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WASTE MANAGEMENT. THE TRIGGER OF CIRCULAR ECONOMY[*]

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Abstract

The circular economy has increasingly attracted the attention of regulators as a result of the emergence of the challenges associated with climate change and the need to increase the lifetime of goods in order to reduce waste and high consumption of resources. Therefore, the paper aims to identify the current state of the circular economy in Romania by analyzing waste recovery in territorial profile. Also, another objective of the work is to identify the gaps in the territorial profile of the recovery rate of collected waste. To achieve the goals of the research, appropriate statistical methods were used in this study, such as: the Jenks algorithm and the Gini Coefficient. The main results of research suggest there are a lot of gaps in territorial profile from recycling rate perspective and a low concern about circular economy in Romania.

Keywords: circular economy, recycling rate, waste management, territorial gaps, public administration

JEL Classification: Q53, R10, R12

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1. Introduction

At the European level, the European Commission has undertaken concrete activities to support member states and economic agents to achieve the objectives necessary to protect the environment. The circular economy has thus become one of the main topics constantly addressed in the last period at an international level, being intensely debated by researchers in the field, starting with its definition. Some studies consider it an economic paradigm (Friant et al., 2020; Garcia-Bernabeu et al., 2020) or an industrial model (Yuan et al., 2006; Hobson& Lynch, 2016). The European Commission (2015) puts forward a different approach, considering the circular economy as a set of principles and actions, whereby "the value of products, materials and resources is maintained as much as possible and the generation of waste is reduced to a minimum". To this end, its implementation would ultimately lead to ensuring the objectives of sustainable development on three levels: economy, society, and the environment (Mazur-Wierzbicka, 2021). Regarding Romania, the circular economy would primarily help to stimulate competitiveness by protecting companies against price volatility caused by reducing the availability of resources, thus contributing to the creation of new business opportunities through innovative and efficient ways of production or consumption of goods and services. In the social field, the benefits include the creation of new jobs and opportunities for integration and social cohesion. Finally, this new type of economy will reduce energy consumption and help avoid irreversible damage caused by using resources at a rate that exceeds the planet's ability to regenerate them (European Commission, 2015).

Regarding the implementation of the measures regarding the deployment of this new type of economy, the European Union has taken important steps since 2014 (European Commission, 2015), by developing monitoring indicator systems. Member States followed suit and transposed it into their domestic policies or adapted them to their specifics. Examples can be found in the Netherlands (Potting et al., 2016), France (Ministry of Ecological Transition, 2018) or Italy (Ministry of the Environment, Ministry of the Economy, 2018). The four pillars measured by the European Commission include supply of raw materials and stimulation of consumption, management of secondary raw materials, waste management or innovation and competitiveness. In addition, during 2022, European Comission has adopted proposals, initiatives and measures of the Circular Economy Action Plan (Sustainable Products Initiative, EU strategy for sustainable and circular textiles, Proposal for a revised Construction products Regulation, Proposal for empowering consumers in the green transition, Revision of the Industrial Emission Directive, Revision of the European Pollutant Release and Transfer Register, Revision of EU rules on Packaging and Packaging Waste, Communication on a policy framework for biobased, biodegradable and compostable plastic).

The circular economy has increasingly attracted the attention of regulators because of the emergence of the challenges associated with climate change and the need to increase the

lifetime of goods to reduce waste and high consumption of resources. It is not uncommon for the question of defining this concept and framing it in the family of terms that address the sustainable development of economic processes. Since 1979, many researchers have studied the possible solutions offered by the circular economy to environmental problems. Thus, Georgescu-Roegen (1979) established the existence of a link between the physical and biological sciences in the form of bioeconomy and presented its implications in economics. By the statement that everything is a source for another thing, Segerson et al. (1991) coordinated the development of a circular model of the economy and its correlation with the environment through three factors: resource provision, waste management and utility. Therefore, the paper aims to identify the current state of the circular economy in Romania by analysing waste recovery in territorial profile. Also, another objective of the work is to identify the gaps in the territorial profile of the recovery rate of collected waste. To achieve the goals of the research, appropriate statistical methods were used, such as: the Jenks algorithm, the Moran Index, and the Gini Coefficient. In Romania, based on the analysis in the territorial profile, very large discrepancies are reported between the counties and the municipality from the perspective of recycling the collected waste. Hence, there is still a lack of involvement from consumers, both the population, and the local public administration to increase the recycling rate of the collected waste. By achieving all the objectives, the work represents a screening of the current state of the circular economy in Romania, serving as a basis for substantiating the action plans aimed to increase the recycling rate of the collected waste. The novelty of the research is represented by the territorial profile analysis of recycling at municipalities levels.

