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WASTE IN THE CIRCULAR ECONOMY: ROMANIA IN THE EU CONTEXT

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Abstract:
Currently, the issue of waste is a priority both at the level of the European Union and at the level of many countries of the world. It is even more important as a special emphasis is placed on changing the current economic model with a sustainable one, that of the circular economy. In this context, in this paper we addressed the issue of waste in Romania in close connection with the European Union. The paper includes an overview of the waste situation in Romania, while seeking to determine a synthetic waste indicator, named the aggregate waste indicator (AWI). Based on this, a ranking of the member states of the European Union was made, thus identifying the place occupied by Romania in the field of waste. The calculation of the AWI was done by going through four stages: selecting the necessary indicators and establishing the time period, normalizing the statistical data, aggregating the indicators and calculating the AWI. The ranking for the 4 selected years did not include all the state members. The lack of statistical data for certain states led us to exclude them from the calculations. If in the first three years Romania was in the second part of the ranking, in the last year it managed to position itself on the 12th place. The situation is explained by the low recycling rates of waste in Romania. However, Romania recorded good values compared to the European average in terms of waste generated. The ranking highlighted the fact that the first position went to Austria (in the first three years), respectively to Lithuania. Estonia has consistently been in last place. It should also be noted that some states have either risen in the rankings or fallen.

Key words: waste, circular economy, aggregate waste indicator, waste situation, Romania, European Union

JEL classification: F64, O44, Q01, Q56

1. INTRODUCTION

According to Statista data, worldwide, in 2018 the waste situation was as follows: the largest amounts of solid municipal waste were generated by: China (15.55%), India (11.95%), USA (11.65%), Brazil (3.85%), Indonesia (3.3%). The countries where the ratio between the share of municipal waste generated and the share of the world's population was super unitary were: USA, Brazil, Russia, Mexico, Japan, France, Great Britain, Italy, South Korea, Argentina, Canada, Saudi Arabia and Australia. Of the countries listed above, only the US draws attention by the extremely high value of this ratio, namely 2.65 (11.65 / 4.4). In fact, the USA registered for the same year (2018) a value of 2.58 kg of solid municipal waste generated daily per habitant. At the opposite pole was India, with only 0.43 kg per habitant. By types of waste, 44% of the total municipal solid waste generated worldwide was food and green waste, followed by waste from: paper and cardboard (17%), plastic (12%), glass (5%), metal (4%), rubber and leather (2%), wood (2%), others (14%). The regional distribution of this waste was as follows: East and Pacific Asia (23%), Europe and Central Asia (20%), South Asia (17%), North America (14%), Latin America and the Caribbean (11%), Sub-Saharan Africa (9%) and the Middle East and North Africa (6%).

The volume of waste generated worldwide is constantly increasing in recent years, causing serious disturbances of the ecological balance. That is why many countries, including the EU, are now making increasing efforts to move from a linear to a circular economy. The latter is a new economic model of production and consumption based on the sharing, reuse, repair, renovation and recycling of existing materials and products as much as possible so that the life cycle of the latter is as long as possible. In this context, waste plays an extremely important role, aiming to reduce and

recycle it, allowing it to be kept longer in the economic circuit of the materials from which the products are made and reducing environmental pressures (www.europarl. europa.eu; Andersen, 2007; Ellen MacArthur Foundation, 2013). The circular economy means, among other things, better waste management (Târţiu et al., 2019), respectively the prevention of waste generation (Czikkely et al. 2018), or zero waste (European Commission, 2014). In a circular economy, waste becomes a resource (Preston, 2012; Park & Chertow, 2014; European Commission, 2014). By transforming them into resources, the loop closes in the circular economy (Geng & Doberstein, 2008; Preston, 2012; Geissdoerfer et al., 2017), the latter thus becoming a moral economy (Gregson et al., 2015).

