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PACKAGING WASTE MANAGEMENT AND THE MAIN CHALLENGES IN RECYCLING PROCESSES

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ABSTRACT

Separate collection of packaging is an important step towards a circular economy. Setting a mandatory collection rate is an incentive for the development of efficient and well-targeted collection systems at national level, thus increasing the amount of waste sorted and potentially recycled. This article presents a comparative analysis, by waste type, of the evolution of packaging waste recycling, for the period 2008-2022. If in the period 2013-2022 the average of EU member states was 65.74% for recycling rates of packaging waste, in Romania the rate it was 50.31%, which involves a series of additional efforts. At the national level, during the period 2013-2022, the highest percentage of packaging waste recycling is represented by paper, cardboard 74.35% and metal a percentage of 56.02%, with wood waste in last place at 23.77%.

KEYWORDS: packaging waste recycling, circular economy, recycling rate

1. Introduction

Since 1950, global production of plastics has increased substantially, driven by their unique properties: high strength-to-weight ratio, high moldability, impermeability to liquids, resistance to physical and chemical degradation, and low cost [1]. As such, they are used in the production of a wide range of products, easily replacing wood, paper, stone, leather, metal, glass, and ceramics "Plastic" is an umbrella term that encompasses a wide range of materials made from semi-synthetic or synthetic organic compounds [2]. Synthetic polymers are typically prepared by the polymerization of monomers derived from petroleum or gas, and plastics are typically manufactured from these by adding various chemical additives [3].

The dynamic growth of global plastic production in recent decades and the increasing consumption of plastics have led to an increase in the amount of plastic waste generated each year [4]. As a result, the risk of mismanagement of plastic waste and its negative impact on the environment has increased. Mismanagement of waste poses a high risk of leakage and transport to the natural environment and oceans through waterways, winds and tides [5].

Plastic litter has impacts on both terrestrial and marine environments. Globally, estimates suggest that approximately 80% of ocean plastic comes from land-based sources, with the remaining 20% from marine sources. Marine plastic pollution is caused by fishing fleets that leave behind fishing nets, ropes and sometimes abandoned ships. For land-based sources, the main contributor is larger plastic litter, including everyday items such as beverage bottles and other types of plastic packaging [6].

New sources of plastic leakage into the environment are also on the rise, posing additional potential threats to both the environment and human health. Microplastics, tiny pieces of plastic less than 5 mm in size, accumulate in the seas, and their small size makes them easy for marine life to ingest [7]. They can also enter the food chain. In total, it is estimated that between 75,000 and 300,000 tonnes of microplastics are released into the environment each year in the EU [8].

As stated in Eurostat - Statistics Explained in 2022, the EU generated an estimated 186.5 kg of packaging waste per inhabitant (varying from 78.8 kg per inhabitant in Bulgaria to 233.8 kg per inhabitant in Ireland). The same source mentions that during the period 2011 to 2022, paper and cardboard was the main packaging waste material in the EU (34.0

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million tonnes in 2022), followed by plastic (16.1 million tonnes) and glass packaging waste (15.7 million tonnes) [9].

According to Directive 904/2019, measures must be adopted to significantly reduce the consumption of single-use plastic products by 2026 [10]. Measures may include national consumption reduction targets, measures to ensure that alternatives for the reuse of single-use plastic products are made available at the point of sale to the final consumer, economic instruments to ensure that single-use plastic products are not provided free of charge at the point of sale to the final consumer, and voluntary agreements. EU Member States may impose restrictions on the marketing of packaging that complies with Directive 94/62/EC, in order to prevent waste generation, in order to ensure that it is replaced by alternatives that are reusable or do not contain plastic [11].

Packaging must be designed, manufactured and marketed in such a way that it can be reused or recycled, thereby minimizing its impact on the environment throughout its life cycle and that of the products for which it is intended. Also, taking into account scientific and technological progress, packaging should be designed and manufactured in such a way that chemical substances of concern are reduced to a minimum and replaced as far as possible, in order to ensure a high level of protection for consumers of packaged products and to avoid adverse effects on the environment [12].

