

# **Analysis Of Difficulties In Solid Waste Collection From The Point Of View Of A Collector In The City Of Manaus, Brazil**

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## **ABSTRACT**

*A large part of humanity already understands that natural resources are finite. It is, therefore, necessary to reuse all the materials and products we use as many times as possible, which has become an increasingly growing challenge. In this sense, this study aimed to analyze the main difficulties encountered in the selective collection of solid waste in Manaus from a collector's perspective. For this, the method used consisted of the following steps: a) elaboration of a theoretical architecture about the stages of the reverse logistics process, b) creation of an interview script based on the elaborate architecture and guiding questions, c) data collection with the member of a group of collectors, who explained and exemplified the interviewee's answers, d) organization of the collected data and generation of answers to the guiding questions. The results showed that five were the main difficulties encountered, which were classified as environmental (regional climate), conscientious (the lack of willingness of the population to collaborate with selective collection), transportation (lack of material and equipment), and commercial (the pricing of materials is not rewarding). The conclusion shows that only the environmental factor cannot be controlled. However, its effects can be mitigated if the other four difficulties are practiced, which is not a simple task.*

**KEYWORDS:** *Reverse logistic. Selective collect. Solid waste collection. Self-employed collectors. Collection difficulties.*

Date of Submission: 18-12-2023

Date of Acceptance: 28-12-2023

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## **I. Introduction**

Reverse logistics can be seen as the harbinger of a change in mentality in the relationship between human beings and the environment, as some scientific studies have begun to suggest, such as those by Dey et al. (2023), Giorgi (2022), Zarei (2022) and Gkountani et al. (2021), among others. This change in mentality has at least two basic foundations. The first is that natural resources are not infinite and can be exhausted. The second is that it is necessary to start reusing materials as quickly as possible. Otherwise, we risk suffering the unpleasant consequences of finite resources, some of which are so severe that they can compromise the continuity of life on the planet. With the increase in the stock of knowledge about reverse logistics and the different processes for reusing materials previously considered waste, a new economy is being built, the circular one (Crome et al., 2023; Di Vaio et al., 2023; Rambabu et al., 2023; Zarbakhshnia et al., 2023), whose mission is to make the circularity of materials effective in countless production cycles.

On the other hand, in a simplified way, it can be said that reverse logistics is the process that guides organizations in the search for adapting their environmental role in society. Consequently, this role has the challenge of generating value in its production process while not compromising natural resources, whether through reuse or reuse of materials in its production cycle or by reducing the amount of material. The raw material must be processed in the production cycle, among other possible combinations. It is not difficult to understand that the circular economy has one of its support points in reverse logistics, as can be seen from studies such as those by Ding et al. (2023), Mallick et al. (2023), and Mishra et al. (2023). However, reverse logistics is a process, and selective collection is one of its fundamental steps.

In countries like Brazil, anonymous collectors carry out a large part of reverse logistics efforts. There are still no reliable statistics on how much their collections represent about the total materials collected periodically in the country. In large metropolises, such as Manaus, capital of the State of Amazonas, located in the Brazilian

Amazon, self-employed collectors likely contribute more than half of everything collected. Anyone who sees them on the streets immediately realizes the likelihood of there being several factors that make the collection more accessible and others that make it difficult. However, what are these difficulties? How do they happen? What agents can help you overcome this? What can these agents do? These questions guided the present study, which aimed to analyze in depth the main difficulties encountered by collectors when collecting solid waste in Manaus.

## **II. REVERSE LOGISTICS: DEFINITION AND PROCESS**

The literature review showed that the most frequent equivalence term for reverse logistics is a process, as shown by studies by Milani (2019), Delponte (2020), and Marusinec (2022). A process can be defined as a sequence of activities and tasks ordered to achieve an expected result. In this way, it can be understood that reverse logistics is a process of the flow of a specific material within a production cycle. Therefore, the result expected to be achieved in the reverse logistics process is, in most cases, the reintegration of the product or raw material into the company's internal or external production cycle.

The terms tool (Sanches et al., 2022) and activities (Delipinar & Durbag, 2021) were equivalent to reverse logistics. It is understood that a tool is a material or non-material instrument that allows certain activities to be carried out. In this sense, reverse logistics works as a tool for analysis and action around a material within a company's production process, generally comprising specific activities such as collection, remanufacturing, and remodeling, among others, that seek to add value to this post-production material—consumption, reintegrating it into the production chain.

Other equivalent terms were movement (Koc & Okudan, 2021) and return (Bataghin & Melo, 2021). Both refer to the flow of materials within the process in question and, more precisely, to the movement of a material from its point of consumption to its point of origin and its possible return to the production cycle or, in some cases, to disposal appropriate. Therefore, it can be defined that these two concepts suggest the mapping of the states of a material at a given moment in its flow in the production process.