2. Literature Review

The circular economy has increasingly attracted the attention of regulators because of the emergence of the challenges associated with climate change and the need to increase the lifetime of goods to reduce waste and high consumption of resources. There is a need to defining this concept and framing it in the family of terms that address the sustainable development of economic processes. Since 1979, many researchers have studied the possible solutions offered by the circular economy to environmental problems. Thus, Georgescu-Roegen (1979) established the existence of a link between the physical and biological sciences in the form of bioeconomy and presented its implications in economics. By the statement that everything is a source for another thing, Segerson et al. (1991) coordinated the development of a circular model of the economy and its correlation with the environment through three factors: resource provision, waste management and utility. Subsequently, numerous definitions and works appeared that led to the creation of a complex framework that incorporates all sectors of activity, among which we mention the valorisation of waste and its use in other processes (Preston, 2012), recycling, limitation and reuse of physical materials in the economy (

European Environment Agency, 2014), replacing the concept of "end-of-life" by switching to renewable energy and eliminating toxic chemicals that would prevent waste recycling (Ellen MacArthur Foundation, 2015), as well as the production and consumption of goods in a closed loop that limits waste generation (Sauve et al., 2016). The most recent definition was developed by the European Commission (2022) and refers to a type of economy in which the lifetime of a product, material or resource is maintained at the highest possible level to decrease the production of waste.

Since no consensus has been reached on a generally valid definition and a clear delimitation of the circular economy concept, both the research community and businesses have aligned themselves with the development of "R" models. Dobre-Baron et al. (2022) presents several adaptations of them, depending on the context of use or the complexity of the processes: "4R" (reduce - reuse - recycle - redesign) adopted by the European Union in its policies in the field, "6R" which additionally comes with two other steps (reproduce and recover), or even "9R" and "10R", which also include factors with partial influence on circular economy processes.

The conceptual sphere of circular economy (CE) includes both interconnected fields, placed on the same level of importance, but also sectors and economic processes that come under its influence. In the first case we distinguish three such terms with an importance comparable to that of the circular economy. Specifically, Kardung et al. (2019) investigated the connection between CE, bioeconomy, green economy, and sustainable development. The main link between the bioeconomy and the circular economy is defined by the term circular bioeconomy and involves the transformation of unusable materials into biomass that can still be used in industrial processes (Stegmann et al., 2020; Baranano et al., 2021). Other recent studies have identified other concepts related to the circular economy by exploring digital solutions that can add value to economic activity. Torfgard et al. (2022) mentioned the digitization process that involves the use of new technologies to adapt traditional sectors to environmental requirements. In addition, digitization facilitates knowledge of the value chain through effective monitoring (Berg et al., 2020).

As stated by D'Amato et al. (2017) and reiterated by Birner (2018) and Kardung et al. (2019), the green economy is presented as an umbrella concept, which includes bioeconomy, circular economy, digital transformation in these areas, but also sustainable and knowledge-based development. This demonstrates the need to optimize resource consumption to reduce waste (Tartiu et al., 2019).

An overview of the links between the concepts connected with the circular economy was made by Grădinaru & Matei (2022). Figure 1 highlights all the links presented previously, but also the subsequent developments, due to digitization and sustainable development.