Starting with 2025, beverage bottles made of polyethylene terephthalate (PET) will contain 25% recycled plastic, and starting with 2030, they will contain at least 30% recycled plastic, calculated as an average for all PET bottles placed on the market in the territory of the Member State concerned [13].

2. Materials and Methods

After the introduction of stricter legislative requirements through Directive (EU) 2018/852 amending Directive 94/62/EC on packaging and packaging waste (Packaging Waste Directive) the recycling and reuse of packaging waste has become a priority at EU level. For these reasons, consideration was given to implementing several forms of recovering packaging waste, consequently diminishing the final disposal of this type of waste, as well as permanent monitoring of recycled quantities.

The information used in this article is based on the datasets posted on the website https://ec.europa.eu/eurostat/databrowser/view/env_waspacr/default/table?lang=en regarding packaging waste statistics, for the period 2013 – 2022 [14].

At the national level, the information processed in this article is sourced from information collected annually by the National Institute of Statistics, the data being reported by economic operators according to the reporting obligations established by Ministerial Order 794/2012. The indicator regarding the packaging waste recycling rate by material types in total packaging waste generated (http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table) refers to the packaging waste recycling rate by material types, representing the ratio between the amount of packaging waste recycled (by material type) and the amount of packaging waste generated, expressed as a percentage. The period taken into account is 15 years, from 2008 to 2022 [15].

3. Results

In order to reduce the amount of waste deposited in landfills and to reuse significant quantities of materials of different types, but especially with the aim of reducing pollution and environmental impact, it is constantly being considered all types of packaging materials, regardless of the type of the base material from which it is made, and to the processes of recycling all types of packaging at the end of its life cycle (packaging waste), regardless of the area of origin where it was generated (in industry, trade, institutions, the service sector, housing or any other sources). EU Member States use a range of economic instruments to provide incentives for waste recycling, including incentives through extended producer responsibility schemes and requirements for producers or responsible producer organizations to adopt waste prevention plans.

Despite all these investments, however, in some countries the recycling rate of packaging waste is quite low. During the period 2013- 2022, the recycling rates of packaging waste in the EU, on average, was 62.69 %. Among the Member States, Slovenia (66.66%), Belgium (81.65%) and the Netherlands (75.19%) the recycling rates of packaging waste. In contrast, less the recycling rates of packaging waste in Malta (37.05%), Hungary (48.42%) and Romania (50.28%).

For the analyzed period, the EU 27 countries average for the percentage of recycling rates of packaging waste varied quite a bit, starting from 65.4% in 2013, with some insignificant increases up to 67.6 in 2017, and then remained relatively within the same parameters, the percentage in 2022 being 65.74%.

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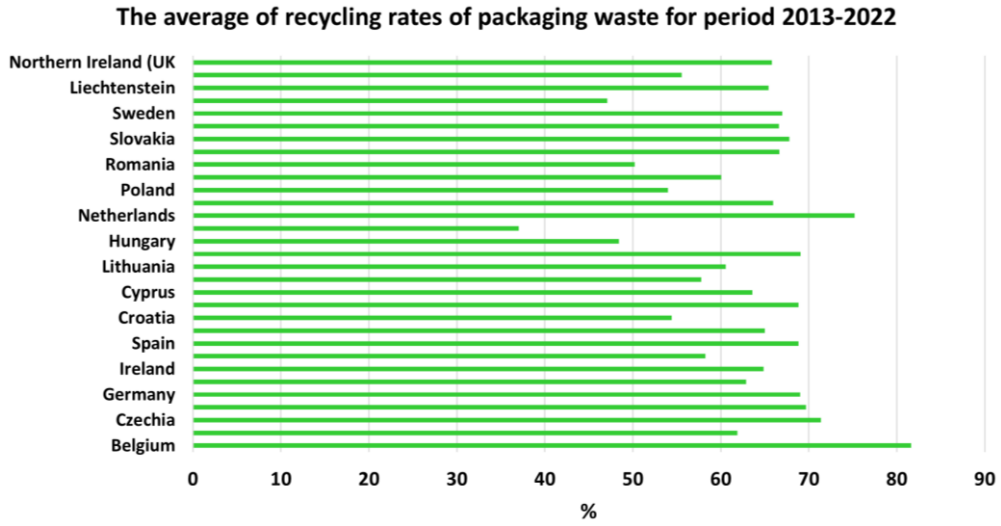

Fig. 1. *The average of recycling rates of packaging waste for period 2013-2022*

In the case of Romania, the average for the percentage of recycling rates of packaging waste was 52.8% in 2013, with an increase up to 60.4% in 2016-2017 and then followed by a gradual decrease up to 38.1% in 2022.

