels berthed per month on average at the Port of Santos in 2010
Plastics	2.89	1,187.79 m³
Ashes from incineration	4.61	1,894.71 m³
Other	3.32	1,364.52 m³
Total of solid waste	10.82	4,447.02 m³

The 4,447.02 m³ of solid waste generated each month by vessels berthed at the Port of Santos are equivalent to approximately 1,334.11 tons [13].
In the port environment, the monthly production of solid waste is approximately 1,749.89 tons (Marim Gerenciamento de Resíduos).
Fig. 2 shows the monthly average in tons of the main solid waste handled at the Port of Santos in the first months of 2010 by the company Marim Gerenciamento de Resíduos.

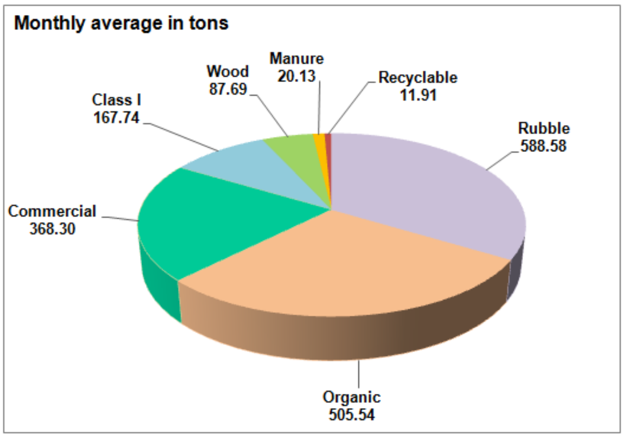

Fig. 2 - Monthly average of solid waste handled by the company Marim Gerenciamento de Resíduos.

Thus, the total production of solid waste in the Port of Santos is 3,083.35 tons per month, which is equivalent to a daily average of 102.78 tons.

2.2 Generation of solid waste in the municipality of Santos

In the city of Santos 251.7 tons of solid waste are generated per day. The waste disposal system of Santos falls, from 2003 to 2010, under appropriate conditions (State Inventory of Household Solid Waste 2010 – Cetesb 2011).

2.3 Sítio das Neves Landfill

Currently, solid waste generated in the city of Santos is disposed in the Sítio das Neves private landfill, located in the municipality.
The project of the Sítio das Neves Landfill is composed of ten cells, each cell capable of storing around 120 thousand tons of waste (City of Santos). The landfill began operations in January 2003, with receiving capacity of 500 tons/day and a useful life estimated at twenty (20) years [14].

III PROPOSED SOLID WASTE MANAGEMENT MODEL

The port solid waste management model proposed in this paper for collection and disposal of waste is based on five macro activities:

a. Identification of sources of solid waste generation in the port area.
b. Determination of quantity and quality of solid waste generated in various sectors.
c. Definition of solid waste segregation procedures at its source.
d. Design of a waste sorting system, with the hiring of an outsourced company specialized in the processes of segregation, disposal and proper final disposal of solid waste.
e. Implementation of the project.

This paper presents the description of the development of the first four macro activities, since the implementation of the project, although necessary, depends on corporate senior decisions and investment as well.

3.1 Identification of sources of solid waste generation

The identification of sources of solid waste generation is the first and also vital step for the study and analysis of any process to improve solid waste management in port environment.

The two main sources of solid wastes are the vessels and also the various activities carried out within the limits of the port area.

3.2 Determination of quantity and quality of solid waste generated in the port environment.

Once the sources of solid waste generation are determined, it is crucial to determine the weight and volume quantity as well as to characterize the main types of solid waste generated.

The waste characterization is extremely important, because each type of waste must have its own disposal or be treated, among other appropriate procedures, according to the specific legislation in force and the requirements of the involved regulatory agencies.

3.3 Definition of solid waste segregation procedures at its generation.

Segregation by waste type and category is based in this paper on the separation of it at the time of its generation, identifying it as the class established in technical standard and packing it properly in order to ensure the best way of temporary storage and thus ensuring the correct final disposal. This way, segregation initially will allow future reuse and recycling of these wastes.