From the point of view of attributes, the research pointed to raw material/product/materials as the main attributes of reverse logistics (Silva & Cruz, 2016; Milani, 2019; Delipinar & Durbag, 2021; Matusinec et al., 2022). The product is the central object of the process in question. On this, the analysis of its movement is carried out, and the appropriate flow of the production process is defined, in addition to which activities and processes will be necessary for its destination. If reverse logistics planning is used to define these issues, the product assumes the role of the object into which the raw material will be transformed. Raw materials and materials appear as synonyms for the reverse logistics product.

Value capture is another abundant attribute of this process (Delponte et al., 2020; Milani, 2019; Koc & Okudan, 2021; Silva, 2016; Cunha, 2022). It can be said that adding and capturing value from a given material is often the main objective for implementing the reverse logistics process in a company. Adding value to a material in its post-use cycle can reintegrate it into the production chain, whether it is the same one it was already in or another external to the company. Likewise, value is captured when the reverse logistics process uses material external to the company, often used as raw material at the beginning of the production cycle.

Other essential attributes for reverse logistics found in the literature review were material flows (Matusinec et al., 2022; Delipinar & Durbag, 2021; Rodrigues, 2022) and production cycle (Cunha, 2022; Sanches, 2022; Bataghin & Melo, 2021). Both concern the movement of material inside and outside the company and the steps this material goes through until its destination, be it reintegration into the production process or appropriate disposal. It can be noted that a production cycle includes one or more types of material flows. For reverse logistics, this flow generally follows the opposite direction of the production cycle. It can follow the opposite direction of an entire supply chain in a broader scope.

The destination was another study found in the studies by Matusinec et al. (2022), Koc and Okudan (2020), and Cunha (2022). After following its flow within a production cycle, the material goes to its destination. At this stage, it can be reintegrated into a production chain in the following ways: as raw material at the beginning of the production chain, in the reuse of the material when it can be reused inside or outside its production process, in the remanufacturing of this material also within or outside its initial production process, among others. However, when it can no longer be used in a production cycle, it must be disposed of in an environmentally friendly manner.

For this study, reverse logistics is a process. This process encompasses the flow of materials and production cycles in a company, and one of its main objectives is to obtain value from a product after its use, either through reintegration into the production cycle or by making the product available for another production cycle. Production is external to the company. Therefore, it can also be said that reverse logistics is the tool that promotes the appropriate destination of a given material.

There are countless ways to employ reverse logistics in a production process, but they all follow similar flows that lead to the company's final objective. It is worth mentioning that the final objective is not always purely financial and may reflect the good environmental actions generated by an effective reverse logistics process.

However, whether for recycling, reuse, remanufacturing, reducing the use of products, or entering strategies, reverse logistics works as a flow of materials that generates value and has contributed enormously to not accentuating the serious environmental consequences of inappropriate material disposal. As a process, this flow is carried out in stages.

The literature analysis showed no response pattern configures a consensual sequence of reverse logistics steps. This occurs because many studies focus on a specific product, meaning each sequence refers to just that product. Due to this specificity, there is also an asymmetry between the number of steps for each product. As shown in the data contained in Table 1, it is possible to verify the difference in steps between the studies by Melquiades (2015), which deals with urban solid waste, and that of Leal Junior et al. (2021), which deals with the reverse logistics of waste cooking oil. In these two examples, only one step (collection) coincides between the two, but still in different order numbers.

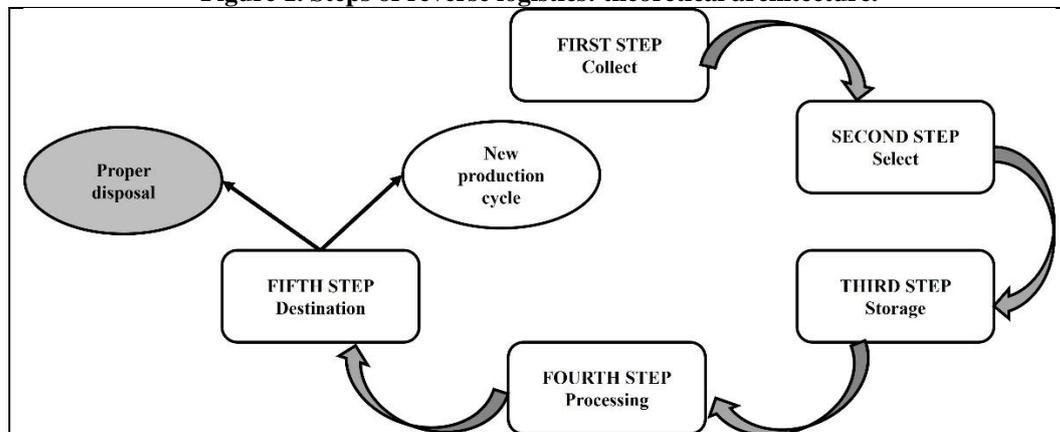
**Table 1. Summary of the literature survey**

