

# Waste management in Brazilian Universities: A case study of Maringa State University

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**Abstract.** This article presents a comprehensive case study on waste management at the State University of Maringá (UEM) in Brazil. It addresses the pressing concerns surrounding environmental sustainability and the escalating waste generation within educational institutions, necessitating the implementation of effective waste management strategies. This case study primarily focuses on UEM's initiative to establish a holistic reverse logistics system, aiming not only to minimize its environmental footprint but also to foster sustainability within its academic community. This study approaches the specific waste streams targeted for inclusion in the reverse logistics system, including electronic waste, paper, plastics, and other materials. Furthermore, it highlights the significance of strategic partnerships forged with manufacturers and recycling organizations, underscoring the collaborative efforts required for successful waste diversion. In addition, this case study examines the substantial impact of educational outreach and awareness campaigns conducted within the university community. These initiatives have played a pivotal role in instilling responsible waste disposal practices among students, faculty, and staff. By taking proactive measures to manage waste effectively, the State University of Maringá aspires to serve as a model for sustainable waste management practices within educational institutions. The insights and outcomes presented in this case study serve as a valuable resource for other universities and organizations embarking on similar sustainability journeys.

**Keywords.** Waste management, reverse logistics, sustainability, educational institutions, environmental impact.

## 1. Introduction

The increasing concern for environmental sustainability has prompted organizations worldwide to reevaluate their waste management strategies. With the escalating volume of waste generated within the academic environment, there is a pressing need to adopt effective waste management practices that align with sustainability goals [1]. Educational institutions, including universities, are no exception. This paper delves into the implementation of reverse logistics for solid waste management at the State University of Maringá in Brazil, highlighting its journey toward establishing a comprehensive system.

As universities play a crucial role in shaping the future and educating future generations, their commitment to sustainability extends beyond the classroom. By adopting sustainable waste management practices, universities can not only reduce their environmental footprint but also serve as models of responsible stewardship [2].

In the following sections, the attention will turn to an examination of waste management, with a specific focus on reverse logistics, at the State University of

Maringá (UEM). This case study aims to provide an impersonal analysis of UEM's approach to waste management, including the incorporation of reverse logistics strategies. It will encompass an investigation of the waste streams targeted for reverse logistics, such as electronic waste, paper, and plastics, among others.

Moreover, the article will underscore the significance of forging strategic partnerships with manufacturers and recycling organizations, recognizing them as indispensable elements in realizing effective waste diversion within the university. Furthermore, it will delve into the influence of educational outreach and awareness campaigns within the university community. These endeavours have been instrumental in nurturing responsible waste disposal practices among students, faculty, and staff, consequently fostering a culture of sustainability within the academic institution.

Through the implementation of reverse logistics, the State University of Maringá aims to set a precedent for sustainable waste management practices in educational institutions. Formatting the title, authors and affiliations

## 2. Research Methods

### 2.1 General Overview

This paper provides a comprehensive analysis of waste management in Brazilian universities, drawing insights from a variety of reliable sources. The research is grounded in federal laws that establish guidelines nationwide and official documents from the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), which provide updated regulations on environmental management.

Furthermore, sustainability practices and environmental policies adopted by the universities themselves are crucial focal points, with an emphasis on sustainability reports detailing waste management initiatives. The National System of Information on Solid Waste Management (SINIR) is also used as an essential data source for the research.

In conjunction with a detailed review of academic literature, including specific articles on waste management in university settings, this study aims to offer a complete and impartial understanding of waste management. It contributes to the promotion of sustainability in Brazilian universities and advances environmental policies in the country.

### 2.2 Literature Review

The law that established the National Solid Waste Management Policy (PNRS) in Brazil is Federal Law No. 12.305, enacted on August 2, 2010. This legislation laid down the guidelines and principles for the management of solid waste, including the creation and implementation of the PNRS, which encompasses aspects of reverse logistics [3].

PNRS, as the legal framework guiding federal solid waste management in Brazil, aims to promote sustainable practices in the collection, treatment, disposal, recycling, and reverse logistics of waste. It also emphasizes shared responsibility among various stakeholders, including governments, businesses, and civil society, in the proper management of federal solid waste. Additionally, it places a strong emphasis on the principles of waste reduction, reuse, recovery, and disposal as essential components of a holistic waste management approach, as shown in figure 1 [3].



Fig. 1 – Waste Management Hierarchy.

CONAMA (National Council for the Environment), an essential entity for environmental management in

Brazil, plays a crucial role in formulating policies and regulations aimed at the protection and conservation of the environment. Among its primary responsibilities is the issuance of resolutions that have a significant impact on environmental regulation in the country [4].

One notable resolution issued by CONAMA is Resolution CONAMA No. 362/2005, which addresses the issue of used or contaminated lubricating oil. This resolution establishes detailed guidelines for the storage, collection, and final disposal of this type of waste, with the aim of ensuring environmentally sound management [5].

