



**Reverse Logistics: evaluation of potential and challenges in Santa Catarina Highlands (Brazil)**

**Logística Reversa: avaliação das potencialidades e desafios na Serra Catarinense (Brasil)**

**Logística Inversa: evaluación de potencialidades y desafíos en la Sierra Catarinense (Brasil)**

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**ABSTRACT**

This research presents an analysis of the potential and challenges of implementing reverse logistics for ‘batteries’ and ‘electronic devices’ in Santa Catarina Highlands. Shared management in Santa Catarina Highlands has been implemented through the Serra Catarinense Intermunicipal Consortium (CISAMA), with the implementation of ecopoints in the municipalities, which aim to receive not only this Reverse Logistics (RL) waste but also other recyclable waste. The Santa Catarina Environmental Institute (IMA), through the “I think, therefore I destiny” program, seeks to make the RL of this waste viable in conjunction with the city governments. In this sense, through a cooperation agreement, eleven municipalities in the mountainous region signed an agreement in 2022. As the main results of this research – through the application of a SWOT matrix considering Santa Catarina Highlands as an internal environment, and the State/Country as an external environment – peculiar characteristics of the researched region could be identified, due to the municipalities having less than ten thousand inhabitants, as well as other factors that hinder the implementation of the aforementioned program, such as the lack of professional qualification of civil servants, the need for greater supervision, as well as raising awareness among the population, thus covering cultural, geographic and demographic issues, in addition to administrative aspects.

**Keywords:** reverse logistics, batteries, electronics, SWOT matrix, Santa Catarina Highlands.

**RESUMO**

Esta pesquisa apresenta uma análise das potencialidades e desafios da implantação da logística reversa para ‘pilhas e baterias’ e ‘eletroeletrônicos’ na Serra Catarinense. A gestão compartilhada na Serra Catarinense vem sendo implementada através do Consórcio Intermunicipal da Serra Catarinense (CISAMA), com a implantação de ecopontos nos municípios, que visam receber não somente esses resíduos de Logística Reversa (LR) mas também demais resíduos recicláveis. O Instituto do Meio Ambiente de Santa Catarina (IMA), através do programa “Penso, Logo Destino” busca viabilizar a LR desses resíduos em conjunto com as prefeituras. Nesse sentido, através de termo de cooperação, na região serrana onze municípios assinaram um acordo no ano de 2022. Como principais resultados desta pesquisa – por meio da aplicação de uma matriz SWOT considerando a Serra Catarinense com ambiente interno, e o Estado/País como ambiente externo – puderam ser identificadas características peculiares da região pesquisada, devido os municípios possuírem menos de dez mil habitantes, bem como outros fatores dificultadores à



condução do referido programa, tais como a carência de qualificação profissional de servidores, necessidade de maior fiscalização, bem como a sensibilização da população, assim abarcando questões culturais, geográficas e demográficas, além de aspectos administrativos.

**Palavras-chave:** logística reversa, pilhas e baterias, eletroeletrônicos, matriz SWOT, Serra Catarinense.

## RESUMEN

Esta investigación presenta un análisis del potencial y los desafíos de la implementación de la logística inversa para ‘baterías’ y ‘electrónica’ en la Sierra Catarinense. La gestión compartida en la Sierra Catarinense se ha implementado a través del Consorcio Intermunicipal de la Sierra Catarinense (CISAMA), con la implementación de ecopuntos en los municipios, que tienen como objetivo recibir no sólo estos residuos de Logística Reversa (LR) sino también otros residuos reciclables. El Instituto Ambiental de Santa Catarina (IMA), a través del programa “Pienso, luego destino”, busca viabilizar el LR de estos residuos en conjunto con las alcaldías. En este sentido, a través de un convenio de cooperación, once municipios de la región serrana firmaron un acuerdo en 2022. Como principales resultados de esta investigación – mediante la aplicación de una matriz SWOT considerando la Sierra Catarinense como entorno interno, y el Estado/País como entorno externo – se pudieron identificar características peculiares de la región investigada, debido a que los municipios tienen menos de diez mil habitantes, así como otros factores que dificultan la implementación del mencionado programa, como la falta de cualificación profesional de los funcionarios públicos, la necesidad de mayor supervisión, así como la sensibilización de la población, abarcando así cuestiones culturales, geográficas y demográficas, además de aspectos administrativos.

