

Application of Reverse Logistics in Hospital Material Processes: Case Study

Tatiane Brandão da Silva¹, Waldinei Rosa Monteiro², Jandecy Cabral Leite³

¹Postgraduate Program in Science and Environment of the Institute of Exact and Natural Sciences the of Federal University of Para (PPGCMA/ICEN/UFPA)

Email: tatibrandao76@gmail.com

²Postgraduate Program in Science and Environment of the Institute of Exact and Natural Sciences the of Federal University of Para (PPGCMA/ICEN/UFPA)

Email: waldinei@ufpa.br

³Galileo Institute of Technology and Education of the Amazon (ITEGAM)

Email: jandecy.cabral@itegam.org.br

Abstract— One of the major current concerns of society is the environmental issue, precisely because this is a prerogative of great importance for the populations in terms of quality of life. International organizations have sought to develop symposiums, seminars, and global meetings that involve discussions on environmental issues. Since the 1992 ECO-Rio-92 world summit, Brazil has sought to develop a normative framework to foster mechanisms of environmental policies, an element that is already part of the 1988 Constitution of the Federative Republic of Brazil. Thus, this article addresses the Reverse Logistics of Health Services Waste in a public hospital in the city of Manaus-Amazonas, with the general objective of analyzing the reverse logistics process in the recycling of medicine and hospital material in a public hospital in the city of Manaus – Getúlio Vargas University Hospital (HUGV) based on the formation of an inventory of environmental/hospital interests, as well as specifically identifying the main characteristics of reverse logistics; verifying if there is flexibility in the application of the reverse logistics process in the recycling of medicines and hospital material; demonstrating a proposal for the application of reverse logistics to reduce the environmental impact caused by solid waste; understanding how the reverse logistics process can contribute to softening the impact of the environmental degradation caused by the incorrect disposal of medicine and hospital material in a public hospital in Manaus; and, demonstrating its environmental benefits to the city of Manaus. The methodology used included integrative review research, as well as documentary research and direct observation. It is concluded that reverse logistics is a way of obtaining environmental management within the legal parameters determined by the Brazilian legal system but cannot be

applied in its entirety in the public hospitals of Manaus, which can make nosocomial disposal dangerous.

Keywords— *Urban solid waste; National Policy on Solid Waste; Reverse logistics.*

I. INTRODUCTION

Reverse logistics is a very old stock control procedure, although it was not named as such in the beginning. Its origin dates back to a cost cutting measure taken by American soft drink producers regarding container collection in the nineteenth century [1].

As the production of glass containers was costly for the soft drink industries, it was much cheaper to collect them directly from sales outlets after use, than to dispose them in city waste storage sites. This practice has been going on for many, many years, regardless of its nomenclature [2]. In the 1950s, quality programs emerged in industry alongside post World War II environmental concerns. The quality programs, embodied in ISO 9000, incorporated environmental quality programs through ISO 14,000 [3]. But the idea of environmental preservation has existed and has already been deeply rooted into society since the Industrial Revolution, as a simple supplier of raw material for the production of goods and of energy sources for the functioning of these goods. However by the twentieth century, and especially after World War II, with the expansion of industrialization as well as the improvement in living standards for consumer societies in underdeveloped countries, the ability to alter natural systems has reached global proportions to the point that it has quickly overcome nature's ability to recuperate itself. It should be noted that some damage to natural ecosystems has been considered irreversible [4].

There have always been concerns linked to sustainability issues based on the relationship between society, nature and the harm caused by mankind to the

natural environment. But these concerns were isolated. Only after World War II, and especially the 1960s, were the environmental problems seen as being extremely serious. It was observed that the Earth was no longer withstanding the intensity of aggression that it has been receiving [5].

The ISO 14,000 was introduced in the early 1990s in order to establish standards for the following environmental treatment processes carried out by companies: environmental management systems; audits in the area of the environment; environmental labeling; environmental performance (performance); life-cycle analysis; definitions and concepts; integrating environmental aspects into product design and development; environmental communication; and climate change. Within this context, environmental management norms have received the nomenclature of ISO 14,001 [6].