One of the objectives of the circular economy is to decouple economic growth from the use of natural resources, which means reducing the consumption of primary sources in production by reusing products and increasing the quantities of reused and recycled materials. At the same time, the circular economy implies the optimization of resource consumption in order to prevent and reduce waste, respectively to promote reuse (Târţiu et al., 2019).

In December 2015, the European Commission adopted a series of measures aimed at stimulating the EU's transition to a circular economy. The measures included proposals to revise waste legislation and a related action plan. These proposals set as objectives the following: reusing and recycling of 60% of municipal waste by 2025 and 65% by 2030; reusing and recycling of 65% of packaging waste by 2025 and 75% by 2030; storage of a maximum of 10% of municipal waste by 2030; prohibition of the storage of separately collected waste; promoting economic instruments to discourage storage. The targets and objectives set ensure the improvement of waste management, while stimulating innovation in recycling and reuse, limiting waste storage and reducing resource losses (European Commission, 2014).

In this paper we focused on presenting the situation of waste in Romania in a European context. The paper was structured as follows: the first part presents the general situation of Romania in the field of waste, a situation approached from a European perspective; the second part refers to Romania's positioning within the EU through a synthetic waste indicator established on the basis of specific indicators published by EUROSTAT; the last part contains the main conclusions of the paper.

2. THE GENERAL SITUATION OF WASTE IN ROMANIA IN THE EU CONTEXT

Compared to the European situation, Romania is relatively good in terms of waste generated per habitant. Romania is well below the EU28 average from this point of view (figure no. 1). Although in the period 1995-2018, the total mass of waste generated fluctuated, starting with 2010 the waste generated per habitant was lower compared to 1995.

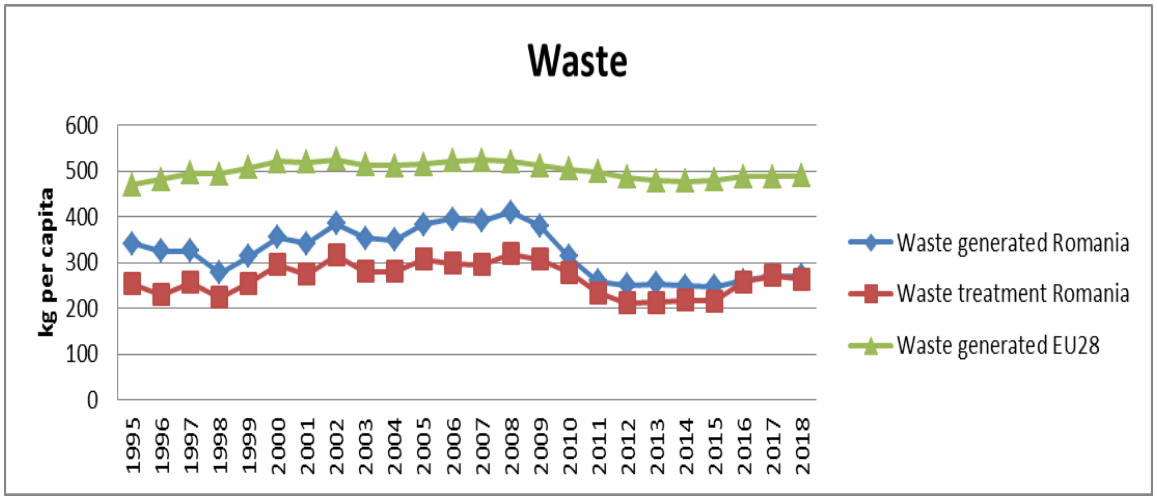

Figure no. 1. Quantity of waste generated / inhabitant: Romania and EU28

Source: made by the author based on EUROSTAT data

If we refer to the total mass of waste generated by Romania, then in 2004, according to Eurostat data, it was over 369 million tons (see table no. 1). Even if over time, this total has experienced a fluctuating evolution, compared to 2004, Romania generated in 2016 with over 191 million tons less waste. Of the total waste generated, most were and are non-hazardous waste, that is over 99%.