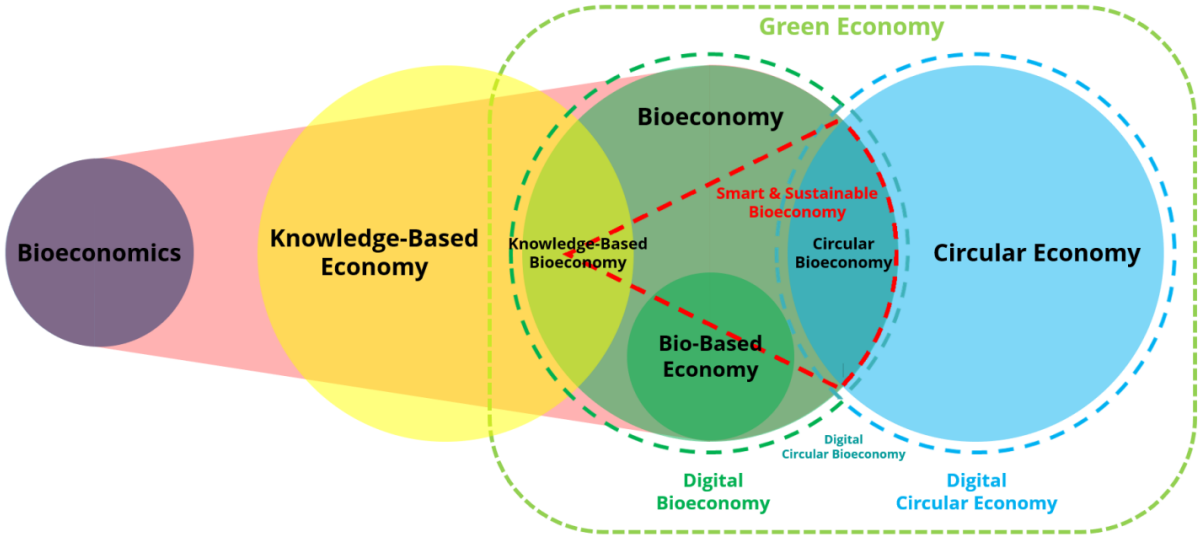


Figure no. 1: Conceptual framework of circular economy

Source: Grădinaru & Matei, 2022

The view based on theoretical studies was practically demonstrated through an analysis of all published articles in each of the mentioned fields. In our case, the circular economy influences and is influenced by the bioeconomy, the green economy, the circular bioeconomy, and the digitized circular bioeconomy.

All these correlations between the different concepts presented previously guide us towards finding some common points, but also differences that can outline the major areas of action of the circular economy. Numerous authors have mentioned capitalism in the sphere of biological resources (Lovins et al., 2008), ecology (Drăgoi et al., 2018) or circular business models (Lewandowski, 2016). Starting from these, Rizos et al. (2017) identified the main processes under CE, each with economic, social, and environmental implications.

At the macroeconomic level, Rizos et al. (2017) highlighted the impact of the circular economy on the three main pillars of sustainability: economic, social, and environmental. Their conclusions showed that the most significant effect on the economy would be a decrease in the unemployment rate, and, especially among unskilled workers. The same studies show greenhouse gas emissions as the main factor determined by the implementation of a circular model. They can be significantly reduced by improving production processes, reducing food waste, avoiding the use of chemical fertilizers, or reusing materials from the textile and wood processing fields.

3. Data & Methodology

In this chapter are described data and methodology used to achieve all objectives of research.

3.1.Data

According to our research objectives, there were identified two variables: „Quantity of collected waste" and „Quantity of recycled waste". Both variables were collected at municipalities level, being measured in kilograms. The provider of data was the National Institute of Statistics from Romania by eDemos platform. The eDemos platform provides statistical data at UAT (locality) level. This database collects information based on a statistical questionnaire, the respondent being the local authority (city hall / local council). Therefore, all data collected from the eDemos waste management database is reported by local authorities based on the reporting of contracted sanitation firms.

Further, based on the data of these two variables, it was computed a new indicator, called „recycling rate" to each municipality (1).

$$\text{Recycling Rate} = \frac{Quantity\ of\ recycled\ waste}{Quantity\ of\ collected\ waste} \quad (1)$$

Moreover, to have a comprehensive screening about waste management gaps in territorial profile, it was used any disaggregation of the „Quantity of collected waste" and „Quantity of recycled waste". In addition, these two variables were fitted to assure the comparability of data by dividing it to municipalities' population. To a better understanding of variables used in research, see the table below.

Table no.1: Short description of variables

Variable	Unit of measure	Formula	Reference period
Quantity of recycled waste	Kilograms per capita	Quantity of recycled waste/Population	2020
Quantity of collected waste	Kilograms per capita	Quantity of collected waste/Population	2020
Recycling Rate	Percentage	Quantity of recycled waste/Quantity of collected waste	2020

Source: authors' computation

3.2.Methodology

To draw a screening of the current state of the circular economy in Romania, methods will be used, such as: the Jenks clustering algorithm, the Moran Spatial Autocorrelation Test/Index, as well as the Gini coefficient.

The Jenks clustering algorithm facilitates the creation of heat-maps at the level of municipalities in Romania. These maps have the role of presenting the current state of the waste management process at the level of cities-municipalities in Romania. Therefore, to have an overview, as real as possible of this phenomenon, the Jenks clustering algorithm is the most suitable. Clustering is done based on so-called "natural breaks". The notion of "natural breaks" refers to the most suitable way of separation, minimizing the variation within a group/cluster, so that the observation units within the clusters are as homogeneous as possible (Ahmad, 2019).