**Palabras clave:** logística inversa, baterías, electrónica, matriz SWOT, Sierra Catarinense.

## 1 INTRODUCTION

The implementation of Reverse Logistics Systems (RLS) in Brazil has been growing since the publication of Law No. 12305/2010, the National Policy on Solid Waste (PNRS), which established shared responsibility for the life cycle of products. For this, there are Sector Agreements concluded between companies (largely manufacturers and suppliers) together with the Public Authorities, whether federal, state or municipal. However, although these agreements are promising, one of the greatest difficulties faced for the full operation of these systems is in the waste collection stage.

In the Serra Catarinense, most municipalities have geographical and population characteristics that are hindering the process of collecting materials for Reverse Logistics (RL), since collection becomes feasible for RLS only from a certain volume of waste, which is not



compatible with small populations and, in large part, rural. The Intermunicipal Consortium of Serra Catarinense (CISAMA), together with the Institute of the Environment of Santa Catarina (IMA) and the Municipalities, act to facilitate this collection in the region. For this, the experiences on successful cases in the implementation of SLR in Brazil and in the state of Santa Catarina are interesting, mainly linked to the so-called ecopoints, or Voluntary Delivery Points (PEVs), which are the places for voluntary delivery of waste by the population. Since ecopoint facilities are planned throughout the region, qualified to receive waste for LR of 'batteries and batteries' and 'electronics', which delimited the scope of this research.

In view of the above, in addition to collecting data and information at the national, state and Serra Catarinense levels, regarding the operation of RL, the general objective of this research is to present an analysis of the potentialities and challenges of the implementation of reverse logistics for 'batteries and batteries' and 'electronics' in Serra Catarinense.

For this, strengths, weaknesses, challenges and potentialities of this structuring of RL in the Region are identified and discussed, thus providing subsidies so that, at the beginning of the operation of the alleged ecopoints, they really act as facilitating agents, in order to implant and maintain functional the RL of waste in the Serra Catarinense.

## **2 THEORETICAL FRAMEWORK**

### **2.1 REVERSE LOGISTICS CONCEPTS**

Allied to the exponential growth of the human population, is the increase in the volume of waste generated by the activities developed. According to Kaza *et al.*, (2018), the volume of Municipal Solid Waste (MSW) will increase from 2.01 billion tons (2018) to 3.40 billion tons by 2050. In addition to the increase in the amount of waste, there is an increase in the diversity and complexity of these, since technological advances are providing the availability of materials with increasingly diverse components in the market.

Countries' concern with the management of MSW is allied to the development of new management technologies, which prioritize the treatment of such waste (Szigethy; Antenor, 2020). In Brazil, decades of discussion led to the promulgation of the National Solid Waste Policy (PNRS), which instituted Reverse Logistics (LR) as an instrument to improve this management



in the national territory.

Currently, there are twelve Reverse Logistics Systems (RLS) implemented in Brazil, with Sector Agreements signed only in RLS originated after the advent of Law 12,305 / 2010 (Sinir, 2025). Among the SLRs in operation in Brazil are the groups of 'batteries and batteries' and 'waste electrical and electronic equipment and its components' (WEEE), which are the focus of this article. According to Sinnecker (2007), LR is a complementary function of traditional logistics, functioning as a channel that allows the return of waste to the origin of products, integrating its life cycle.

## 2.2 LAW 12.305/2010

In Brazil, the National Policy on Solid Waste (PNRS) was established in 2010, after a long period of discussions and reviews. This policy brings in its wording some basic instruments and principles, in order to support subsequent actions and guide citizens. Chapter III, Art. 8 establishes reverse logistics and selective collection as its instruments, in addition to encouraging the consortium management of solid waste in the national territory. In Chapter II, Art. 6, eleven principles are listed (Brazil, 2010). Among all, the principles of cooperation and shared responsibility are considered the most relevant for the present study.

### 2.2.1 Principle of cooperation

Principle VI establishes cooperation, which must be carried out between the public and private spheres and society in general. According to Pereira Neto (2011), the intention with the institution of this principle was to reinforce the need for solidarity between the powers and civil society. The author also mentions that this means that responsibility for the management of all waste generated should be distributed among the parties that carry out its management.