The ISO 14001 is an internationally accepted standard that defines the requirements to establish and operate an Environmental Management System. The standard recognizes that organizations may be concerned with both their profitability and environmental impact management [6].

Environmental Responsibility is a concept that institutions have adhered to in order to understand themselves and seek new courses of action. Among the various forms of conceptualization of environmental responsibility, all have the same vector - civil society - that values the actions of institutions, conscious of the duty of preserving the environment [7].

In this manner, environmental management adds another dimension to the way of operating a company, not something that can be controlled, except by the company itself. Thus, a better expression for environmental management of this would be institutions with a focus on society. Thus, environmental management would be a series of actions that interact with each other to create value. [8].

Based on these premises, Brazil issued Law No. 12,305, of August 2, 2010, instituting the National Policy on Solid Waste; amending Law No. 9,605 of February 12, 1998; and making other provisions. Its objective was [9]: Chapter I – Object and scope:

Art. 1 This Law institutes the National Policy on Solid Waste, its principles, objectives and instruments, and sets forth guidelines in relation to integrated management and solid waste management (including hazardous ones), generators' responsibilities and applicable economic instruments.

§ 1o This Law shall apply to all individuals and legal entities, ruled by Private or Public Law, which are either directly or indirectly responsible for the generation

of solid waste, and develop actions related to integrated management or solid waste management.

§ 2o This Law does not apply to radioactive waste, which shall be regulated by specific legislation.

Art. 2 In addition to the provisions outlined herein, provisions of Laws No. 11,445, of 5 January 2007, 9,974, of 6 June 2000, and 9,966, of 28 April 2000, and the norms established by bodies of the National Environment System (hereinafter referred to as SISNAMA), the National Sanitary Surveillance System (hereinafter referred to as SNVS), the Unified System of Animal and Plant Health (hereinafter referred to as SUASA) and the National System of Metrology, Standardization and Industrial Quality (hereinafter referred to as SINMETRO) also apply to solid waste. [10].

Law No. 12,305 has a hierarchy of ordinary law that regulates the validity, application, interpretation and repeal of norms in Brazilian law regarding the National Solid Waste Policy. Thus, it is a "law on the law". [10].

According to Resolution 275/01 of the National Environmental Council - Conama, the types of waste produced in this kind of generating unit include [11]:

- Domestic/Organic: Food Remains, Fruit and Vegetable Skins, Grass, Small Branches etc. [11];
- Industrial/Waste: Toilet Paper, Sanitary Napkins, Toothpicks, Cigarette Filters, Contaminated Paper, Contaminated Plastic, Labels etc. [11];
- Industrial/Hazardous: Ink cans (empty), Contaminated cloth and towels, PPE, Cans with contaminated alcohol, Fluorescent lamps, Air conditioner filters, Batteries, solder pads, plates and components, general scrap etc. [11];
- Office / Recyclable: Paper, Cardboard, Clean plastics in general [11];
- Recyclable: Styrofoam, Metal etc. [11];
- Domestic/ Organic - Whatever is deposited in standardly identified Brown 100 liter garbage collectors, following resolution 275/01 of CONAMA [11];
- Industrial/Waste - Whatever is deposited in standardly identified Gray 10.5m³ rooms, following resolution 275/01 of CONAMA [11];
- Industrial/Hazardous Rejects - Whatever is deposited in standardly identified orange 21m³ rooms, following resolution 275/01 of CONAMA [11];
- Office/Recyclable - Whatever is deposited in standardly identified Blue/Yellow/Red rooms, following resolution 275/01 of CONAMA [11].

II. APPLIED METHODOLOGY

Bibliographical research was carried out reading from the main knowledge bases (LILACS, MEDLINE, PUBMED, SCIELO, BIREME, among others) and on websites for official organs such as PAHO/WHO (Pan

American Health Organization and World Health Organization) and FAO (United Nations Food and Agriculture Organization), as well as books in print highlighting the words solid waste; Environment; Reverse Logistics [12].