Tabel no. 1. Waste generated, Romania – tonnes

Year	Total	Hazardous	Non-hazardous	Change from the year 2004 – total	Change from the year 2004 – hazardous	Change from the year 2004 – nonhazardous
2004	369.300.408	2.293.510	367.006.898	-	-	-
2006	344.356.921	1.054.266	343.302.655	-24.943.487	-1.239.244	-23.704.243
2008	189.138.507	530.753	188.607.754	-180.161.901	-1.762.757	-178.399.144
2010	201.432.951	695.689	200.737.262	-167.867.457	-1.597.821	-166.269.636
2012	249.354.926	689.251	248.665.675	-119.945.482	-1.604.259	-118.341.223
2014	176.607.415	590.299	176.017.116	-192.692.993	-1.703.211	-190.989.782
2016	177.562.905	624.979	176.937.926	-191.737.503	-1.668.531	-190.068.972

Source: Eurostat data, own calculations

Most of the total waste generated came from the extractive industry (figure no. 2). As in the case of total waste, and in their case, the fluctuating evolution of waste generated by the three industries is noticeable: extractive, processing and energy. However, it should be noted that in 2016, the amount of waste generated was lower compared to 2003.

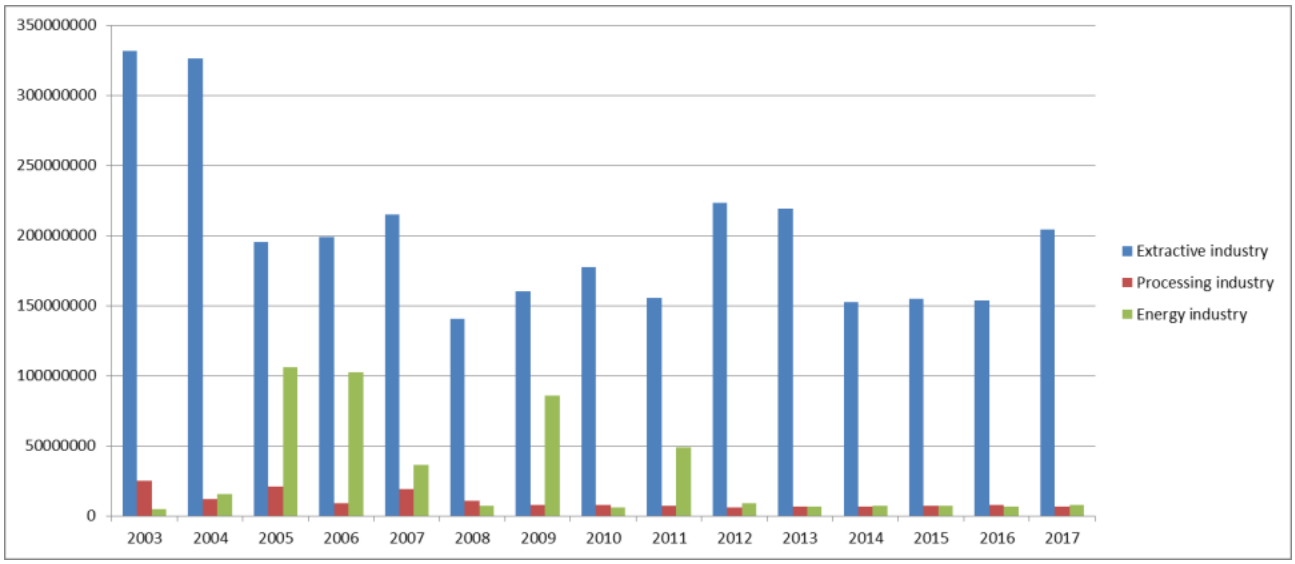

Figure no. 2. Waste generated: extractive industry, processing, energy – Romania (tonnes)

Source: made by the author based on INSSE data

Regarding the municipal waste generated by Romania, according to EUROSTAT and INSSE data, they also fluctuated during the period 2000-2017. However, the general trend was decreasing, the volume of municipal waste generated in 2017 being lower compared to previous years. The highest level was reached in 2008 (over 8,439 thousand tons), and the lowest in 2015, over 4,903 thousand tons.