For the segregation of waste at their generation, identification patterns of waste packaging containers (plastic bags, boxes for disposal of contaminated, piercing or cutting material, etc.) must be established according to the criteria for class, raw materials, dimensions, among other requirements established in the relevant Basic Regulatory Standards of the Brazilian Association for Standardization (NBR/ABNT).

3.4 Waste Sorting System Proposed

The project defined in this paper specifies a new operational model for handling and disposal of solid waste generated in a port environment and also specifies the hardware and software architecture necessary to implement it.

To implement the proposed system it is necessary that two areas, one internal to the port complex and one external, are projected and designed.

They are:

a. Temporary Storage and Screening Center – CATT, internal area.
b. Final Disposal Specific Area – AEDF, external area.

3.4.1 Temporary Storage and Screening Center – CATT

To enable the proposed model, it is necessary to create a specific agency, reporting to the Environmental Management of the Port of Santos, with responsibility for the management and supervision of such activities. In this article, this proposed agency is called Department of Solid Waste Management (DGRS).

In addition, for the segregation of solid waste, it is proposed in this paper the implementation of a local, internal to the port, reserved and specific for this purpose, called Temporary Storage and Screening Center (CATT), which must comply with the environmental and public health conditions provided in the legal rules.

Thus, a change in the organization chart of the Port of Santos is presented in this proposal, with the creation of the Department of Solid Waste Management (DGRS) and, reporting to it, the Temporary Storage and Screening Center (CATT).

Fig. 3 shows the new Codesp Organization Chart Model proposed, with the creation of the Department of Solid Waste Management (DGRS) and, reporting to it, the Temporary Storage and Screening Center (CATT).

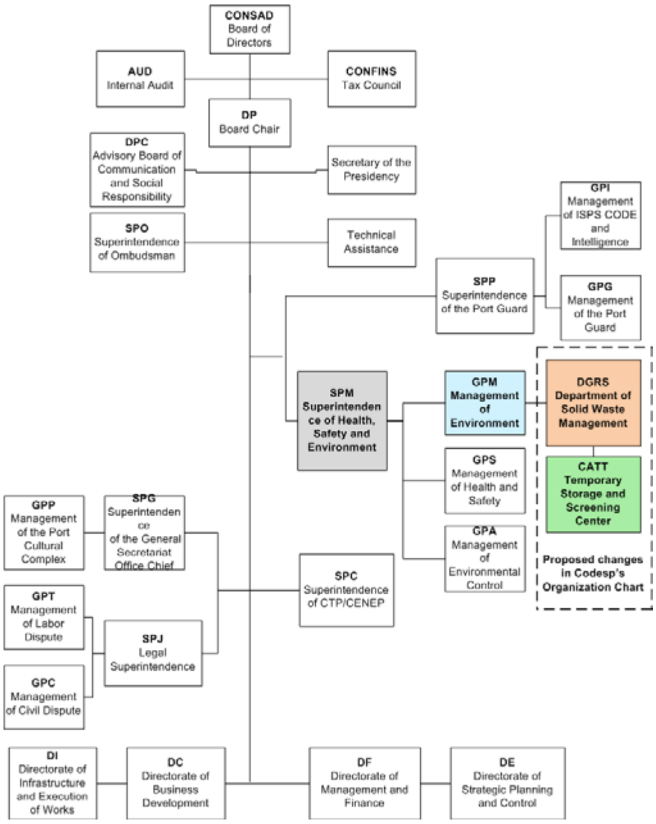

Fig. 3 – New Codesp Organization Chart Model proposed, with the creation of the Department of Solid Waste Management (DGRS) and, reporting to it, the Temporary Storage and Screening Center (CATT).