Research on documentation was carried out between November 2017 and January 2018, in the city of Manaus - Amazonas, on technical documents from the Getúlio Vargas University Hospital (HUGV), which belongs to the Federal University of Amazonas (UFAM). The approach to planning the solid waste disposal process was initiated referring to the main question: Why discard? How to measure something that seems so abstract that is procedures widely used in diagnostic studies. In this sense, the observation must be precise. That is, one should note behavior during observation. Three (3) direct observation technical visits were made. [12].

essentially environmental in scope? These instruments aim to analyze the internal environment from needs assessments. They aim at mapping or portraying the critical aspects that shape the moment. At the document analysis stage, the documents pertinent to the theme were sought for; their importance and representativeness were evaluated. These documents concerned only issues related to the waste disposal program. [13].

Direct observation is a technique of collecting data obtaining information and using one's senses in obtaining certain aspects of reality. It is not merely seeing and hearing, but also examining facts or phenomena that one wishes to study. Observation is recording that includes

For the integrative review, scientific articles and books dealing with the theme were used, specifically those dealing with the issue of garbage, solid waste, the environment and reverse logistics [12]. Table 1 presents the operational capacity of the HUGV.

Table.1: The operational capacity of the hospital.

Total Number of Employees		1.075
Number of outsourced employees		125
Total number of insourced employees		950
Number of registered beds in service		159
Number of actively used beds		159
Total admissions 2016		3.429
Total surgeries 2016		2.589
Total operating rooms		11
Units Services	Installed beds	Beds in use
Neurosurgery	27	-
Surgery	52	-
ICU	09	-
Nephrology	10	-
CV. orthopedic	26	-
C. Medical	26	-
Services rooms		-
Laboratory	06	-
Transfusional	01	-
Administrative	23	-
Nutrition	06	-
Pharmacy	10	-
Surgical Center	11	-

Source: [14].

Table.1: Classification of solid waste according to ANVISA Resolution No. 306 of December 7, 2004, and CONAMA Resolution No. 358 of April 29, 2005.

Group	Composition	Examples
Group A	Components with the possible presence of biological agents that, due to their characteristics of greater virulence or concentration, may present a risk of infection.	Laboratory plates and laminae, carcasses, anatomical parts (limbs), tissues, transfusion bags containing blood, among others.

Group B	Chemicals that may pose a risk to public health or the environment, depending on their flammability, corrosivity, reactivity and toxicity characteristics.	Confiscated medication, laboratory reagents, metal-containing wastes among others.
Group C	Any material resulting from human activities containing radionuclides in amounts exceeding the elimination limits specified in the standards of the National Commission for Nuclear Energy – CNEN	Nuclear Medicine and radiotherapy, etc.
Group D	Those posing no biological, chemical or radiological risk to health or the environment, can be considered as household waste.	Eg: food leftovers and leftovers from the preparation of food, waste from administrative areas, etc.
Group E	Sharpening or scarifying materials.	Shaving blades, needles, glass ampoules, diamond tips, scalpel blades, lancets, spatulas, etc.

Source: [14].

The next item in the document is the definition of the PGRSS, which describes in detail the strategies, goals and targets established in the plan that pose challenges, as they entailed changes in the environment and internal processes of HUGV. The main challenge is to change people's attitudes, as well as the nature and quality of their working relationships. This implies changes in the unit's organizational culture and climate. It is understood that, in parallel with the Solid Waste Management Plan process, there will also be a need to plan internal changes, taking as a reference solid knowledge of the organizational culture and climate aspects of the hospital.

Then, the classification of solid waste by group and subgroup generated in the hospital is presented; waste management; segregation and packaging; identification of solid waste in which each group is divided into subgroups of solid waste. This division is extremely important because it allows a much more detailed view of each type of waste.

Afterwards, these informative details are transformed and applicability seeking to detail each step that must be followed in the plan for the introduction of new practices into the organizational culture of the organ.