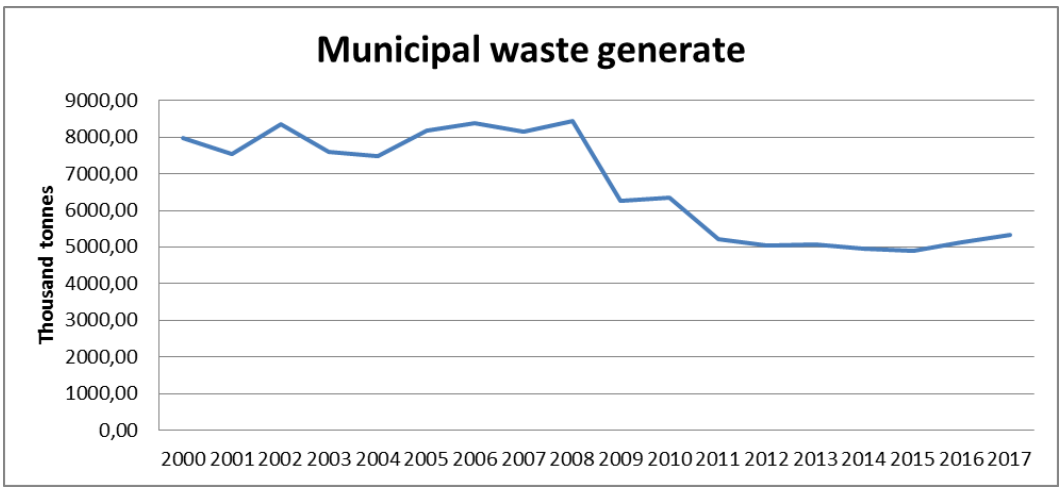

Figure no. 3. Municipal waste generated in Romania
Source: made by the author based on Eurostat and INSSE data

If we look at the perspective of the 8 regions of Romania, in 2008, the largest amounts of municipal waste generated came from the South-East region and the Bucharest-Ilfov region. The lowest volume of municipal waste generated was generally recorded in the South-West region. Overall, according to figure no. 4, there is a positive evolution of the mass of waste generated at regional level (decreased significantly in 2010, 2011 and 2012).