### 2.2.2 Principle of shared responsibility

Principle VII provides for shared responsibility with regard to the life cycle of products, being the first step towards the implementation of reverse logistics and sectoral agreements.



According to Art. 3 of the PNRS, the product life cycle comprises the entire chain, from the removal of raw material from nature, its processing, to consumption and its final destination. Thus, it can be concluded that all citizens and companies hold a certain degree of responsibility for the environmentally sound disposal of all products they sell and consume.

### 2.3 DECREE 10 240

Decree No. 10,240, of February 12, 2020, regulated the reverse logistics system for WEEE in Brazil (Brazil, 2020). Where the structuring of the RL project of WEEE is foreseen in two main phases. According to Palhares *et al.* (2021), although recent, the phases are well advanced, and there is, published in 2019, the Sectoral Agreement between the Union and companies in this branch, which provides for cooperation between the parties to carry out the LR of their products marketed in the national territory (Brazil, 2019).

### 2.4 BATTERIES AND WASTE ELECTRONICS

With the rapid growth of the population, in addition to the Third Industrial Revolution, which brought electronics products as protagonists of technological evolution, there is a growing problem of the disposal of waste from these products. According to NBR 10.004 (Abnt, 2004), waste electrical accumulators are classified as hazardous waste, that is, Class I. Its environmentally correct final destination must occur in landfills destined to these specific types of waste.

Conte (2016) states that there is a wide variety of batteries marketed in Brazil. Each model is used for one type of equipment. Still, each type of battery and battery, when discarded, is capable of causing a type of negative impact on health and the environment. In a study by Silva *et al.* (2011), the authors carried out a survey on the composition of batteries marketed in Brazil in the last decades, it was evidenced that until the beginning of the 1990s there was no express concern with the limits allowed for heavy metals in batteries - especially mercury (Hg). After years of discussions, CONAMA Resolution 257/1999 was approved, which regulated the maximum permitted levels for Hg, Cadmium (Cd) and Lead (Pb). However, in the 2000s new speculation about further lowering the limits began. Thus, CONAMA Resolution 401/2008



(Conama, 2008) was published in 2008, which revoked the previous one and further limited the presence of the above substances in batteries marketed throughout the national territory. In addition to establishing shared responsibility and the obligation of consumers to take waste to collection points of the system (Goeldner *et al.*, 2020).

However, Zhou *et al.* (2023) point out that there are other compounds that are used as anodes, especially in cells, such as bismuth (Bi), antimony (Sb) and zinc (Zn). The non-regulation of these other compounds and the existence of a large amount of imported batteries in trade in the country, are factors that hinder the RL process and environmentally appropriate destination.

Just like batteries, there are a multitude of types and compositions of electronics components, which have been growing exponentially in recent years. According to SINIR (2025) the different compositions of this material can cause different negative impacts (on the environment and human health) associated. The main impacts are related to the presence of heavy metals in these components, which can pollute soil and water and cause health problems.

## 2.5 NATIONAL SECTORAL AGREEMENTS AND MANAGING BODIES

CONAMA Resolution 401/2008 (Conama, 2008) states that all manufacturers and traders of 'batteries and batteries' must enable the LR of their products through the provision of voluntary delivery points (PEVs). There is no Sectoral Agreement agreed for the RL of these wastes in Brazil, since this RLS was established before the PNRS, and remains so to date (Sinir, 2025).

The LR of 'electronics products and their components' is regulated by Decree No. 10,240, in addition to the Sector Agreement signed between the Union and the companies in the field, in 2019. This sectoral agreement follows the precepts of PNRS and provides for the use of the principle of shared responsibility for the product life cycle, which defines two phases for the implementation of SLR, which is the responsibility of manufacturers and importers, through the Brazilian Association of Electrical and Electronic Industry (ABINEE). According to Conte (2016), the manufacturers that make up a SLR tend to develop increasingly improved techniques for recycling and recovery of components, conferring environmental gain when implementing the Sectoral Agreements and accountability of the parties, since natural resources are saved in



the form of raw material, in addition to there being adequate disposal of hazardous waste generated by these materials.

The WEEE management entities operating today in Brazil are: 'Green Electron' and the 'Brazilian Association of Recycling of Electronics and Household Appliances (ABREE)', aiming to direct the actions and enable the suitability to Law 12.305 / 2010 (Abree, 2025; Green Electron, 2025).