III. RESULTS AND DISCUSSIONS

The Getúlio Vargas University Hospital created an Environmental Management Committee in 2015, which produced the document 'Internal Regulation', forecasting all Environmental Management actions in this institution, which as a whole has the purpose of taking corrective and preventive action within the assumptions of ISO 14001 following the following model [14]:

1 - Purpose. Corrective and preventive action should be planned and documented. Corrective and preventive action focuses on the elimination of symptoms and the root causes of problems [14];

2 - Research and analysis. Nonconformities, imperfections or deficiencies are prioritized and the most important ones are analyzed and eliminated first. Some of

the analysis tools used are cost of quality, SPC, user complaints and inspection results [14];

3 - Prevention and control actions. The goal of corrective action is to prevent recurrences. Corrective action results are investigated to ensure that the problem is not repeated [14]; and,

4 - Documentation and registration. Corrective action is adequately documented from the beginning to its outcome [14].

This committee also produced the Health Services Waste Management Plan of the new HUGV – PGRSS [14].

This plan contains the waste classification process that must be analyzed along with the Integrated Management System - SGI, because although the hospital is already certified, a reassessment of these will always be necessary in order to guarantee the effectiveness of the system. And for correct selective collection to take place, the characteristics and the places where the waste must be deposited must be pointed out.

Recyclable waste (eg paper, plastic, metals) is destined for recycling and converted into raw material for new products while non-recycled waste go to landfills, incineration and / or decontamination.

Transportation - After collection, waste is transported by carts or manually to the existing waste storage location in this generating unit ¹⁴.

Packaging - Packaging is done in the Storage Area, which is in the outer area, taking into consideration the following physical characteristics: roofed rooms of volume 21m³ each (for Styrofoam, cardboard, plastic, waste and dangerous materials) and for organic waste, a roofed area near the cafeteria, where plastic bags collected and previously selected will be deposited in specific areas [14].

Disposal - the waste is internally deposited in specific collectors and later goes to temporary storage and awaits collection by to its appropriate destination. [14].

The process of raising awareness with the company's 407 employees took place during the monthly

meeting held on September 10, 2014 in which the importance of disposal and selective collection of waste generated by the company was presented. [14].

After the employees are made aware of the classification of the waste generated in the organization, compliance with the actions set forth in the Waste Management Plan is ensured [14].

The Waste Management Plan has two phases [14]:

a) Collection and removal of waste to the area for temporary storage: waste is collected from the sites where it is generated, handled and stored in the temporary waste area [14];

b) Final disposal of waste: the waste is transported to its final destination of disposal.

Compliance with the Waste Management Plan is linked to other environmental actions of the Organization, such as selective waste collection and internal audits of the Environmental Management System [14].

For the final disposal of the waste, service providers duly authorized by the Environmental Agency are selected to transport the waste to its final destination of disposal, respecting legal requirements and other applicable environmental requirements. The choice of environmental service providers complies with the criteria of IT.08.001 - the Matrix of Prior Qualification of Suppliers of Services (Legal Environmental and Quality Requirements). Waste may be removed from the Organization by SGI authorization and follow-up with appropriate documentation.

When the waste is sent for treatment, processing or any other form of final disposal to the environment, suppliers of such services should send a "Final Destination Certificate" to the Organization, describing the characteristics of the waste, quantity, final disposal methods and final results of the disposal as shown in Table 2.

Table.2: Stages for waste management ANVISA and Conama standards compared to what is carried out in HUGV.

Conditional qualities	Concept	HUGV
Segregation	Separation of waste at the time and place of its generation, according to its physical, chemical, biological characteristics, physical state and the risks involved.	Yes
Packaging	Packaging of waste in bags or containers that resist rupturing and leaking.	Yes
Identification	Recognition of waste contained in the bags and containers.	Yes
Internal Transport	Internal transport of waste carried out according to a previously defined route which should be done separately according to the group of waste and in specific containers for each group of waste.	Yes
Temporary storage	Temporary storage of the containers containing the waste in a place near the generation points.	Yes
Treatment	Modifying the characteristics of the risks inherent in the waste, reducing or eliminating the risk of contamination by applying appropriate methods, techniques or processes.	Yes
Collection and transportation	Removal of the RSS to the treatment unit or final disposal, respecting the conditions of packaging.	Yes
Final disposal	Disposal of waste in soil appropriately prepared to receive it.	Yes

In this study, documents from the Getúlio Vargas Hospital which deal with the reverse logistics process were researched. In this way, it is extremely important for the environment that this institution uses the terms of reverse logistics, within the parameters of the ISO 9000 standards of product quality and ISO 14000 standards of environmental responsibility.

