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PREVENTION OF ENVIRONMENTAL POLLUTION RESULTING FROM WASTE GENERATION AND MANAGEMENT IN ROMANIA

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Abstract: This paper analyzes the structural dynamics of waste management in Romania, evaluating the interdependence between the volume of waste generated, the efficiency of existing infrastructure, and pollution prevention strategies. Based on data from Eurostat and the National Environmental Protection Agency (ANPM), the study highlights an upward trend in per capita municipal waste generation between 2016 and 2023—a development that intensifies anthropogenic pressure on national ecosystems. An assessment of treatment systems reveals a critical reliance on a linear economic model: over 74% of waste is disposed of in landfills. This method leads to severe secondary pollution, including soil contamination via leachate and the emission of greenhouse gases—risks exacerbated by the fact that the biodegradable fraction accounts for the majority (~49.2%) of the waste composition by weight and undergoes fermentation due to a lack of industrial composting facilities. As a structural reform measure, the paper examines the impact of implementing the Deposit-Return System (DRS) during the 2024–2026 period. The analysis demonstrates how the use of a direct economic incentive has altered consumer behavior, facilitating the diversion of waste from landfills and enabling the separate collection of over 82% of primary packaging (plastic, metal, and glass). Effective pollution prevention in Romania requires moving away from "end-of-pipe" remediation solutions in favor of a circular economy. Optimizing the traceability of materials at the source, applying the "pay-as-you-throw" principle, expanding the infrastructure for Integrated Waste Management Systems (IWMS), and strengthening ongoing environmental education are essential.

• Introduction

In the current context, marked by accelerated urbanization and an ever-growing consumer culture, the issue of waste has ceased to be merely an administrative matter; it has become one of the greatest ecological challenges of our generation. For Romania, this reality is all the more apparent given that, while society has developed rapidly over the last few decades, the infrastructure for waste collection and recycling has often lagged behind. The pollution of soil, waterways, and the air—resulting from the inadequate management of waste—serves as a warning sign that we can no longer afford to ignore. As future professionals, I believe it is essential to view this issue through the lens of the circular economy—a regenerative model that seeks to fundamentally shift the traditional "buy, use, and discard" logic. The transition toward an economy in which waste is transformed into secondary raw materials is no longer just a legal obligation mandated by European Union directives; it is a moral and ecological necessity for ensuring a sustainable future. Although Romania's legal framework has been modernized, practical implementation at the local community level still faces numerous obstacles—ranging from a lack of modern sorting facilities to cultural resistance regarding the selective sorting of waste within households. In this paper, I aim to analyze how these shortcomings affect environmental factors in our country and to explore concrete solutions through which we can transform waste from a major source of pollution into a valuable economic resource.

• Material and method

The methodology applied in this paper was specifically designed to analyze the interdependence between the three central elements mentioned in the title: waste generation, the efficiency of waste management, and solutions for preventing environmental pollution in Romania.

The research relied on the following specific materials and methods:

- **Materials used for the analysis of waste GENERATION:**

To assess the volume and typology of waste generated within the country, I utilized statistical datasets from the national reports of the National Environmental Protection Agency (ANPM), as well as European indicators from Eurostat. These materials enabled me to identify the primary sources of waste (household, commercial, and industrial) and the trends in per capita waste quantities over recent years.

- **Methods for evaluating current WASTE MANAGEMENT:**

I employed a comparative analysis to assess how waste collected in Romania is handled (landfilling, sorting, recycling, composting) in relation to the mandatory targets established by legislation (Emergency Ordinance 92/2021). Furthermore, I conducted a case study based on monitoring data from the ReturRO system, evaluating the effectiveness of the Deposit-Return System (DRS) as a novel, direct method for managing packaging waste.

- **Analytical methods for the PREVENTION OF ENVIRONMENTAL POLLUTION:**

Drawing on specialized scientific literature, I applied a qualitative synthesis method to map environmental risks. We analyzed how optimizing the links in the waste management chain can prevent soil and groundwater contamination by leachate, as well as reduce methane and CO_2 emissions from landfills.

Packaging Material	Recorded Recycling Rate	National / European Target	Efficiency Assessment by Segment
Paper and Cardboard	67,88%	60,0%	Performance in compliance; increased traceability in the commercial sector.
Plastic (PET and mixed polymers)	31,59%	50,0%	Subpar; extremely vulnerable to dispersal into the natural environment.
Glass	42,10%	70,0%	Significant decline due to a lack of local infrastructure.
Aluminum and Metals	51,20%	50,0%	At the threshold of compliance; supported by intrinsic economic value.