Another relevant resolution is Resolution CONAMA No. 401/2008, which establishes maximum limits for lead, cadmium, and mercury in batteries sold in the national territory. Additionally, this resolution defines criteria and standards for the environmentally correct management of these products [6].

Resolution CONAMA No. 416/2009 also deserves attention, as it addresses the prevention of environmental degradation caused by unserviceable tires and their environmentally appropriate disposal. This resolution establishes guidelines for the proper management and final disposal of used tires, aiming to avoid negative impacts on the environment [7].

The National Solid Waste Management Information System (Sistema Nacional de Informações sobre a Gestão dos Resíduos Sólidos or SINIR) was created by the Brazilian government as a tool to implement and monitor the National Solid Waste Policy (PNRS). It serves as an online platform that was developed to centralize data related to solid waste management. SINIR was established by the Ministry of the Environment (Ministério do Meio Ambiente) and primarily caters to various stakeholders involved in solid waste management in Brazil, including municipalities, government agencies, environmental authorities, and private companies. Its creation aimed to streamline and improve waste management practices while ensuring compliance with national regulations [8].

The National System for Information on Solid Waste Management (SINIR) in Brazil consists of several integral online panels that significantly contribute to effective waste management and monitoring across the country. The system includes the National Registry of Operators of Hazardous Waste (CNORP), Selective Waste Collection and Reverse Logistics Panels, Environmental Licensing and Solid Waste Plans, Waste Generators Registry, Final Disposal Units Registry, Waste Transport Manifest (MTR), and other tools with similar objectives. [9].

The Selective Waste Collection and Reverse Logistics Panels focus on monitoring and collecting information regarding selective waste collection and the reverse logistics of products covered by sectoral agreements and commitments outlined in the PNRS [9].

To implement reverse logistics for hazardous waste and protect the environment and public health, the SINIR system in Brazil has established various programs managed by different entities. Table 1 includes all the managers for each category of waste in Brazil [9]:

**Tab. 1** – SINIR Reverse Logistics System.

Hazardous Waste	Managing Entity
Agrochemical Packaging	inpEV
Automotive Batteries	IBER
E-waste	ABREE/GreenEletron
Steel Packaging	Prolata
Lubricant Oil Packaging	Institute Jogue Limpo
General Packaging	Coalizao Embalagens
Lamps	Reciclus
Medicines and Packaging	Grupo de Acompanhamento e Performance
Used or Contaminated Lubricant Oils	ANP
Batteries	GreenEletron
Unserviceable Tires	Reciclanip
Aluminum Cans for Beverages	Reciclatatas

In addition to reverse logistics, SINIR (National System of Information on Solid Waste Management) has developed a program called "Citizen Selective Collection" which allows the accreditation of associations and cooperatives of recyclable waste collectors. The program aims to promote the social and economic inclusion of waste pickers while contributing to sustainable solid waste management and strengthening the recycling chain in Brazil. This program is an important initiative to address solid waste management more comprehensively and incorporate selective collection as an integral part of sustainable waste treatment practices [10].

### 2.3 Academic Approach

In most Brazilian universities, environmental management initiatives are typically fragmented efforts originating from specific departments. Faced with this scenario, there is a mounting concern to increasingly focus on finding an alternative path towards sustainable development. This approach encompasses not only the educational aspect but also emphasizes the importance of ensuring that the operational practices of these institutions are environmentally responsible [11].

According to Machado et al., they identified that among the practices adopted by Brazilian Higher Education Institutions (HEIs). In Table 2, some

common practices adopted by Brazilian Higher Education Institutions (HEIs) stand out, and these include the following [12]:

**Tab. 2** – Common Practices Adopted by Brazilians HEI's.

Nº	Practices
1	Environmental Management Policies
2	Use of recycled materials.
3	Recycling programs.

The Chapecó Community University (Unochapecó) is actively involved in promoting a greener campus environment through practices like Selective Waste Collection and Biological Sewage Treatment [13].

At the Santa Catarina's Federal University (UFSC), they've taken a proactive approach by focusing on the safe Management of Chemical Waste [13].

The Federal University of Rio Grande do Sul (FURG) is playing a significant role in waste management by efficiently handling Urban Solid Waste (USW) and implementing Selective Waste Collection across all campuses [13].

In the University of Caxias do Sul (UCS), they've made it a mission to ensure proper waste disposal through practices like Selective Collection of Batteries, Lamps, Organic Materials, and Recyclables [13]. The Federal University of South of Bahia (UFSE) and Blumenau Regional University (FURB) embraced the PDCA Cycle to Implement an Environmental Management System (EMS) [13].

University of São Carlos (UFSCAR), State University of Campinas (UNICAMP), Federal University of Minas Gerais (UFMG), Federal University of Lavras (UFLA) and Federal University of Pernambuco (UFPE) adopted a simple effective approach: separating waste into recyclables and non-recyclables and implementing a Waste Management Project [13].