In addition to these quality programs, the Getúlio Vargas Hospital is in line with the Public Sector Quality Program - Gespública, which is the result of the necessary

compilation that was essential for the quality programs of Brazilian public governance to be brought together into a single program. This came into fruition in 2005 under the government of Luiz Inácio Lula da Silva through Decree No. 3778 of February 23, 2005. It is a program focused solely on the public sector and established within the parameters of the governance of the Brazilian public sector based on excellence that follows the dictates that can be observed in the figure 1:

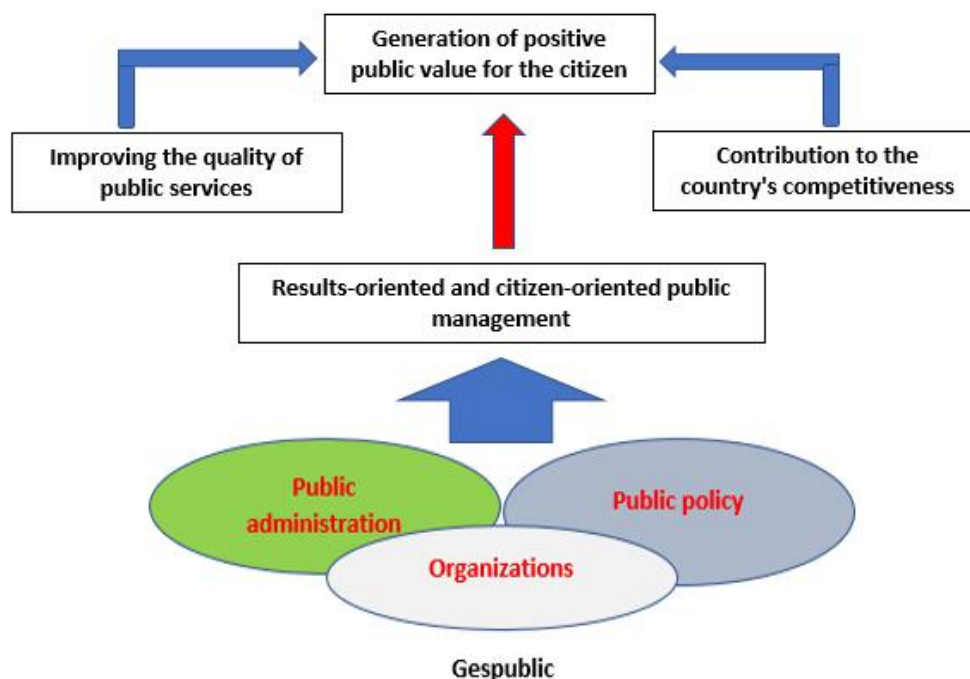


Fig.1: Performance of Gespública.

Source: Adapted from [8].

In the case of HUGV, there is a need to plan its reverse logistics, since the unit already has a solid Management Plan for Solid Residues that has been applied within the daily routine of the hospital. Thus, the very specific work of doing an analysis of the conditions

of application of reverse logistics was taken into consideration, described in Table 3, where compliance means existing and non-compliance means not yet implemented [15].

Table.3: Compliance or non-compliance to implement reverse logistics.

Solid Waste Management Plan	Compliance	Non-compliance
Description of project or activity.		
Diagnosis of solid waste generated or managed.		
Definition of operational procedures.		
Identification of the solutions shared with other generators.		
Preventive and corrective actions in situations of incorrect management or accidents.		
Goals and procedures related to the minimization of solid waste generation.		
Existence of actions regarding shared responsibility for the product life cycle.		
Sanitation measures of environmental liabilities related to solid waste.		
Periodicity of review.		