This decrease in the recycling rate is an extremely important aspect that must find a number of ways to improve the current situation, primarily by educating and raising awareness among the population about the impact of recycling and investing funds in improving the collection infrastructure.

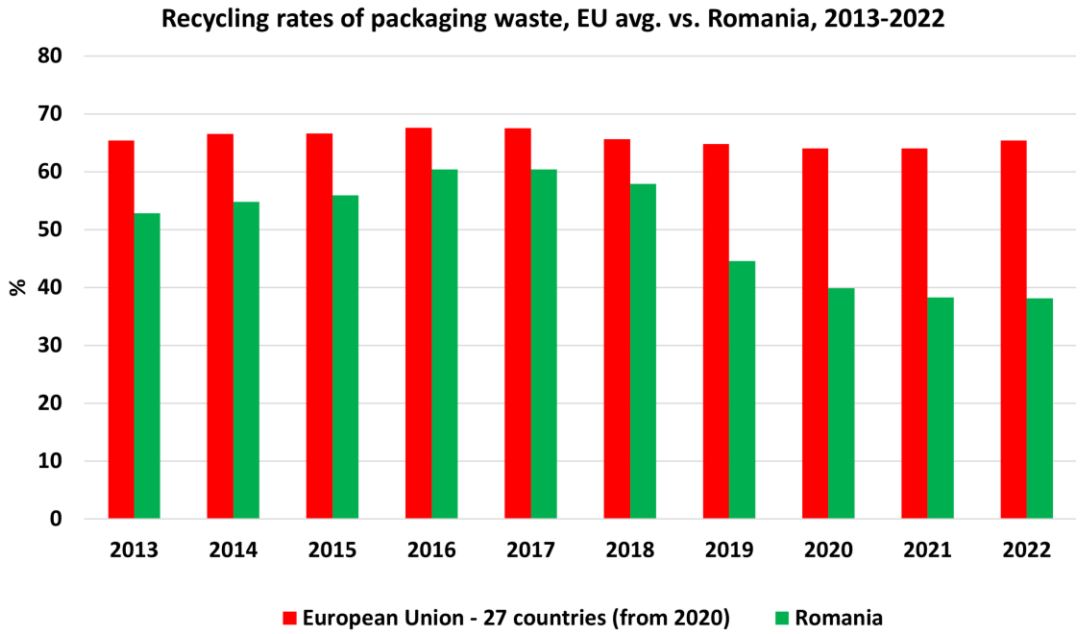

Fig. 2. *Recycling rates of packaging waste, EU avg. vs. Romania, 2013-2022*

As an EU member state, Romania has committed to recycling a certain percentage of packaging waste generated by the population, companies and institutions. The target set for 2025 was that 65% of total waste would be recycled (plastics 50%; wood 25%; ferrous metals 70%, aluminium 50%, glass 70%, paper and cardboard 75%) and 70% by 2030 (plastics 55%; wood 30%; ferrous metals 80%, aluminium 60%, glass 75%, paper and cardboard 85%).

Since 2005, a series of requirements have been legislated in Romania regarding the management of

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packaging and packaging waste, and since 2008, the National Institute of Statistics has been collecting data on recycled quantities annually. Economic operators, producers and importers of retail packaging and local public administration authorities are the main ones responsible for reporting the data.

During the period 200-2022, the highest recycling percentage 74.35% is represented by paper, cardboard. In 2008, the recycling rate for paper and cardboard was 61.63% and experienced an upward trend until 2016 when it reached 92.5%, followed by a gradual decrease to 64.13% in 2022.