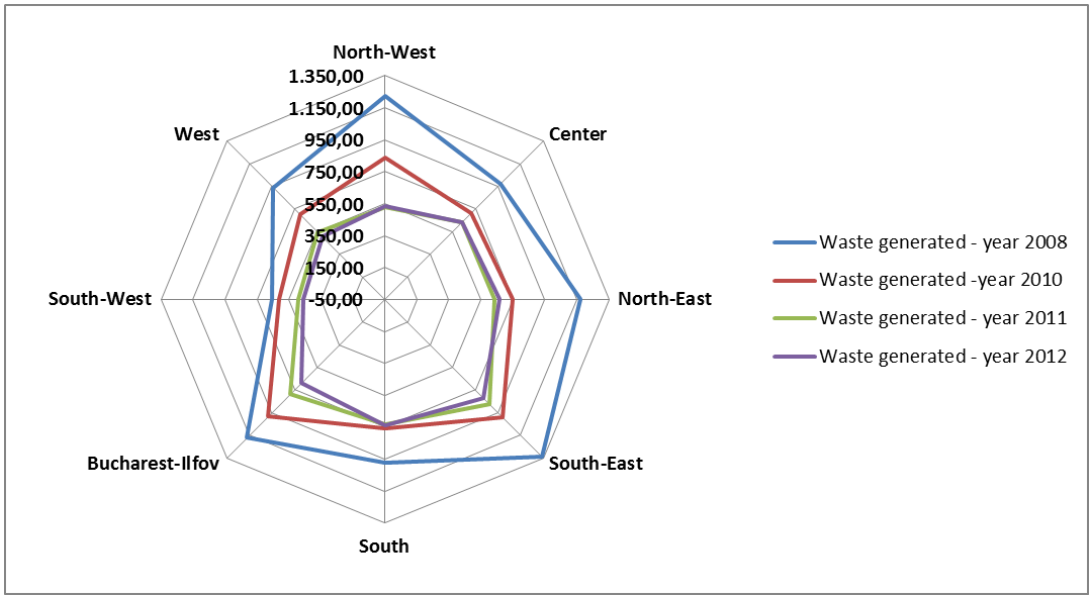

Figure no. 4. Municipal waste generated - regions Romania (thousand tonnes)
Source: made by the author based on Eurostat data

In terms of waste generated without major mineral waste compared to domestic consumption of materials, Romania is doing very well. The statistical data published by Eurostat for the four years taken into account in the calculation of the synthetic waste indicator (2010, 2012, 2014, 2016), were either very close to the minimum or even minimal. The same can be mentioned in the case of waste generated relative to a unit of gross domestic product. Romania registered relatively low values compared to other EU countries.

If the situation of waste generated in Romania compared to other EU member states was good, in the case of recycled waste the situation is reversed. Waste recycling rates were low or very low.

There were also significant differences between Romania and the EU average in terms of waste management (Figure no. 5). Thus, in 2018, at EU28 level, waste was treated by: recycling (30.6%), energy recovery (28.1%), storage (23.1%), composting (17.3%) and incineration (0.8%). In Romania, however, the main way of disposing of waste remained storage (75.8%). Only 8% of the waste generated was recycled, 5.5% was recovered and 3.4% was composted. It should also be mentioned that in the period 1996-2000, in Romania the generated waste was eliminated exclusively by storage (100%). It was not until 2001 that the waste generated began to be recycled, but its share was extremely low (2.2%). Although in the following years the recycling rate increased a little bit, still, the percentage reached by Romania in 2018 was well below the EU28 average. Also, the disposal of waste by composting registered a decreasing trend in Romania between 2010-2018. Thus, if in 2010, the composting rate was 11.5%, starting with 2013, it decreased continuously to 3.4% in 2018. However, there was an increase in the share of waste disposal through energy recovery. (from 0.4% in 2010 to 4.5% in 2018).

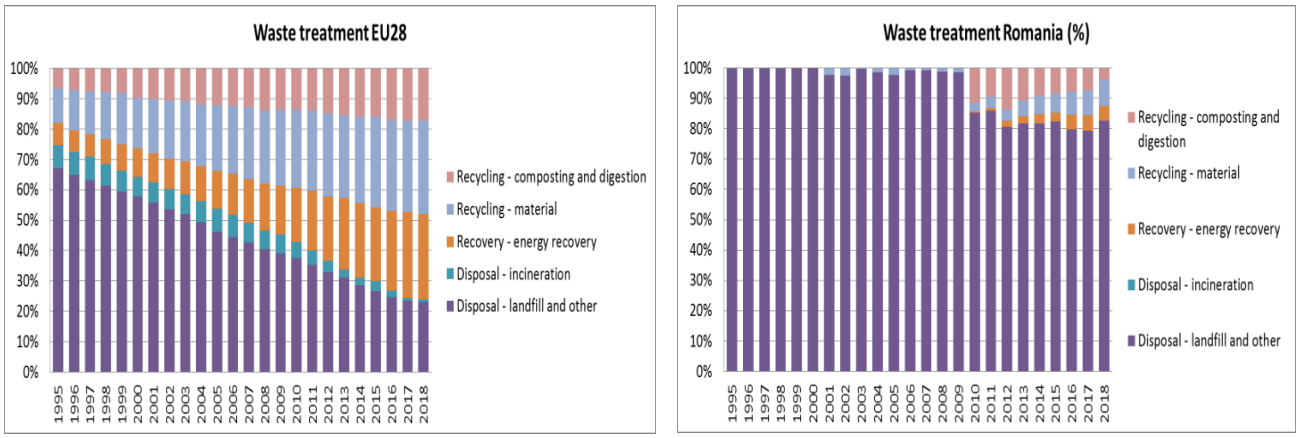

Figure no. 5. Waste treatment: EU28, Romania

Source: made by the author based on Eurostat data

According to the National Waste Management Strategy 2014-2020, the low recovery rate of waste until 2010 was explained by: lack of separate collection and sorting infrastructure in many areas of the country and lack / low level of recycling capacity for certain types of materials; lack of financial instruments to stimulate / oblige the sanitation operators in order to deliver the collected waste to the treatment or recovery facilities.