Source: Adapted from [15].

As can be seen, HUGV complies with all the conditions for the implementation of reverse logistics. And for this the following are needed:

- 1) Formatting of the Reverse Logistics application manual;
- 2) Survey of suppliers;
- 3) Analysis of suppliers;

- 4) Analysis of environmental management documentation;
- 5) Suppliers sign a participation agreement with Management to ensure compliance to Reverse Logistics;
- 6) Selected Delivery Points that adhere to the System with Management;
- 7) Selected recycled waste transport companies that sign the service agreement after applications for transparent objective proposals.
- 8) Implementation of the pilot project
 - 8.1 - Screening of disposable waste through the conceptual orientations of bibliographic references;
 - 8.2 - Separation of waste:
 - 8.2.1 - Waste for reverse logistics;
 - 8.2.2 - Waste for disposal;
 - 8.3 - Waste transportation company collects waste and transports it to the Suppliers of the environmentally appropriate final destination units;
 - 8.4 - Suppliers pass waste to recycling companies that promote environmentally adequate final disposal;
- 9) Suppliers sign a participation agreement with Management to ensure compliance with Reverse Logistics.

However, through the analysis that the HUGV has been seeking solutions from decentralization models of local environmental management, from the selective collection of solid waste. But there have been many difficulties since the implementation of the Solid Waste Management Plan in the hospital, due to the lack of support from both the university and the federal government,

The case study pointed out that there is a need to meet some requirements, so that the project encompasses the entire unit, since, according to data taken from the study, even though it has a Solid Waste Management Plan, there is still no reverse logistics. There is a need to place collector containers in all hospital settings.

Therefore the requirements are as follow:

- 1) Action focused on the disclosure of information for the improvement of environmental management in HUGV;
- 2) Cost of investments in technical assistance aiming at the equipping of the unit, decentralized reverse logistics project management.
- 3) Direct investments in the reverse logistics program as a goal for global improvement;
- 4) Preparation of studies necessary for the development of new financial or material resources;
- 5) Provide specific financial support for the community to maintain the continuity of services

With the existence of the Solid Waste Management Plan in HUGV, there is a need to determine four (4) essential

points of view: *why, what, how* and *who* after the application of a Pilot Project in the surgical center. [16].

Previous studies have argued that the following types of characteristics are relevant to characterize reverse logistics such as [16].

- Why things are returned: reviewing the driving forces behind companies and institutions becoming active in Reverse Logistics, Conveyors (receiver) and the reasons for flow reversal (reasons for return), i.e why reverse logistics is being done. In the specific case of HUGV, why it is directly associated with the existence of the Solid Waste Management Plan with reverse logistics being the final step.
- What is being returned: characteristics of the product should be described that make recovery attractive or obligatory and examples given based on actual cases (products and materials) that in the case of HUGV, in the pilot project to be applied, only serum bottles will be used of the surgical center (FLEISCHMANN ET AL, 2017) [16].
- How reverse logistics works in practice: the reverse logistics system must be applied from a very well defined process / system that begins with the formation of partnerships; from the correct collection of material, delivered to the carrier; returning to the supplier that sends it for recycling and returns it to the productive system [16].
- Who is performing reverse logistics activities: In this case, only the surgical center is used as the basis in the HUGV Solid Waste Management Plan [16].

Factors such as economics, environmental laws and environmental awareness of consumers. Generally, it can be said that companies get involved with Reverse Logistics through which they can reduce costs with application [17].

In this sense, HUGV's reverse logistics program will gain directly by reducing the use of raw materials, adding value to recovery or reducing disposal costs. Independent of any other gain, financial opportunities are offered in the dispersal of superfluous or discarded goods and materials.

Thus the HUGV reverse logistics network requires a collection network that is already determined by the Solid Management Plan. The starting point will be the surgical center where serum bottles are discarded into specific collectors. Thus, the first process will be to determine the HUGV area in which the products (surgical center serum bottles) will be disposed of in accordance with the Solid Management Plan. Then, after choosing the location and collecting and storing the material correctly, it will be delivered to the contracted carrier and to the supplier and / or suppliers [16]. Table 4 shows the benefits of using reverse logistics.