Authors	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Carmo et al. (2017).	Collect	Inspection	Separation	Purchase	Sale	Devolution
Sbordone et al. (2022)	Transport	Handling	Storage	Crushing	Treatment	Destination
Peixoto (2019)	Disposal	Receipt	Disposal	Recycling	Destination	
Santos et al. (2012).	Collect	Consolidation	Selection	Processing	Destination	
César et al. (2018).	Repair	Maintenance	Remanufacturing	Cannibalization	Recycling	
Melquiades (2015)	Collect	Screening	Manufacturing	Recycling	Destination	
Leal Júnior et al. (2021)	Preparation	Collect	Transport	Storage		
Miguel & Franco (2016)	Storage	Collect	Transport	Destination		
Santos & Martins (2012)	Recovery	Transport	Destination			
Santos & Botinha (2013).	Collect	Selection	Destination			

Source: data collected by the authors.

These studies also have different stages, and these differences will be present in most of the data collected. Because of this, a more general approach to the sequence and number of steps was necessary. Therefore, a semantic analysis between all stages of scientific data collection is needed to find a logical sequence that could satisfy most of the needs of the reverse logistics flow of all products.

**Figure 1. Steps of reverse logistics: theoretical architecture.**



Source: prepared by the authors based on data collected in the literature.

Analysis of the data and its situational context allowed the steps to be organized as follows: 1) collection, transport, receipt, and recovery were grouped as “collection”; 2) inspection, separation, handling, selection, sorting, and preparation were grouped as “selection”; 3) storage and consolidation were grouped as “storage”; 4) crushing, treatment, recycling, processing, repair, maintenance, remanufacturing, cannibalization, and recycling have been regrouped as “processing. The result groupings were then organized in the most operational way possible, aiming to generate a generalist sequence encompassing most cases of reverse logistics processes, as demonstrated in Figure 1.

The first stage is waste collection within the reverse logistics material flow. The desired material is obtained through this, which is often mixed with other waste that has no value. According to the study by Carmo et al. (2017), this stage is subject to problems such as the inefficiency of collecting the material due to factors such as the cost of collection, incorrect disposal, and disposal in inappropriate locations. It can then be seen that efficient collection is the first step towards an efficient reverse logistics process.

The second step is selecting the material after it has been collected. According to Santos and Gomes (2012), selecting materials is essential for their appropriate destination. However, the materials gathered in the collection are sorted at this stage. According to the study by Melquiades and Rodriguez (2015), urban solid waste undergoes sorting so that those plausible for recovery or recycling are transported to sorting centers and the rest to landfills. It is noted that the sorting stage can sometimes be subdivided into other additional selection stages in large specific centers, which forward the materials to companies or for disposal. However, the selection of materials begins with the collection and can be affected by the same problems, such as incorrect disposal and inappropriate separation locations.

The third step is storing the selected material. This is an essential step in reverse logistics, as according to the studies, this must comply with certain specificities. We can mention, for example, the need for the storage location to be by the needs of the materials so that they do not suffer from internal and external agents. Another issue is the warehouse's compliance with current legislation and policies. One can take as an example the study by Miguel et al. (2016), which states that cooking oil must be stored in specific tanks and pre-defined locations that meet the requirements proposed by law and comply with environmental and safety policies. Therefore, efficient storage is essential for the correct and continuous flow of the materials involved, which will be processed differently.

The fourth step is the processing of the stored material. The processing stage is essential for transforming the material that will be reintegrated into a production cycle, whether from the company that is adding value to it or from another company to which it will be destined. Processing is understood as processes such as recycling, remanufacturing, repair, crushing, and chemical treatment, among others, that act on the material in order to transform it in some way, not necessarily into another material, but in such a way that it becomes a product necessary for some stage of a production cycle. The studies analyzed in this question demonstrate numerous types of processing that vary according to the type of material and its destination. We can take as an example the recycling of electronic waste discussed by Peixoto (2019) and the chemical processing of cooking oil studied by Santos et al. (2012).