3.4.2 Project of the of final disposal specific area (AEDF) of port solid waste

The final disposal location must meet all requirements and specifications of the regulatory bodies. It must also have an Integrated Weighing Station (PPI) associated with the supervision and control system technological infrastructure of the Integrated Automated Weighing Station System (SIPPA) [15]

3.4.3 Integrated Automated Weighing Station System (SIPPA)

This proposal is based on the adaptation presented by Pereira [15], called Integrated Automated Weighing Station System (Sippa).

This paper proposes that the so-called PPO (Operating Weighing Station) and PCC (Registration and Weighing Station) [15] are implemented in a single Tour Integrated Weighing (PPI) called Integrated Weighing Tour Center and Temporary Storage Screening (PPI_CATT). And an Integrated Weighing Station of the Final Disposal Specific Area (PPI_AEDF) that performs only the PPO function.

SIPPA consists of one PPI_CATT to be installed in the most convenient CATT area and one PPI_AEDF, which must be installed in the most convenient AEDF area.

The main difference between a PPI_CATT and a PPI_AEDF is that PPI_AEDF does not perform the functions of PPI_CATT and therefore operates in a totally independent way.

In the PPI_CATT, the vehicle is registered and weighed. In the PPI_CATT, the role of placement or removal of the electronic seal in the carrier vehicle is also performed.
In this proposal, the vehicle registration is made during the placement of the electronic seal. The weighing and automatic recognition are performed on the weighing platform or electronic scale.
Fig. 4 shows an generic illustrative plant of a Temporary Storage and Screening Center (CATT) and the Integrated Weighing Station (PPI) in SIPPA. The routes of internal waste disposal and the route of collection of the waste already segregated are also illustrated; in this case the carrier vehicles must be weighed empty at the entrance and exit after the loading.

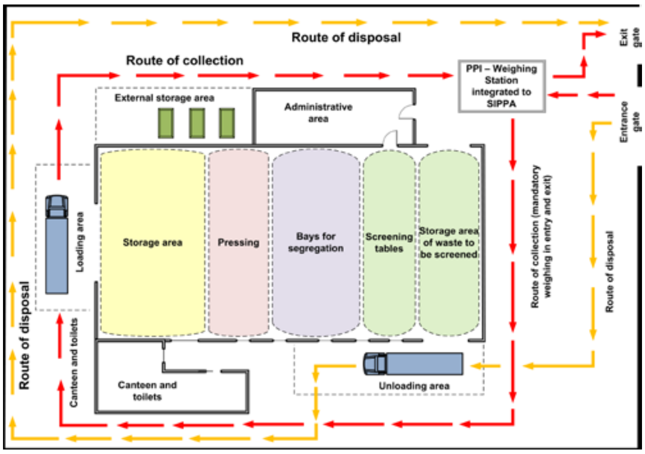

Fig. 4 - Illustrative generic plan of a Temporary Storage and Screening Center (CATT).

Fig. 5 shows the macro architecture of hardware of a PPI_CATT and a PPI_AEDF.

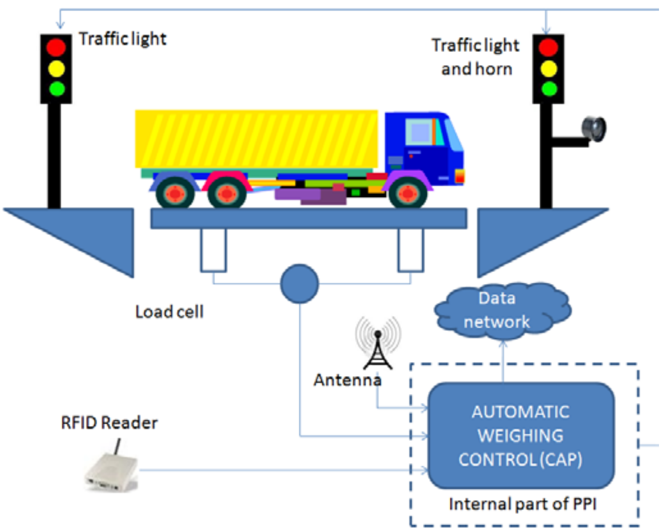

Fig. 5 – Macro architecture of hardware of a PPI_CATT and a PPI_AEDF [15].