3. ROMANIA'S POSITION IN THE EU FROM THE PERSPECTIVE OF WASTE

In order to know Romania's position within the EU from the perspective of waste, we used the calculation of an aggregate waste indicator (AWI) using the indicators published in this field by EUROSTAT. The establishment of this indicator involved the following: the establishment of the necessary indicators and the period subject to analysis; normalization of indicators; aggregation of indicators; determination of AWI.

The selected indicators are presented in table no. 2, being taken from the Eurostat website and grouped into two categories: generated waste and recycled waste. The analyzed period was much restricted due to the existence of many situations of lack of data. As such, only four years were chosen (2010, 2012, 2014 and 2016), at which the most statistics were found for all indicators taken in the calculation of the aggregate indicator.

Data normalization was performed based on the minimum-maximum method (Nardo et al., 2005; OECD, 2008; Azevedo, SG et al., 2017), using the following formulas: relation (1) for indicators with favorable influence on the circular economy (optimized by maximization) and the relation (2) for those with unfavorable influence (optimized by minimization).

$$I_{i,j}^{t} = \frac{I_{i,j}^{t} - minI_{i,j}^{t}}{maxI_{i,j}^{t} - minI_{i,j}^{t}} \quad (1), \qquad I_{i,j}^{t} = \frac{maxI_{i,j}^{t} - I_{i,j}^{t}}{maxI_{i,j}^{t} - minI_{i,j}^{t}} \quad (2)$$

where: $I_{i,j}^{t}$ = the value of the indicator "i" of the country "j" at the moment "t"

$minI_{i,j}^{t}$ = the lowest value of the 'i' indicator after country 'j' at time 't'

$maxI_{i,j}^{t}$ = highest value of the 'i' indicator after country 'j' at time 't'

The values of the normalized indicators were between 0 (the least favorable case) and 1 (the most favorable case).

For all cases of unavailable data, we chose the option of eliminating the countries concerned. The aggregation of data was performed on account of the arithmetic average calculated according to table no. 2. For each category of indicators were established aggregate indicators calculated in turn based on partial aggregate indicators.

Table no. 2. Waste indicators and AWI calculation mode

Aggregate indicator	Aggregate indicators based on categories	Partial aggregate indicators	Indicator Name / Influnces over EC (±)	Indicator category
Aggregate Waste Indicator (AWI) **AWI = (AIC1+AIC2)/2**	**AIC1 = (1.1+1.2+1.3)/3**	-	1.1 municipal waste generated per person / (-)	1. waste generated (C1)
			1.2 wastes generated exclusively from major mineral waste per unit of gross domestic product / (-)	
			1.3 wastes generated exclusively from major mineral wastes for domestic consumption / (-)	
	AIC2 = (Ai1+Ai2)/2	Ai1 = (2.1+ 2.2)/2	2.1 municipal waste recycling rate / (+)	2. recycled waste (C2)
			2.2 total waste recycling rate without major mineral waste / (+)	
		Ai2 = (2.3+ 2.4+ 2.5+2.6)/4	2.3 packaging recycling rate - total / (+)	
			2.4 demolition and construction waste recycling rate / (+)	
			2.5 WEEE recycling rate (waste electrical and electronic equipment) / (+)	
			2.6 biomass recycling / (+)	

Source: made by the author

According to the calculations performed, the situation of the evolution by country of AWI was the one in figure no. 6.