### **2.5.1 Green Electron**

According to the company itself, its foundation took place in 2016, through the Brazilian Association of the Electrical and Electronic Industry (ABINEE), due to the growing demand for the implementation of a real RL program in Brazil. Today, the social framework of Green Electron has associated and non-associated companies, with the objective of operationalizing the LR system and making it more efficient and economical (Green Electron, 2025).

The entity is responsible for the RL of batteries, batteries and WEEE. The last annual performance report of Green Electron published in SINIR, referring to the year 2021, found that the entity is in compliance with Law 12.305/2010, and the report was approved with reservations, due to the Communication Plan not reaching the expected (Sinir, 2025).

### **2.5.2 ABREE**

The Brazilian Association of Recycling of Electronics and Home Appliances (ABREE) was founded in 2011 and was, until the foundation of Green Electron, the only managing entity for WEEE in Brazil. In 2021, in a report published in SINIR (2025), the company did not reach the targets established with respect to the amount of waste collected at its collection points, so the government considered that the entity is in disagreement with Law 12,305 / 2010, the report being approved with reservations, also referring to the Communication Plan.

## **2.6 BRAZILIAN OVERVIEW**

In a study by Goeldner *et al.* (2020), the authors highlight the situation of the SLR of



'batteries and batteries' in Brazil, presenting the most common steps in the collection, separation and recycling process, in addition to the responsibility of manufacturers and suppliers. This study also points out a disadvantage of the RL process of batteries in relation to others, such as tires, which is the unavailability of a "reward" for the allocation of batteries to collection points, in addition to not setting clear numerical targets. Mendes, Ruiz and Faria (2016), conclude that the main obstacle to the full operation of the battery and battery LR program is the inertia of the Brazilian Government in relation to the import of these materials, causing a lack of accountability of these manufacturers, in addition to making materials available on the market with concentrations of substances above that allowed by CONAMA Resolution No. 401/2008.

A very interesting case study is that of Resch, Matheus and Ferreira (2012), which provides information on ecopoints installed in the City of São Paulo, dealing with the implementation of collection points distributed regularly throughout the territory, being managed by the subprefectures. In this study, the authors show that the main challenges for the collection phase of the RL process are related to factors of 'environmental education' and 'functioning of the ecopoints', especially with regard to the operating hours and the way in which the waste is received.

It is concluded that, in general, in Brazil, the operation of RL processes face administrative barriers, with regard to tax incentives, in addition to inspection of the various constituent stages of the process, as well as social barriers, such as the absence of environmental education practices and awareness of individuals, with regard to the ability of society to contribute to the collection stage of this waste; leading to the understanding that the Government and the Management Entities still sin by not acting with more emphasis in the social area, sensitizing consumers to collaborate by exercising the fulfillment of their responsibility in the disposal of their waste.

## 2.7 SANTA CATARINA – STATE PLAN FOR SOLID WASTE

The State of Santa Catarina released the State Solid Waste Plan (PERS) in 2018. The PERS was elaborated with the objective of directing the actions of waste management in Santa Catarina territory; throughout the report the actions for RL in Santa Catarina are foreseen.

The diagnosis was carried out through research in the IMA systems, in the Municipal



Management Plans and in Sectorial Agreements signed until then. The guidelines for RL are: expand chains and improve the efficiency of RL in Santa Catarina and encourage shared responsibility in post-consumption. After diagnosis and prognosis, two programs were conceived (Santa Catarina, 2018):

- a) Plan for the improvement of Reverse Logistics Systems;
- b) Aid plan for the management and supervision of Reverse Logistics in the State.

## 2.8 SANTA CATARINA SCENE

In 2021, Santa Catarina had 399 establishments practicing LR (Fiesc, 2021), being the second state that most adheres to this practice in Brazil. The Institute of the Environment of Santa Catarina (IMA) articulates LR actions aimed at civil society through cooperation terms signed between the IMA and the Municipalities. These terms deal with actions to enable collection in small municipalities, IMA published news about the actions developed in this program, mainly on the operation of the "Penso, Logo Destino" Program.