Technical Performance Indicator	Current Value for Romania	Mandatory European Target	Gap Relative to Targets
Overall Municipal Recycling Rate	13,7%	55,0%	-41,3% (High risk of infringement proceedings)
Landfill Disposal Rate	74,3%	< 10,0% (by 2035)	+64,3% (Overcapacity of landfills)
Overall Packaging Recycling Rate	38,3%	65,0%	-26,7% (Major collection deficiencies)

• Results and discussions

Waste Generation Trends: Municipal waste generated in Romania shows a steady upward trajectory, increasing from 260 kg/capita in 2016 to over 300 kg/capita in 2023. This reflects rising consumer purchasing power but triggers massive anthropogenic pressure on national collection systems.

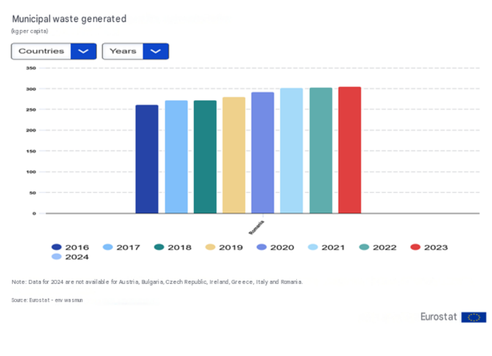
Gravimetric Composition: Mixed municipal waste is heavily dominated by the biodegradable fraction (~49.2%), which represents the primary environmental risk due to greenhouse gas emissions (methane) and leachate generation in landfills. Plastics account for 14.5%, showing a high reliance on single-use packaging.

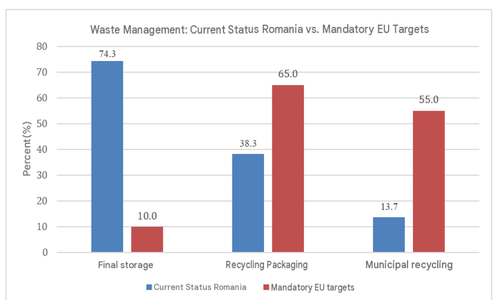
The Linear Model Deficit: Waste treatment in Romania deeply contradicts the European waste hierarchy. The country faces a severe structural gap compared to mandatory EU targets:

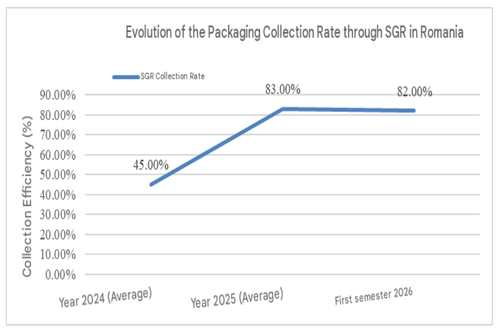
- Landfill Disposal Rate: Currently at 74.3% vs. the EU target of < 10.0% by 2035 (a critical +64.3% overcapacity overloading the system).
- Overall Municipal Recycling Rate: Stagnant at 13.7% vs. the EU target of 55.0% (a -41.3% deficit exposing Romania to imminent infringement sanctions).

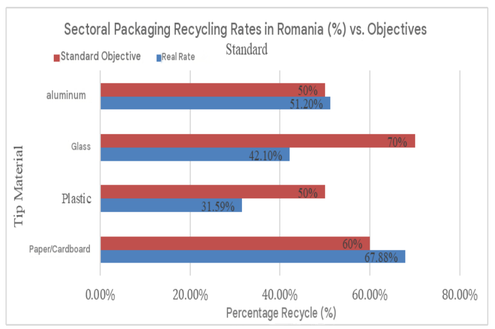
Sectoral Packaging Performance: Recycling success correlates directly with the material's market value. While paper/cardboard (67.88% vs. 60% target) and metals (51.20% vs. 50% target) achieve compliance, complex logistics leave glass (42.10% vs. 70% target) and plastic (31.59% vs. 50% target) severely lagging.

The Success of the Deposit-Return System (DRS/SGR): Implemented between 2024 and 2026, the introduction of a direct economic incentive successfully shifted consumer behavior. Collection efficiency skyrocketed from 45% in 2024 to 83% in 2025 and 82% in the first semester of 2026. This system successfully diverted over 5.2 billion packaging units from landfills directly to recycling facilities, proving that pollution prevention is most effective when executed via material traceability at the source.









• Conclusions

In conclusion, transitioning away from high landfill disposal rates toward a circular economy model is a critical national priority for Romania, and the outstanding logistical success of the DRS proves that environmental pollution can be effectively prevented through direct economic incentives, digitalization, and source-level separation, which must be expanded in the future alongside Integrated Waste Management Systems (IWMS) and ongoing environmental education.