The components of a PPI_CATT or PPI_AEDF are:

a. Weighing platform – it is the platform where the vehicles are positioned to be weighed.
b. Traffic lights are bright flags to help drivers about the inbound and outbound movement on the weighing platform.
c. Load cell – it is the device that converts the weight on the platform into an electronic signal.
d. RFID (*Radio Frequency Identification*) Reader – it is the reader that receives the signal emitted by the tag installed in the vehicles to be weighed. It allows unambiguously identification of the vehicle information by radio frequency [16].
e. Radio frequency signal transmitting antenna that activates the transponder installed in the vehicles.

Fig. 6 illustrates the software architecture of the Automatic Weighing Control and its interaction with hardware equipment internal to PPI.

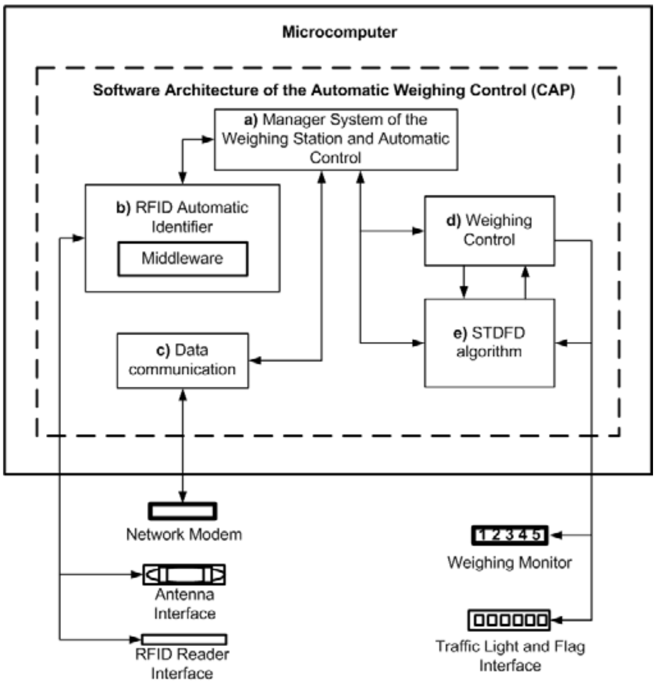

Fig. 6 – Macro architecture of software of the Automatic Weighing Control and its interaction with hardware equipment internal to PPI [15].

Each module has a specific function as [15]:
a. Tour Manager module that controls the transfer of control and parameters between software modules, performing the tasks and synchronizing the post.
b. Interaction Module with the module identifier, the Tour Manager triggers the instant identifier that the algorithm STDFD confirm the weighing process correct [15]. This model is based and developed in open source software called “middleware”. “It is the software responsible for the exchange of information between different operating platforms and communication protocols” [17].
c. Interaction Module Communication Module. At the end of each weighing process acknowledged, the station Manager provides the data to the communication module which, in turn, transmits it to the central system.
d. Module Interaction Control Weighing module and algorithm STDFD. The Tour Manager manages the control module and the module Weighing STDFD. This function signals as well as sensory, the operating conditions of

vehicle motion on the platform. This module has the ability to verify that the process of entry and exit of vehicles positioning on the platform or was not done properly.

3.4.4 System Operational Model

Fig. 7 shows the steps of monitoring of the proper final disposal of port solid waste, involving the operations of collection, sorting and temporary storage in CATT, weighing, transport and final disposal in the Final Disposal Specific Area (AEDF).