## 2.9 SERRA CATARINENSE – TERMS OF COOPERATION

In 2022, eleven municipalities in the mountain region of SC signed cooperation terms, together with the IMA. The aim of these agreements is to make RL in the region viable. In this particular case, the characteristics of the population and the location of these municipalities have peculiarities. Most cities have less than ten thousand inhabitants, and the geographic distribution is well dispersed, with considerable distances between urban centers and even within the urban region. The eleven municipalities participating in the agreement are: Anita Garibaldi; Bom Jardim da Serra; Bom Retiro; Campo Belo do Sul; Capão Alto; Otacílio Costa; Paniel; Palmeira; Rio Rufino; Urubici; Urupema (IMA, 2022).

In these agreements, concluded between the Municipalities and the IMA, are described the characteristics and responsibilities of each public agent in the implementation of the Program "Penso, Logo Destino", which aims to provide collection points of waste members of Reverse Logistics.



### 2.9.1 Agreed liabilities

Clause 3 provides for the main responsibilities agreed in the Terms of Cooperation, which are presented in Table 1.

Table 1. Responsibilities of each co-operation officer

AGENT	RESPONSIBILITY
<b>IMA Chair</b>	Disseminate the program; Conclude agreements, cooperation agreements and other acts relevant to the program.
<b>IMA Directorate of Engineering and Environmental Quality</b>	Disseminate and prepare material for the dissemination of the program; Provide technical support and train the Environmental Development Coordination; Define the annual schedule of activities; Evaluate the strengths and weaknesses of the program, as well as carry out its evaluation.
<b>Regional Coordinator</b>	Present the program to municipalities with a population of less than twenty thousand inhabitants within the region; Support and train Municipal Coordinators; Mediate the negotiations between the Managing Entities and the Municipal Coordinations.
<b>Municipality</b>	Join the cooperation agreement; Appoint the Municipal Coordinator and the alternate of the program; Enable program Consolidation points (collection).
<b>Municipal Coordinator</b>	Develop the activities related to the program in the Municipality, as well as guide and inform society; Mediate negotiations with the coordinator of the region and society in general on the installation of voluntary delivery points (ENPs), as well as monitor their facilities; Record and forward to regional coordination the location of ENPs and the report of waste destined there; Select the trades that sell products object of Reverse Logistics and summon them for training, structured by him.

Source: Adapted from IMA (2022)

With this, it is concluded that in the Serra Catarinense there are agreements with most municipalities. These agreements clearly define the responsibilities of each public official for the operation of the proposed program.

### 2.9.2 Ecopoints in Serra Catarinense

The Municipalities of Serra Catarinense are articulated in the Intermunicipal Consortium of Serra Catarinense, CISAMA, which acts on the three pillars of sustainability, seeking to optimize the processes in these Municipalities through consortium management. It turns out that



CISAMA has a basic sanitation sector, which has turned its activities to the integrated management of solid waste in the region. Thus, CISAMA seeks, through the elaboration of projects and fundraising with the competent spheres, the implantation of ecopoints (or PEVs), which will be qualified to receive recyclable waste and waste from LR (batteries, batteries and WEEE), as well as Solid Waste Management Centers (CGRS), which were allocated, in project, according to the characteristics of geographic and population distribution (Cisama, 2023).

### **3 METHODOLOGY**

#### **3.1 DATA COLLECTION**

Data collection was done through matrix analysis based on information provided by the Regional and State environmental agencies, as well as the bibliographic research carried out in the present study.

Therefore, it was used as a procedure the application of a SWOT matrix on the information collected throughout this research.

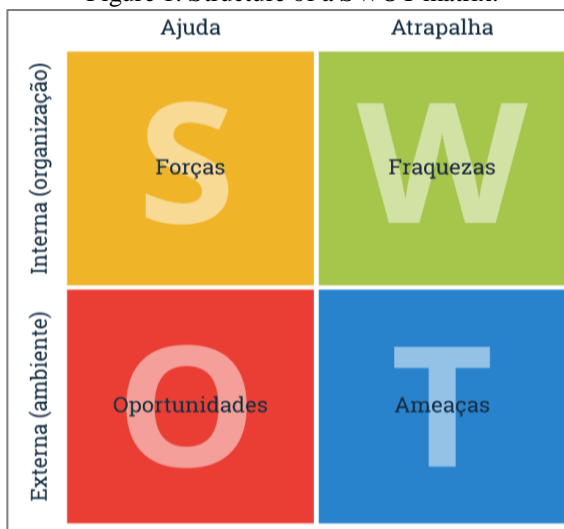
#### **3.2 COMPARISON OF RESULTS – SWOT MATRIX**

In order to list elements that hinder and facilitate the implementation and operation of the SLR in the Serra Catarinense, the data collected were used to elaborate a SWOT matrix, widely used in corporate environments, for use in strategic planning. According to Fernandes (2015), the data analysis through this matrix allows to evaluate the strengths and weaknesses in relation to the internal and external environments in which the evaluation point is inserted.