The fifth stage is the destination of the processed material. The last stage concerns the destination where the material will be reintegrated into a new production cycle or until its same cycle of origin begins. As in the processing stage, the destination of the material varies according to the nature of the material and its need in a production flow. This issue can be exemplified by taking the study by Santos and Botinha (2013), which exemplifies the destination of solid waste, demonstrating that these materials return to different production centers in the form of secondary raw materials, such as iron scrap and recycled paper. Suppose the material is not reintegrated into a production cycle. In that case, it must be disposed of in an environmentally correct way, as, according to Sbordone et al. (2022), the inadequate disposal of solid and liquid waste can impact the environment and the population's health.

### **III. RESEARCH METHODOLOGY**

This study analyzed a collector's difficulties in collecting solid waste and its impacts on the reverse logistics process. The assumption is that the greater the difficulties, the more compromised the quality execution of the subsequent stages will be. Here, the methodological design that led to the generation of answers to the guiding questions formulated will be presented and later compared with the literature review.

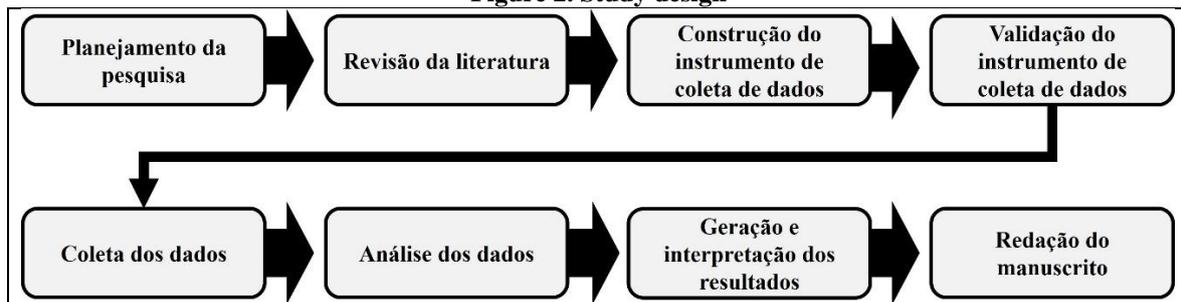
#### **Guiding questions**

During the planning of the study, five guiding questions were formulated that allowed the achievement of the general objective of this investigation: 1) What are the difficulties that most impact the collection of solid waste? 2) How do these difficulties occur? 3) What examples can be given to understand these difficulties? 4) Which agents could contribute to improving the collection of materials by autonomous collectors in Manaus? 5) How could agents act to alleviate difficulties? These questions were formulated based on the recommendations of Nascimento-e-Silva (2020a; 2021a).

#### **Study design**

The study design consisted of eight stages, with adaptations from studies by Silva and Nascimento-e-Silva (2023), Bastos and Nascimento-e-Silva (2022), and Cabral and Nascimento-e-Silva (2022). The first stage was planning the research, where the guiding questions and their respective response patterns were defined (Nascimento-e-Silva, 2021b). The second stage was the literature review, the purpose of which was to reconstruct the state of the art on the stages of selective collection of solid waste for the construction of the theoretical architecture of the study. The third stage was constructing the data collection instrument based on the previously constructed theoretical architecture. The fourth stage was the instrument validation, carried out with other collectors who did not agree to participate in the study. Figure 2 summarizes these procedures.

Figure 2. Study design



Source: Adapted from Silva and Nascimento-e-Silva (2023), Bastos and Nascimento-e-Silva (2022), and Cabral and Nascimento-e-Silva (2022).

In the fifth stage, after many failed attempts with several collectors, an interview was carried out with a group of three collectors who, due to personal reasons, decided to elect a representative to answer for everyone, whose answers were later validated by the group. In the sixth stage, the collected data was carefully transcribed into a text editor, considering every detail asked and answered, configuring what Nascimento-e-Silva (2023) calls a mass of data. They were then organized into individual tables, with the answers grouped in a column, each with an alphabetical identification from A to E, totaling five different answers for each question, always maintaining the anonymity required by the respondent. In the seventh stage, results were generated, based on the organization carried out, seeking the semantic and pragmatic meaning of each set of answers for each guiding question, and then each result was compared with the theoretical architecture. In the eighth stage, the manuscript was written to submit the findings to the international scientific community (Nascimento-e-Silva, 2020b).

### Research subjects

The research involved the participation of three subjects, but only one synthesized the varied responses into a joint opinion. More than ten potential participants were contacted without success because they did not agree to follow the research protocol, which required signing an informed consent form for submission to the research ethics committee. The group was interviewed at the same time and place they were approached, in this case, next to the point of sale for materials collected from the center of the city of Manaus. In the meantime, between the explanation of the protocol and the beginning of the questions, the objectives of the research and its ethical issues were also explained.