The Pontifical Catholic University of Rio de Janeiro (PUC-RIO) have fostered Thematic Groups, focusing on crucial areas like Materials and Waste [13]. The campus of Federal University of Juiz de Fora (UFJF), adopted an engaging approach with their campaign "Recycle or I'll Devour You". Such creative campaigns resonate with everyone and promote responsible waste management [13].

State University of Maringá (UEM), made a big real difference with Project for Selective Waste Collection and Proper Disposal of Solid Waste [14].

### 3. Results

The State University of Maringá (UEM) was formally recognized by the federal government in 1976 [15]. Taking a significant step forward, UEM attained state autarchy status in 1991 [16]. Recognizing the importance of comprehensive environmental management, the university implemented the Environmental Policy Resolution in 2013 [17]. This resolution underscored the commitment to

sustainable practices across all campuses.

Currently, the institution operates from its main campus in Maringá and six regional campuses in the municipalities of Cianorte, Cidade Gaúcha, Diamante de Norte, Goioerê, Ivaiporã, and Umuarama. Additionally, it encompasses a research outpost in Porto Rico and an experimental farm in the district of Iguatemi [18].

To effectively manage waste and further environmental goals, UEM established the Environmental Management Committee (CGA) in July 2015, as outlined in Resolution No. 005/2015 COU (University Council) [19]. This committee plays a crucial role in coordinating sustainable initiatives and waste management efforts throughout the university, aligning with UEM's dedication to environmental responsibility and sustainable growth.

In 2018, UEM initiated two recycling campaigns focusing on organic and inorganic waste: "Alimentando a Consciência" (Feeding Awareness) and "UEM Recicla" (UEM Recycles). The former campaign emphasizes awareness and recycling of organic waste through composting, while the latter focuses on the management of inorganic waste, promoting the recycling of paper, cardboard, glass, plastic, and metal. These campaigns play a crucial role in fostering sustainable waste management practices within the university community [20].

In adherence to the Brazilian federal decree 5940/2006, 4216/2006 and in alignment with the state decree 8426/2013, UEM has entered into a contract with a Recycling Collectors Cooperative in Maringá for the purpose of implementing Selective Waste Collection on the university campus. Consequently, every material undergoes thorough collection, weighing, and subsequent delivery to the designated department for diligent oversight and monitoring of the recyclable waste generation status. The table 2 shows the amount of inorganic waste recycled by the institution between the years 2018 and 2022.

**Tab. 3** – Evolution of Recycled Waste.

Year	Recycled Waste (ton)
2018	19,925 ton
2019	29,616 ton
2020	22,383 ton
2021	22,635 ton
2022	23,208 ton

The State University of Maringá (UEM) diligently follows Brazil's reverse logistics system, effectively managing the correct disposal of used engine lubricants from its official vehicles, unneeded tires, automotive batteries, lightbulbs, batteries, and electronic waste. This commitment is further reinforced by the valuable support received from cooperatives and authorized waste management

entities, contributing to a comprehensive and sustainable waste management approach within the institution.

In addition to common organic and inorganic waste, UEM has a plan for managing chemical waste and healthcare waste. These wastes are collected at the university through a bidding process with qualified private companies responsible for environmentally sound disposal of these wastes. Currently, chemical waste is generated in the 92 laboratories on campus, and healthcare waste is generated in the departments of biological sciences, medicine, and nursing as part of university studies or community healthcare services [21].

The culmination of these efforts has enabled the State University of Maringá to achieve a prominent position in the GreenMetric Ranking. The institution currently holds the 18th place among the most sustainable universities in Brazil for the year 2022 [22]. In summary, the State University of Maringá (UEM) embarked on a sustainability journey, gaining recognition from the federal government in 1976 and attaining state autarchy status in 1991. The university emphasized sustainability through the Environmental Policy Resolution in 2013. Key milestones included establishing the Environmental Management Committee (CGA) in 2015 and launching impactful recycling campaigns in 2018. UEM demonstrated responsible waste management by adhering to government decrees and collaborating with recycling cooperatives. This commitment resulted in notable quantities of recycled waste. Additionally, the university addressed chemical and healthcare waste disposal, showcasing a holistic waste management approach. Achieving the 18th position in Brazil's GreenMetric Ranking for 2022 affirmed UEM's dedication to environmental responsibility and sustainability. Overall, UEM serves as a beacon for sustainable practices, emphasizing the importance of responsible waste management for a better future.

#### 4. Conclusion

In summary, the State University of Maringá (UEM) embarked on a sustainability journey, gaining recognition from the federal government in 1976 and attaining state autarchy status in 1991. The university emphasized sustainability through the Environmental Policy Resolution in 2013. Key milestones included establishing the Environmental Management Committee (CGA) in 2015 and launching impactful recycling campaigns in 2018.

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