The structure of a conventional SWOT matrix is presented in Figure 1.



Figure 1. Structure of a SWOT matrix.



\* S: Strengths (strengths); W: Weaknesses (weaknesses); O: Opportunities (opportunities); T: Threats (threats)  
Source: Adapted from Pereira Neto (2022).

The choice of this matrix model was due to the fact that, being the objective of investigating what are the challenges and potentialities of the alleged SLR in the Serra Catarinense, in comparison with initiatives at the State and National level, the SWOT matrix shows promise.

In this sense, two lines were defined for the elaboration of the matrix in this study: the internal environment was considered the SLR implemented in the Serra Catarinense and the external environment the SLR implemented at the state and national scale. Thus, generating comparison elements, which are presented and discussed below.

#### 4 RESULTS

The SWOT matrix, elaborated based on the information collected during the research, is available in Chart 2.



Table 2. Elaborated SWOT Matrix

S – Forces	W - Weaknesses	Internal Environment (Serra Catarinense)
<ul style="list-style-type: none"> <li>· Consortium management;</li> <li>· Small urban perimeters, facilitating the operation of ecopoints;</li> <li>· Trained professionals at CISAMA.</li> </ul>	<ul style="list-style-type: none"> <li>· Amount of waste generated;</li> <li>· Low adherence of the population to selective collection programs;</li> <li>· Low level of education of the population;</li> <li>· Absence of environmental education policies in Municipalities;</li> <li>· Absence of trained professionals in City Halls.</li> </ul>	
O – Opportunities	T - Threats	External Environment (State, Country)
<ul style="list-style-type: none"> <li>· Improve the relationship between Municipalities and IMA;</li> <li>· Establish greater partnerships between Municipalities / State / Union, for the implementation of environmental education actions, installation and operation of ENPs;</li> <li>· Hiring of qualified personnel in the environmental area.</li> </ul>	<ul style="list-style-type: none"> <li>· Inertia of public agents;</li> <li>· Lack of inspection of the operation of the collection system;</li> <li>· Low adhesion of cooperatives to operate the ecopoints;</li> <li>· Geographical allocation of ecopoints in the cities of the region.</li> </ul>	

Source: Prepared by the authors, based on bibliographic research

## 5 ANALYSES AND DISCUSSION

### 5.1 FORCES

The consortium management of solid waste in the Serra Catarinense has been implemented through CISAMA, with its Basic Sanitation sector. The Consortium intends to implement an ecopoint in each Municipality of the region, according to the model in Figure 2. These sites will act as a voluntary delivery point for recyclable and RL waste and will be entitled to receive batteries, batteries and REE.

The initial conception of the projects foresees that the ecopoints have a place for storing the waste of the LR, making it possible to gather a significant amount of them, reaching the minimum quantities necessary for the manufacturers to carry out the collection route in the Serra Catarinense.



Figure 1. Ecopoint installed in the Municipality of Palmeira - SC



Source: CISAMA Collection (2023).

The small urban perimeters of the cities of the region can act as a facilitator of the waste management systems of the LR. Although it comes accompanied by a series of cultural characteristics, this can be a characteristic that, if well exploited by the public power, can facilitate the elaboration of collection routes, the scope of door-to-door campaigns, also the inspection of vitiated points of improper disposal of waste.

CISAMA has trained technical personnel in its basic sanitation sector, who are able to act in the decentralized management of ecopoints and SLRs in the Serra, creating opportunities that will be discussed below.

## 5.2 WEAKNESSES

The weaknesses listed are strongly related to the issues of size and culture of the Municipalities. As shown in Table 1 and Figure 3, nine of the 17 municipalities in the region have populations below five thousand inhabitants.