The group was heterogeneous, comprised of two men and one woman, two of whom constituted a couple. No one had a formal job or a pension, but they did not use collecting and selling solid waste as their only income. The individual whom the group chose to give his report and generate responses to the questionnaire was a 68-year-old man who had worked in this field for just over five years. From now on, he will be treated as “Participant X.”

During the interview, Respondent X received additional financial assistance from the government called “Emergency Aid,” created by the federal government during the COVID-19 pandemic lockdown. However, this man, who had always worked as a bricklayer, could no longer get jobs and was no longer physically fit due to his age. Therefore, the income from government assistance alone was not enough to meet his family's basic needs, which was made up of five people. For this reason, the respondent started using solid waste collection as a new source of income.

Although the group did not participate directly in the study, the couple in the group complemented the composition of the answers with their opinions for each question. Some people contributed clarifications and examples, while the researchers asked the entire group questions aloud. The couple and Participant X had carts full of recyclable waste and were heading to sell them to their customer.

### Data collection instrument

Data collection was carried out through semi-structured interviews that followed a pre-determined script according to the guidelines of Nascimento-e-Silva (2023). The questions were created based on the first stage of the reverse logistics process, the collection of materials, according to the theoretical framework generated in the study. In Manaus, selective collection is supported by individual collectors, but there are many difficulties in carrying out their work. The instrument created by the researchers focused on identifying and possibly solving these problems, using a sequence of questions in the form of a script: 1) What are the main difficulties in collecting waste? 2) How do these difficulties occur? 3) What examples can be given to understand these difficulties? 4) Which agents could contribute to improving the material collection activity by collectors? 5) How could these

agents contribute? After preparing the script, its validation was through comparison with the theoretical framework of this study, in addition to evaluation and suggestions from other researchers.

### **Data collection strategy**

Firstly, there was a search for places to sell recyclable materials and solid waste, such as cardboard, aluminum, and PET bottles. These points concentrate a flow of collectors, and as these individuals were difficult to search indirectly by phone call, text message, etc., in-person research was then carried out in these locations. Then, each potential participant was approached, and amid many attempts, three collectors agreed to participate in the interview.

Before the interview, which would follow the pre-determined script, the group demonstrated how they do their work, the places they usually visit, how they choose the materials collected, what tools and equipment they use for this, what means of transport they use (types of loading cart) and how materials are stored until sale. Although the three individuals already had their carts filled with materials at the interview, the researchers could observe, through practical demonstrations and reports, how the collection stage was carried out from start to finish.

In the second part of the interview, there was a focus on the pre-determined script regarding the difficulties faced following the guiding questions presented in this study. This step occurred while the group organized, unloaded, separated, and arranged the materials for sale. While each task mentioned was carried out, a group representative tried to correctly answer the questions in the script based on the entire group's responses, and the researchers duly noted everything in a field notebook. Then, other questions were asked to clarify each point so that a more precise and detailed final answer could be prepared. We also took the opportunity to observe how material buyers work, those who send the already separated and packaged waste to companies that will recycle and use the materials as raw materials for their processes.

### **Data organization and analysis techniques**

After collection, the data was carefully transcribed into a text editor, maintaining the original form of how each question was asked and how the researchers noted each answer. Such care was taken to maintain the integrity of the data without interference from those who transcribed it. After this task, the answers were organized into two tables, the first presenting each answer from the main topic about the difficulties experienced in the collectors' daily lives. On the left of the first table, the answers to the difficulties were organized, and on the right, the summary of each difficulty was presented, as shown in Table 2. Therefore, to make it possible to reflect the answers to each of the guiding questions adequately, it was necessary to organize the new answers in other tables, always keeping the difficulties in the left column. Table 3 shows how the difficulties occur in the right column. The same procedure was done in Table 4, with examples of how each difficulty occurs; in Table 5, showing the agents that could collaborate to solve the difficulties in the right column; and in Table 6, with the actions that agents could take to solve the problem in the right column.

To analyze the data, the focus was maintained on the guiding question in each question. Regarding what difficulties were faced, the researchers focused on knowing I) the types of difficulties, II) the difficulties that most differed from each other, and III) which were the most similar. The question about how such difficulties occur and what examples could be provided was guided to collect the information in a summarized way, summarizing its meaning, as in "We work day and night in much heat, a lot of sun and rain too," where it was realized that the extreme climate in the region is an obstacle and the core of the problem. Finally, for the last guiding question related to the agents who could collaborate in solving the problem and what they could do, the focus was on identifying individuals/public positions and various institutions that could act in this direction.