The average for the 15 years analysed for metal packaging waste was 56.02%, with a series of variations from 50.99% in 2008 reaching the maximum value of 64.18% in 2014 and then decreasing to 42.16% in 2022.

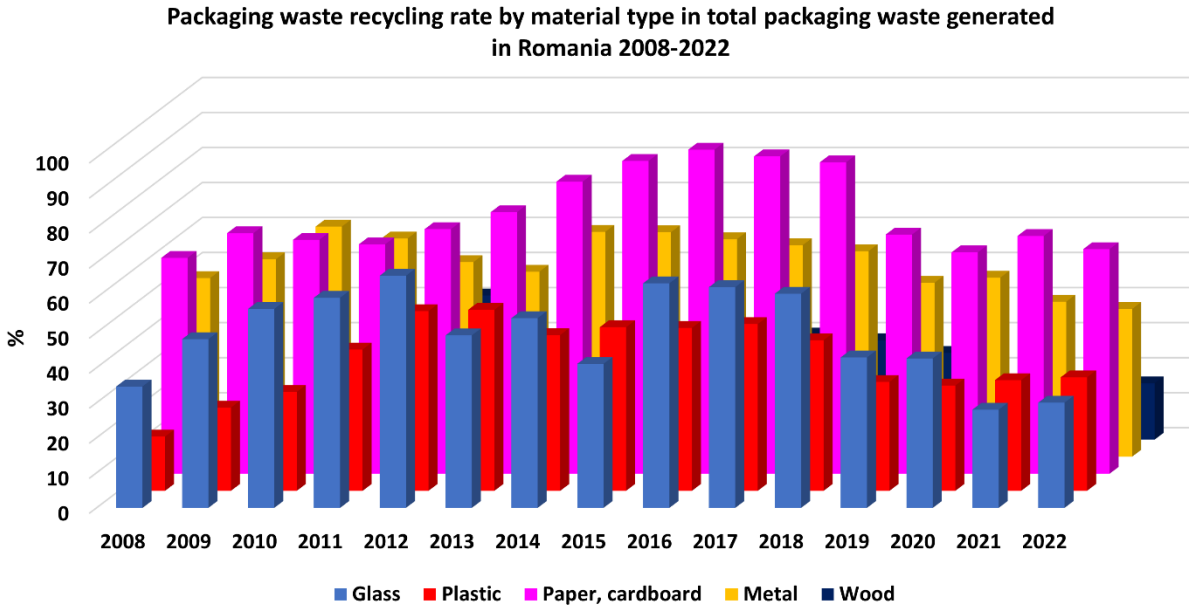

Fig. 3. *Packaging waste recycling rate by material type in total packaging waste generated in Romania 2008-2022*

Glass packaging waste had an average of 49.48%, with a series of variations from 34.66% in 2008 and a maximum value of 66.26% in 2012, a decrease and a return to 64.1% in 2016 and then the decreasing trend continued until 30.02% in 2022.

Plastic packaging waste had an average recycling rate of 37.61%, following the same trend as other types of waste, i.e. an upward trend from 2008 from 15.48% to 51.65% in 2013 and then a decrease in this recycling rate to 32.41% in 2022.

The lowest recycling rate is for wooden packaging at 23.77%. In 2008, the recycling rate was 8.26% and reached its peak in 2012 at 41.15%. After a steady decline, the rate reached 15.68% in 2022.

4. Conclusions

Turning waste into resources is a key element of the circular economy. Proper implementation of EU waste legislation requires the application of the waste hierarchy, which prioritizes preparing for re-use and recycling and considers landfilling as the least preferable waste treatment option.

Plastic waste is the subject of EU measures and general waste management targets. To achieve an ambitious and sustainable reduction in global packaging waste generation, targets for the reduction of packaging waste per capita must be set, to be achieved by 2030.

A good waste management is essential to prevent the negative impacts of waste generation on the environment and health and to achieve the objectives of the zero-pollution action plan on waste and marine litter. The increased use of packaging, combined with low reuse and recycling rates, hinders the development of a low-CO_2 circular economy.

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