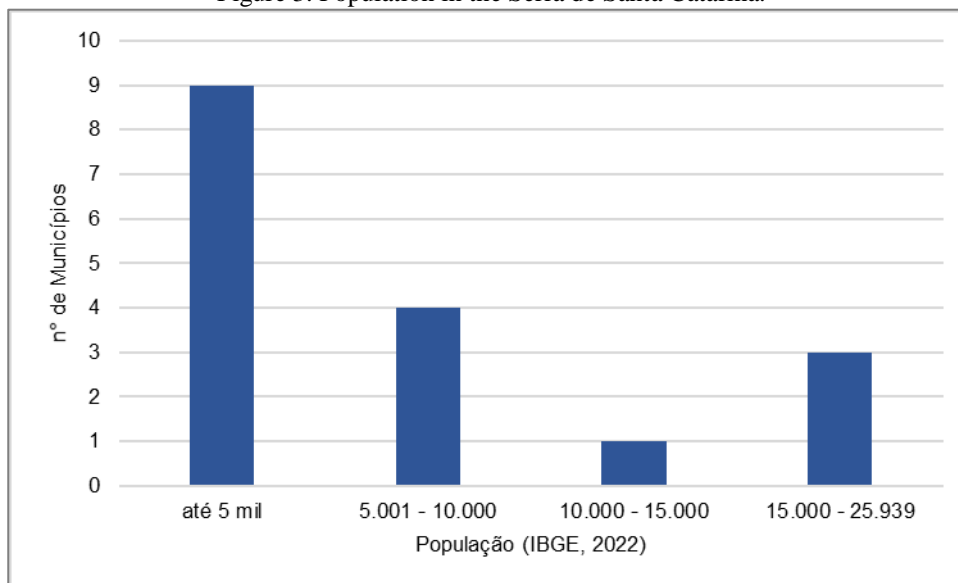


Table 1. Population of each Municipality, ordered from lowest to highest

Municipality	Population in the year 2022
Panel	2215
Rufino River	2397
Palm tree	2561
Capão Alto	2625
Urupema	2656
Black Hill	3317
South Bocaine	3515
Bom Jardim da Serra	4026
High Bridge	4437
Campo Belo do Sul	7257
Anita Garibaldi	8285
Bom Retiro	8418
São José do Cerrito	8708
Urubici	10834
Correia Pinto	15727
Otacílius Costa	17312
Saint Joachim	25939

Source: Adapted from IBGE (2025)

Figure 3. Population in the Serra de Santa Catarina.



Source: Adapted from IBGE (2025)

In municipalities with a population below 5,000 inhabitants, it is estimated that the *per capita* generation of batteries, batteries and REE is not large enough, making it difficult for manufacturers or those responsible for this stage of the cycle, who usually carry out the collection route only from a certain amount made available.

Therefore, this "insufficient" amount of waste generated was listed as one of the weaknesses of the SLR in the Serra. This weakness will be worked by CISAMA through the



installation of ecopoints in each of the Cities, allowing a greater amount of waste to be absorbed in centralized collection and storage, seeking to make the LR process of these materials in the region viable.

Another weakness associated with RLS in the Serra Catarinense is the low adherence of the population to existing systems, such as the IMA program "Penso, Logo Destino", whose implementation suffers remarkable difficulties in adhering to the population. This may be associated with the other two weaknesses listed: the low level of education of these populations and the absence of more effective environmental education policies in the territories. In addition, it is necessary to have a greater presence of trained professionals in the environmental area of the municipalities, and this area is usually inserted within the Secretariats of Agriculture.

### 5.3 OPPORTUNITIES

The opportunities of the system were listed seeking to offer subsidy for the entities and the public power to act in the effective development of LR in the region. Thus, there is the possibility of strengthening the relationship between the municipalities and the IMA, seeking to implement more effectively the "Penso, Logo Destino" program and through this partnership, establish actions that implement / strengthen environmental education and awareness of the population.

An opportunity that should be explored by the Municipalities is the hiring of more technically specialized personnel in the environmental area, aiming to carry out the functions of design, coordination and supervision of these RL programs in the Municipalities.

This action can facilitate the operation of the ecopoints, since decentralized management with the support of CISAMA should be the best form of waste management, facilitating the IMA to implement the actions when in contact with technical officials with broad mastery of the subject.

### 5.4 THREATS

The threats were listed by observing the experiences obtained during the conduct of the present study, as well as possible threats pointed out in the bibliographic review. Thus, it was



decided to show that one of the threats to the correct functioning of RL is the performance of public agents, whose roles are fundamental for a good progress of the programs.