### **Techniques for generating and interpreting results**

Each result was generated through responses to the guiding questions. For the first question about difficulties, a diverse set of problems a collector faced in his work was obtained. Next, a descriptive list was obtained of how these problems occurred in an objective and summarized way, which was only possible due to the practical and accurate reports of the collectors. Finally, the result of the question related to the responsible agents and their possible actions in the face of the problems presented aimed to know that each agent, whether the local community, a public agent, a group of people, or state and federal agencies, including each government, has a role and duties to be performed when collecting recyclable materials so that each difficulty in this work base can be alleviated. This information generated another set of responses that shaped the results of the interviews.

Each result cited is related to the first focus of this study, "The point of view of a collector from the city of Manaus." To interpret them, there was a separation into two instances: the first in a more empirical way, worrying about how each piece of information collected occurred in the collectors' daily lives; in another instance, in a more theoretical way, each result was interpreted worrying about the reasons for the problems and their ramifications according to each guiding question. In this way, it was possible to combine these two sources of

information, one of a more experimental nature, with information collected in the field, and another more theoretical, also based on reports but considering the theoretical framework generated by the study.

**Study limitations**

However, this study is not free from limitations in several aspects, which do not invalidate the results obtained. However, there are some striking problems for such research. Firstly, we can highlight the sample size, represented by a group of individuals with only one respondent who followed all research protocols. The study's concern was understanding how the respondents felt about the difficulty. In a city where collectors are concentrated in the center and on the outskirts and where there is no regularization of the service by the local government, there are, in fact, no marked differences in the daily lives of these individuals, regardless of the area of the municipality they work in or the material they seek as collection focus.

Another critical limitation concerns restricting only one source of evidence to collect the data. The ideal would be to have other recording sources that ensure the generalization of each information. The main problem that prevented researchers from achieving this objective is the simple reality of potential participating individuals' lives. Fundamental problems such as a friendly approach to an interview without seeming like a threat to them, like someone who could act against their livelihood, and the lack of education and literacy to understand the research protocol and its objectives, which culminated in the almost non-existence of individuals 100% able to participate in the research. That is why the choice of a group where there was a participant capable of being the spokesperson for each experience lived by him and his co-workers.

**IV. RESULTS AND DISCUSSION**

This study aimed to understand in depth the difficulties faced by a solid waste collector who works in the city of Manaus. The findings of this study are organized here, by and following the interview guide, with each section corresponding to a guiding research question. When discussing the results, this strategy of presenting the results was chosen to facilitate understanding the study's conclusion.

**Main difficulties in collecting materials**

It is known that the climate in the metropolitan region of Manaus is marked by two extremes: abundant sunshine and torrential rain. This climate is divided differently from the rest of the country because Manaus is located at a latitude close to the equator, which means that the region has only two noticeable seasons during the year: the hot and humid summer and the winter. Rainy and even more humid. These extremes are a significant obstacle for those who work in open fields as they are at the mercy of the weather. Within this extreme climate environment, there is another obstacle for independent collectors in the region: the lack of selective collection, or rather, selection and separation of waste before disposal. Without this equipment, the need to separate during collection makes collecting materials even more arduous. The data contained in Table 2 summarizes these findings.

**Table 2. Main difficulties in collecting materials.**

<b>Difficulties</b>	<b>Syntheses</b>
A	Climate of the Region
B	Lack of selective collection
C	Weight and volume of the material
D	Material transport
E	Material sales price

Source: data collected by the authors.

Added to these two problems are also the weight and volume of the material loaded and, consequently, the difficulty of transporting it through the streets of Manaus. The first problem is due to the necessary collection amount for a minimum daily profit, since the greater this amount, the greater the weight and volume of it to be transported. Transporting materials end up being more arduous the greater their quantity since the traction and strength of the collector himself powers the means of transportation used in the case of the interviewee. These two problems are linked to the low selling price of most common collection materials such as aluminum, cardboard, etc., which, despite having increased during the pandemic, was offset by the lack of collection materials.

**How difficulties appear in everyday life**

As explained, the region's climate greatly influences a collector's daily life in Manaus. This is what happens with the interviewee in question. According to him, it is almost impossible to collect material during the day on sweltering days. This problem is added to the chaotic traffic in the capital, which makes moving with a transport cart on the city's streets dangerous. Movement through the capital's irregular and flooded streets becomes unfeasible in heavy rain. Added to this is the fact that there is still a need to separate the materials sought among

the waste discarded by the population, in the case of the interviewee, in the trash of homes and establishments in the city. This situation can harm the collector, such as handling contaminated waste and sharps.

**Table 3. How difficulties happen**

<b>Difficulties</b>	<b>Como acontecem</b>
Climate of the region	Durante o ano todo, o clima está muito quente ou muito chuvoso
Selective collect	É preciso revirar o lixo para fazer a separação, dependendo do local
Weight and volume	É preciso coletar grande volume para renda financeira razoável
Transport	O carrinho de transporte não é ideal: quanto mais peso menor a mobilidade
Sale price	A maioria dos compradores não pagam preço justo pelo material

Source: data collected by the authors.