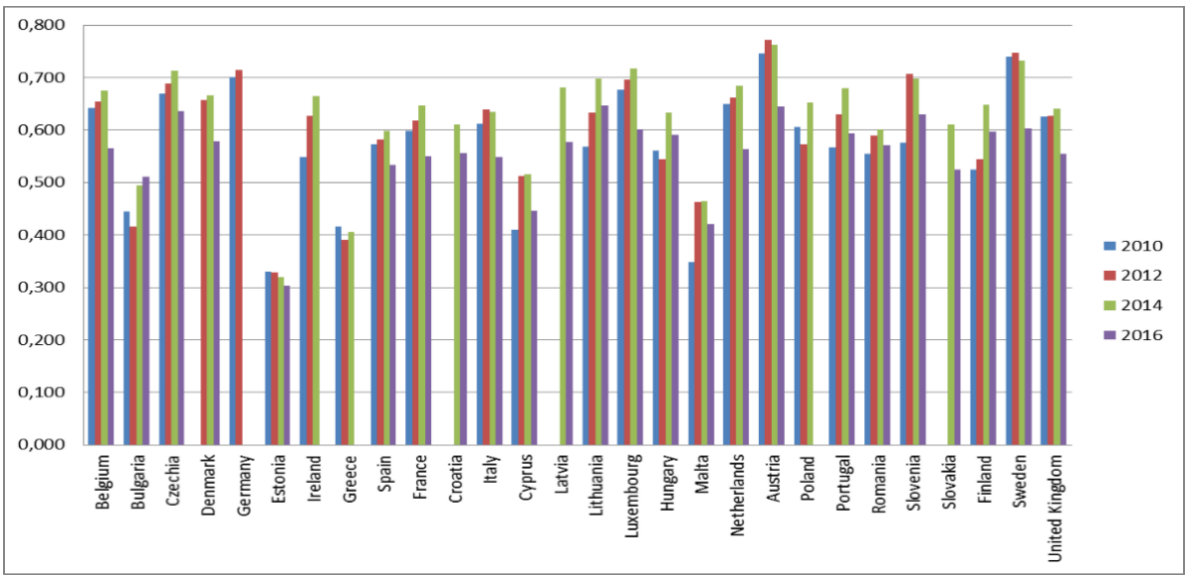

Figure no. 6. AWI - EU28: 2010, 2012, 2014, 2016

Source: own calculations based on Eurostat data

The lack of data in the case of some countries did not allow the establishment of the AWI in certain years, for which reason the related columns are missing in the chart above. The hierarchical situation by country for the four years studied was according to table no. 3:

Table no. 3. Hierarchy of EU countries by AWI

Country	AWI				Position after AWI				Change of position 2016/2010
	2010	2012	2014	2016	2010	2012	2014	2016	
Belgium	0,643	0,654	0,676	0,565	7	9	10	13	-6
Bulgaria	0,444	0,416	0,494	0,511	20	23	24	21	-1
Czechia	0,670	0,689	0,712	0,636	5	6	4	3	+2
Denmark	:	0,656	0,666	0,579	-	8	11	10	-
Germany	0,700	0,715	:	:	3	3	-	-	-
Estonia	0,330	0,328	0,319	0,303	24	25	27	24	0
Ireland	0,549	0,627	0,665	:	18	14	12	-	-
Greece	0,416	0,391	0,405	:	21	24	26	-	-
Spain	0,573	0,582	0,598	0,533	13	17	22	19	-6
France	0,599	0,617	0,646	0,550	11	15	15	17	-6
Croatia	:	:	0,610	0,556	-	-	19	15	-
Italy	0,611	0,638	0,635	0,548	9	10	17	18	-9
Cyprus	0,410	0,512	0,515	0,446	22	21	23	22	0
Latvia	:	:	0,681	0,578	-	-	8	11	-
Lithuania	0,569	0,632	0,698	0,646	14	11	6	1	+13
Luxembourg	0,677	0,696	0,717	0,602	4	5	3	6	-2
Hungary	0,560	0,544	0,632	0,591	16	19	18	9	+7
Malta	0,349	0,462	0,464	0,420	23	22	25	23	0
Netherlands	0,650	0,662	0,685	0,564	6	7	7	14	-8
Austria	0,745	0,771	0,762	0,645	1	1	1	2	-1
Poland	0,605	0,573	0,652	:	10	18	13	-	-
Portugal	0,566	0,630	0,679	0,594	15	12	9	8	+7
Romania	0,554	0,589	0,602	0,571	17	16	21	12	+5
Slovenia	0,576	0,706	0,698	0,629	12	4	5	4	+8
Slovakia	:	:	0,610	0,525	-	-	20	20	-
Finland	0,524	0,543	0,648	0,597	19	20	14	7	+12
Sweden	0,741	0,747	0,732	0,602	2	2	2	5	-3
United Kingdom	0,626	0,627	0,641	0,554	8	13	16	16	-8
Total	-	-	-	-	**24**	**25**	**27**	**24**	-