Table.4: The benefits of using reverse logistics.

ISSUES	SUPPORTING EXISTENCE IN COMPANY DOCUMENTS	
	YES	NO
Environmental policy	X	-
Decreased pollution	X	-
Service Improvement	X	-
Decrease in waste	X	-
Attitudes	X	-
Suggestions	-	X
Information on product acquisition	X	-
Pre-certification Changes	-	X

Source: Authors, (2018).

IV. CONCLUSION

Generalizing from the reflections made throughout the study, three (3) important conclusions emerge about the application of a reverse logistics project in HUGV:

1. The successful implementation of an institutional strategy that will involve leadership and management factors. The 1988 Federal Constitution determined the principle of efficiency as a fundamental for the public service to assume responsibility for the enunciation of objectives and the negotiation of terms of responsibility before its area of competence. The efficiency principle has come as a determining factor for the necessary improvement in public activities, which in some specific cases are visible, but in most cases they are completely insufficient, creating negative public value to civil society, which was not evident in HUGV, whose implementation of reverse logistics may add public value to the institution's activities.

2. Activities in HUGV need to be attuned to the amount of pressure it imposes on the institution, as challenges are followed by credits; criticism, praise; demands, new resources. The first opposition and defections are considered incidents of course, but the environmental management of the hospital knows that in order to fulfill its goals and objectives, everyone will have to recruit partners inside and outside of the institution creating, especially public value.

3. Environmental management committed to the principle of efficiency, as determined by the Federal Constitution, art. 37, caput, influences the performance of other related institutions or not using only part of the manipulation of administrative systems. When this prerogative is used in institutions, the visibility of their performance is not guided by abstract notions of what constitutes integrity, perfection or modernity of systems; rather, they are guided by sound assessments of what will help them focus effort on civil society, creating value.

This research presents its conclusions regarding the specific objectives and the general objective established for the study:

1 - The HUGV Solid Waste Management Plan model reverts from the Satisfaction Philosophy, that is, the organ seeks only to achieve a satisfactory level of environmental performance, without the pretension of optimizing its environmental indicators. In addition, the plan gathers the prescribed normative elements. The organizational diagnosis made through specific instruments visualizes future scenarios.

2. The results of the implementation of the Solid Waste Management Plan are promising, which points to the next step - the application of reverse logistics - but that will depend on the maturation time and the commitment of the teams to executing it.

With regard to the specific objectives of the research it can be inferred that:

1) Identifying the main characteristics of reverse logistics was achieved when the entire reverse logistics process applied in some institutions was very clearly described;
 2) Checking if there is flexibility in the application of the reverse logistics process in the recycling of medicine and hospital material; was successfully verified, since the institution already has a Solid Waste Management Plan;
 3) Making a proposal for the application of reverse logistics to reduce the environmental impacts caused by solid waste; was demonstrated with the suggestion of applying the principles of GESPÚBLICA as a second step for the adoption of a Reverse Logistics Project, since the first one was already done so with the adoption of the Solid Waste Management Plan;

- To understand how the reverse logistics process can contribute to softening the impact of the environmental degradation caused by the incorrect disposal of medicine and hospital material in a public hospital in Manaus; this understanding was possible from the moment it was verified that although there is a Solid Waste Management Plan in the HUGV, the City Hall of Manaus is in charge of the disposal of the material, which dumps all these materials into the city landfill as common garbage;

- To demonstrate its environmental benefits to the city of Manaus; it was shown that a reverse logistics program

will infer prominent results to HUGV, as instead of discarding perfectly recyclable materials no longer dumped at landfills, creates bonds with suppliers and strengthens the production chain concept.

In conclusion, the HUGV Solid Waste Management Plan if fully implemented, can perfectly lead to the reverse logistics process. The execution of the plan directly affects structural and behavioral variables of its internal and external environment.

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