In day-to-day collection, there is a need to fill the transport cart with the most significant possible load to obtain the greatest possible profit. However, the cart used by the interviewee is not ideal for a hefty load as it has poor mobility generated by the collector's strength and does not have adequate maintenance, such as changing tires and reinforcing the structure. However, the collection practice becomes unfeasible without a large volume of materials, mainly due to price variations in different city regions. Such variation is generally negative, with most points of sale offering below-average prices without prior explanation.

**Examples of how difficulties happen**

When leaving his home, the interviewee cannot predict the weather during the day. It is known that on the same day, there are extreme variations in the weather in the city of Manaus, which can be full sun at one moment and then torrential rain throughout the city. It is common for the collector to miss a few days of collection just because of bad weather. Regarding the lack of selective collection, there are times when you have to open several garbage bags to find very few collection materials, especially when starting with residential waste. What worries the interviewee most is the foul smell and the need to deal with possibly contaminated waste.

**Table 4. Examples of how difficulties happen.**

<b>Difficulties</b>	<b>Examples</b>
Climate of the region	Collection is done in the open; It is hard not to be at the mercy of the region's climate.
Selective collect	Generally, the waste is mixed.
Weight and volume	When the cart becomes too full, transportation becomes more difficult.
Transport	The cart is small for so much material; there is no more giant cart; the used cart is not maintained.
Sale price	There is no standard for prices; Many buy below the price they should

Fonte: dados coletados pelos autores.

Regarding the transport of materials, some aspects make the day-to-day life of the interviewed collector difficult. Among them are old and unsuitable carts for the service, lack of maintenance due to lack of money, as the selling price of the materials is too low for the volume and weight achieved with this transport, bustling streets that pose a danger for transportation of materials due to the flow of cars, irregular streets, and no sidewalks, among others. According to the interviewee, renting a larger transport cart from a colleague is sometimes necessary. Regarding the sales prices of the collected materials, the interviewee exemplified that there is no standard price even within the same area of the city. Because of this, it is not easy to know where the best place for collection will be since materials are transported on foot and with a personal cart.

**Agents that could help reduce difficulties**

According to the interviewee's report, as these are problems experienced within the reality of the city and state, most problems could be resolved by municipal and state governments. Furthermore, to help with field collection problems, unions could be created to support the category's causes. In this way, problems could be solved, ranging from simple ones, such as helping with the maintenance of transport carts, to more complex ones, such as fixing the selling prices of materials.

**Table 5. Agents that could reduce difficulties.**

<b>Difficulties</b>	<b>Agents</b>
Climate of the region	Municipal government
Selective collect	Residents and businesspeople
Weight and volume	Municipal government
Transport	Municipal government
Sale price	Federal government

Fonte: dados coletados pelos autores.

At the federal scale, the primary agents would be the executive government and the Ministry of Workers. These would be responsible for more profound and long-term solutions such as the creation of laws and regulations that protect and value the service of collectors, the creation of national campaigns to raise awareness of the work done by them, and the selective collection that is a significant obstacle in their day to day. Such actions would contribute both to the daily lives of collectors and to improving the lives of Brazilian society.

**Role of agents in reducing difficulties**

According to the interviewee, there could be places to welcome collectors, as they play a significant environmental and economic role in the region. This way, the municipal government could work on projects for help stations for collectors, providing them with food, temporary shelter against bad weather, and early morning service, among other activities. To improve selective collection, there should be greater awareness among the population and companies that dispose of materials conventionally. The municipal and state governments should also promote actions as a month to raise awareness, as occurs in months of awareness of diseases and social problems.

**Table 6. What should agents do to reduce difficulties?**

<b>Difficulties</b>	<b>Action of agents</b>
Climate of the region	Donation of equipment to withstand the sun and rain
Selective collect	Separation of waste for selective collection
Weight and volume	Donation of carts and help with maintenance.
Transport	Create a station or place to obtain carts and support maintenance.
Sale price	Set purchase prices for materials that are profitable for collectors.

Source: data collected by the authors.

The two governments should also, in the reception centers themselves when designed, offer periodic maintenance of the collectors' work instruments since these, in most cases, are in a situation of social vulnerability and receive much less than what they need to live, leaving no money left to improve their work. On a federal scale, more complex activities could develop projects to include waste pickers as a category with full labor rights. Furthermore, the executive and the Ministry of Workers should seek ways to stabilize and normalize the sales prices of collected materials, creating laws and regulations that ensure more reliable charging by buyers.