The second threat listed was the lack of monitoring of the progress of the programs. The inspection is a crucial step for the evaluation of how the program is developing and what improvements will be needed in the next actions. In the cooperation agreements, the IMA servers are responsible for evaluating this continuous improvement, together with the coordinators of each Municipality. It was not possible to observe if these actions have been carried out periodically, given the lack of return of the communication attempts made.

The last two threats listed are more related to the operation of the ecopoints: the initial conception of CISAMA is that a cooperative collector is responsible for operating the ecopoints, performing the reception and allocation of waste in commercial hours, that is, the operation of these voluntary delivery points will depend on the availability of a cooperative collector to be there. Noting that not all cities in the region have a large number of collectors, this can be a difficulty faced for the full operation of the ecopoints. Again, there is a strong link between the difficulties and opportunities, as this is a gap of opportunity to improve relations between City Halls, the State, CISAMA and public agencies in general, in the capture and training of these personnel.

In view of the difficulties encountered in some cases, there may be difficulty in the operation, in the adhesion of this cooperative, in addition to the time, which will be commercial, and may be a limiting factor of the adherence of the population to take their waste to the ecopoint. In addition, CISAMA installs the ecopoints on land donated by the Prefectures, which often configures a distance from the centers and a factor that also hinders the adherence of the population. As an example, we have the ecopoints of two randomly chosen cities, which are already installed. The locations can be seen in Figure 4.



Figure 2. Location of two ecopoints in Serra Catarinense



Source: Prepared by the authors.

Observing Figure 4, it is clear the threat of the location of the ecopoints in relation to the



fullness of their operation.

In the case of City A, the land donated to CISAMA by the City Hall for the allocation of the project is located in the final portion of the city, in an area with little circulation of people and that is not easily visible to residents. Thus, in the operation of these ecopoints, dissemination actions will be necessary to make residents move to this point to deposit their waste.

Already observing the location of the ecopoint of City B, it is observed that this is in an extremely privileged location, being in the center of the City, right next to the City Hall, with easy visualization and easy access for all who pass there. In this case, the operation of these ecopoints will tend not to present the challenge mentioned above for the operation of the ecopoint A, since, when allocated in a place of easy visualization and access, citizens tend to create the habit of depositing the waste at this point, mainly because they do not need a deviation from their daily route so significant.

Thus, it is possible to observe an intertwining between the difficulties and the facilitators of the operation of these ecopoints, a small urban territory will not always represent an ease in the operation of the ecopoint if there is no well-developed strategy from the moment of its conception.

## **6 FINAL CONSIDERATIONS**

This research presented an analysis of the potentialities and challenges of the implementation of reverse logistics for 'batteries' and 'electronics' in the Serra Catarinense.

Considering the content addressed in the present research, it can be concluded that the implementation of Reverse Logistics Systems in the Serra Catarinense faces problems related to geography, demography and culture of the population, as well as aspects related to administration.

It was observed a relationship between the strengths and weaknesses of the Reverse Logistics System in the Serra Catarinense, demonstrating the great importance of planning and partnership between Municipalities and CISAMA from the conception of the ecopoints project, through its execution and the care in their operation, thus providing the possibility of effectively becoming consolidated voluntary delivery points.

By addressing potential strengths, weaknesses, opportunities and threats, this study



sought to provide subsidies for CISAMA to trace more assertive strategies when operating its ecopoints, leading them to act as facilitators and facilitators of the operation of Reverse Logistics in the Serra Catarinense, thus contributing to the best adaptation of the municipalities associated with the National Solid Waste Policy and, consequently, to the improvement of the environmental quality of the region.

In a complementary way, it is worth pointing out a difficulty experienced during the execution of this study, in the alleged data collection through interviews with public agents involved in the Reverse Logistics process in the Serra Catarinense, which could not be executed, because there is not enough openness for the application of such procedure.

For future research, it is suggested to follow the evolution of this theme in the Serra Catarinense, involving analyzes about the actions developed, the results achieved, as well as the visualization of opportunities for improvement and the elaboration of proposals from this.

It is also worth congratulating the efforts of the public authorities and other participants and collaborators in order to make Reverse Logistics viable in the Serra Catarinense, even in the face of the adversities inherent in the region.

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