Source: own calculations based on EUROSTAT data

Note: the sign (+) represents the rise in the ranking and the sign (-) represents the falls; : = data not available

According to the obtained data, even if the AWI increased in 2010 (AWI = 0.554), 2012 (AWI = 0.589) and 2014 (AWI = 0.602), Romania was only in the second half of the ranking. In 2016, it managed to find itself in the first half (12th place) taken into consideration that the value of AWI was lower (0.571), thus climbing 5 positions compared to 2010, respectively 9 positions compared to 2014. For this last year, however, it should be noted that there has been a decrease in AWI for all states, with the exception of Bulgaria for which AWI has been higher compared to the rest of the years (see also figure 6).

As can be seen from the table no. 3, Austria manages to stay in the top of the hierarchy in the first three years with AWI values of over 0.7, ranking second in 2016 with an AWI below 0.7, being ahead of Lithuania with approx. 0.001. Austria was seconded by Sweden in 2010, 2012 and 2014. Third place goes to Germany, Luxembourg and the Czech Republic. It is also worth noting that the last place belongs to Estonia throughout the period. Over the four years, with the exception of three countries (Germany, Slovakia - not present in the rankings for all four years - and Estonia), all countries have experienced changes of position. Compared to the initial year, some have either climbed, fallen or parked. Of these, Lithuania draws attention, which climbed 13 positions in 2016 compared to 2010, thus reaching the first place. Finland had the same favorable route (it climbed in the ranking from 19th place to 7th place) and Slovenia (from 12th place it climbed to 3rd place). The biggest falls in the ranking in 2016 compared to 2010 were known by countries such as: Italy, the Netherlands, Great Britain, France, Belgium and Spain. The stationary states in 2016 compared to 2010 were Estonia, Cyprus and Malta.

4. CONCLUSION

In the context of the circular economy, waste is an important source for economic activity, with an increasing emphasis on their recovery/recycling. Their recycling can lead to a reduction in the consumption of natural resources and to the maintenance of the ecological balance. That is why special attention is currently being paid to waste management, with an emphasis on increasing recycling rates.

The situation of waste in the EU is different from one country to another, which is why we calculated a synthetic indicator of waste that allowed us to make a ranking of member countries and track their evolution. From this point of view, Romania, although it is good in terms of waste generated, still due to their low recycling rates, failed to place in the first three years studied (2010, 2012, 2014) among the top 14 states. Only in 2016 Romania managed to do this.

Austria is the country that remained for three years (2010, 2012, 2014) on the first position, being overtaken, however, in 2016 by Lithuania. Estonia, however, kept its last position in the ranking throughout the period studied. There were states that either climbed the rankings or, although they initially had good positions, fell. Other states, however, maintained their position in 2016 compared to 2010.

It should also be noted that unfortunately, the lack of statistical data for some countries has not allowed us to track their evolution in the rankings. This was the case in Germany, Denmark, Ireland, Greece, Croatia, Latvia, Poland and Slovakia.

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