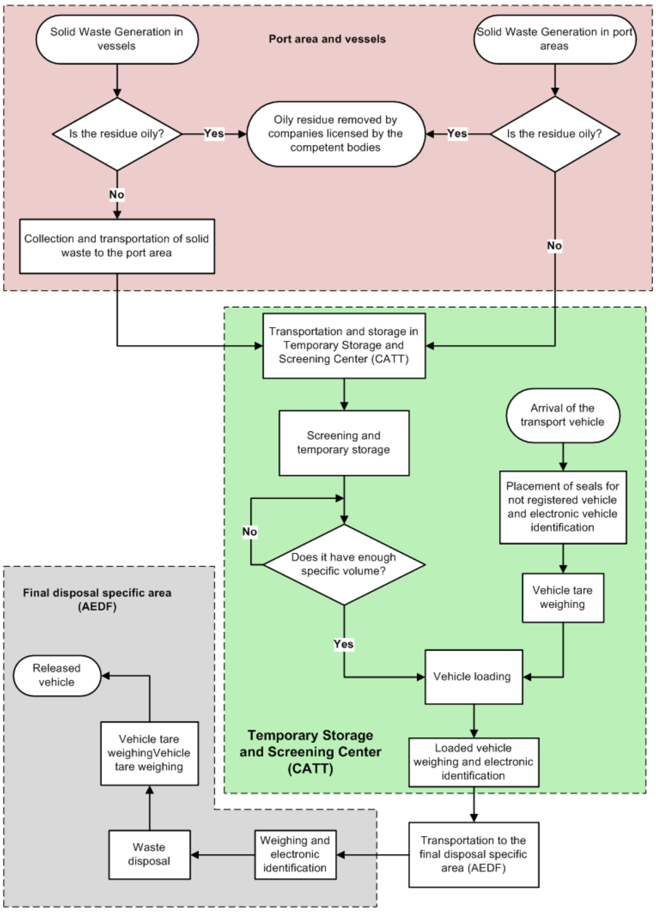

Fig. 7 - Operational flowchart of the model of monitoring of the correct final disposal of port solid waste.

The stages of the operations of loading, weighing, removal and transportation of solid waste must be documented and controlled through the use of electronic seal and tracking technologies that enable to identify and verify for the regulatory agencies the location and path from the loaded truck departure from the temporary storage location (CATT) to the proper final disposal of waste in accordance with the current legislation.

The removal of waste from locations of generation, port area and vessels should be every day, and the schedules, routes, equipment and number of collections to meet the demand should be established according to the amount generated.

DGRS and the subcontractors must receive electronically information on the weighing of waste dumped in the specific disposal locations so that they could have control over the disposal of it.

Therefore, final disposal companies must issue the Solid Waste Final Disposal Electronic Certificate (CEDF), and a copy must be electronically sent to the company providing the collection services, and another copy to DGRS.

IV Conclusion

In this context it is necessary to develop an automation model to address these issues efficiently and providing a solid waste management port an environmentally sound manner.

Thus, with positive to the port environment, but also contribute to improving the competitiveness of Brazilian ports in global markets increasingly demanding and also environmental issues.

Proper solid waste disposal is a effective way to control negative impacts to the environment, contributing to minimizing pollution observation needs in environmental preservation in accordance with the principles of sustainable development and, consequently, ensuring improved quality of life and providing environmental conservation of the planet.

The complexity of environmental issues in port areas requires the search for innovative alternatives for implementing appropriate practices of solid waste management, relating to the classification, collection, treatment and proper disposal, and thereby mitigate potential impacts such as air pollution, soil water resources, among others. Also contribute to the protection of public health by preventing the introduction of diseases from other locations and thereby also avoiding the risk of epidemic outbreaks. Consequently with positive environmental port, helping to improve the competitiveness of ports in global markets increasingly demanding and also on issues related to environmental sustainability port.

Therefore, this research hopes to significantly contribute to development of a methodological proposal for the collection, transportation and disposal of solid waste port, which if implemented, will allow, among other gains, the development of a sustainable strategy for the disposal of solid waste in accordance with legislation force, but also contribute significantly to reduce the volume of solid waste generation port due to recycling processes and segregation of the same.

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