**Discussion of Results**

The results presented in this study can be summarized as follows: the main difficulties encountered in the selective collection of solid waste are environmental (regional climate), conscientious (population's desire to separate materials), transportation (equipment and maintenance), and commercial. The studies by Shishkov et al. (2023), Marica and Pînzaru (2023) and Ranganathan et al. (2023) also considered temperature as an environmental factor that influences the selection process; the findings of Bernardo et al. (2023), Brunhara et al. (2023) and Del Carmen-Niño et al. (2023) emphasize the fundamental importance of population participation for selective collection to be effective; the findings contained in the studies by Galavote et al. (2023), Santos and Mendes (2023) and Luo et al. (2023) also highlight transportation as essential for the success of reverse waste logistics; while the results achieved by the investigations by Cavalcante et al. (2023), Espinosa-Aquino et al. (2023) and Porto et al. (2023) present the impacts of commercialization on selective collection.

Science has shown differently that reverse logistics is still a phenomenon that requires more studies on the growing aspects that make it up. Every time we try to describe the practices of reusing materials in their longitudinal sense, from collection to delivery to customers of products generated with the remanufacturing of solid waste, we discover new and diverse aspects that often contribute to decisive ways for the success or failure of any reverse venture. As this study shows, environmental, conscientious, transport and commercial factors interfere with collection in Manaus and several other practices across the planet. This seems to suggest that reverse logistics is a multifactorial phenomenon and that the different realities where it is practiced effectively have managed to combine these countless factors appropriately. On the other hand, the realities where they are still a challenge need to generate more knowledge to unite the different aspects around an action scheme in which the actors are aware of the fundamentality of their actions.

In the specific case of Manaus, the study by Cabral and Nascimento-e-Silva (2022) on cardboard recycling carried out by a private company found a tendency in the city to increase the population's awareness of their relationship with the environment. Some actions are being taken to protect, preserve, and enhance environmental factors. The study by Bastos and Nascimento-e-Silva (2023) found that the difficulties in carrying out the selective collection of solid waste by the population are the lack of knowledge about the treatment of the material, how selective collection works, where to find collection points, in addition to the lack of public equipment and practical government actions in this regard. The findings of the study by Gomes et al. (2023) about the difficulties faced by a group of collectors in carrying out selective collection, including the strenuous physical

effort, people's rejection, unhealthy working conditions, the lack of personal protective equipment, and the lack of people's participation, companies and governments.

It can also be inferred that if selective collection is not done correctly, the effectiveness of reverse logistics is completely compromised. This is because, in its longitudinal dimension, one stage feeds the next stage. Suppose a previous stage is not carried out adequately. In that case, the product that will be delivered to a subsequent stage has a high probability of not meeting the minimum quality and quantity requirements, among others. This study shows that if the population participates, the collectors have available, donated, or purchased the equipment for transporting and moving waste. If there is a satisfactory pricing and marketing scheme, the probability increases that the collection stage is done correctly. Consequently, it can feed the next stage, the selection of materials, with materials that can be reused somehow.

Finally, when talking about selective collection, what needs to come to people's minds is not the image of a ragged, often marginalized individual who collects and sells materials to support an addiction. This stigmatizing image is, little by little, being replaced by the image of selective collection as the first stage of a long cycle of reusing materials in all forms, whether solid, liquid, or gaseous. Moreover, the individual who collects the waste is one of the few who are willing to touch their body in the filth that users leave after use, an action that, if it were not done, cities would have a high probability of becoming centers of irradiation of diseases and other unpleasant consequences that a lack of education in dealing with materials generates.

## V. CONCLUSION

This study showed five main difficulties encountered in carrying out the selective collection of waste in Manaus: the region's climate, lack of selective collection, weight and volume of the material, transportation of the material, and selling price. These difficulties can be classified as environmental (regional climate), conscientious (population's lack of willingness to collaborate with selective collection), transportation (weight, volume, and transport of the material), and commercial (selling price of the material). If the conscientious, transport, and commercial difficulties are overcome, the weight of the environmental factor can be significantly reduced since nature cannot be controlled. These difficulties must be overcome because they compromise the effectiveness of the entire reverse logistics chain.

Reverse logistics is a material flow process in which the value of raw material is captured in a production cycle and its appropriate destination. This process is essential when working on an organization's culture, as in addition to having an extreme environmental concern that helps maintain a good image of the company, it also favors the organization of its production processes. In this way, numerous opportunities arise for reducing production costs and continuous improvement of its production process due to concern for the environment and the company's environmental responsibility. Therefore, the market starts to see this company in a positive light, positively impacting its image in an increasingly competitive scenario.

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