Furthermore, to identify the possible influence in the territorial profile, the spatial autocorrelation is tested by means of the Moran index. The Moran Index uses GIS (Geographic Information Science) technology. It is calculated based on the following formula:

$$I= N/W*\sum\sum w_{ij}(x_i\text{-}x_{mean})(x_j\text{-}x_{mean})/\sum(x_i - x_{mean})^2 \quad (2)$$

Where:

N: the number of territorial units indexed by i or j

w_{ij} : the adjacency matrix

W : the sum of the weights in the adjacency matrix

x : the variable of interest

x_{mean} : the mean of x

A queen adjacency matrix will be used to estimate the Moran's Index, like a queen on a chessboard. Therefore, the mean and variance are calculated for the analysed units. Then, the variance of the neighbours is multiplied by the weight in the adjacency matrix, resulting in a "cross product". For example, when the values associated with neighbouring units are higher or lower than the average, the "cross product" value will be positive. On the other hand, when the value of one unit is above the average and the other is below the average, the "cross-product" value will be negative (Pro, 2022).

However, to be able to state that there is spatial autocorrelation or not, the p-value approach is used. In other words, the existence of spatial autocorrelation will be guaranteed with a statistical probability (Zach, 2021). Therefore, comparing the p-value with the significance threshold will respond to the acceptance of one of the hypotheses below:

H_0 : there is no autocorrelation

H_1: significant autocorrelation

Finally, the Gini coefficient was used to identify disparities at the level of cities and municipalities from the perspective of the circular economy. The Gini coefficient was developed by the Italian statistician Corado Gini in 1912, becoming one of the most used indices for identifying the inequality of distribution in a territorial profile. The coefficient takes values between 0 and 1, 0 meaning perfect equity and 1 perfect inequity (Hayes, 2022). It is calculated based on the Lorentz curve (Figure 1), by the formula A/(A+B), where A represents the area above the Lorentz curve, while B represents the area below the Lorentz curve (Boyce, 2021).

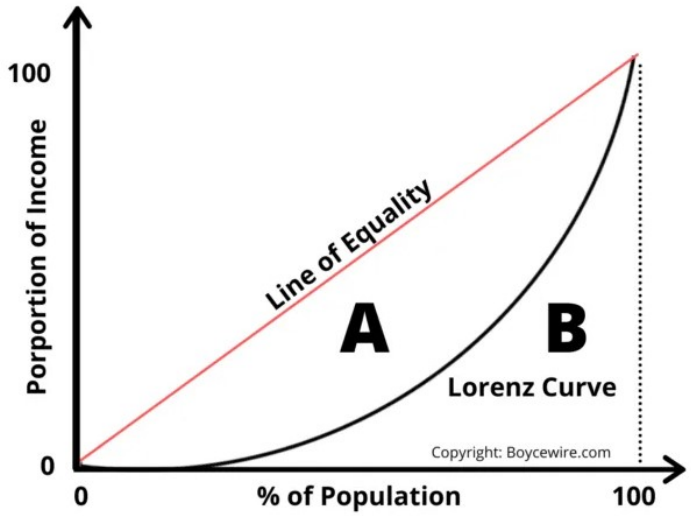


Figure no.2: Lorenz Curve

Source: boycewire.com

The statistical methods used in this study allow the identification of gaps in the territorial profile. Also, based on the results of the spatial analysis, the main cause of the gaps in the territorial profile can be identified.

4. Results and Discussions

The circular economy in Romania, although partially regulated by the previously presented decisions, does not provide a framework for monitoring the progress recorded, but only statistical data reported annually on a series of components. Based on them, we can create an overview of Romania's current state.

4.1 Household waste recycling rate from the population, mixed collection

Household waste from the population, in a mixture, represents the waste collected and recycled from the population, in a mixture, without being separated beforehand.

Table no. 2: The recycling rate of household waste collected in a mixed way from the population, in 2020

Indicator	Value
Min	0%
Q1	0%
Median	0%
Mean	23.31%
Q3	33.22%
Max	100%
Coefficient of variation	1.67

Source: authors' computation

The values of municipalities in Romania regarding the recycling rate of mixed waste collected from the population vary between 0 and 100. Interestingly, 50% of Romanian municipalities do not recycle mixed waste collected from the population, while only 25% of the municipalities recycle at least 33.22% of the collected waste. Even in this context, there are municipalities that reach a maximum point from the perspective of the utilization of waste collected from the population, in the mix, at the level of city-municipalities. On average, in Romania, at city-municipality level, 23.31% of the waste collected from the population is recycled, in a mixture. However, this average is not representative for the whole country, the analysed population being heterogeneous (Table no.2). Therefore, there are considerable differences between cities-municipalities in each county regarding the recycling of waste collected from the population, in the mix.

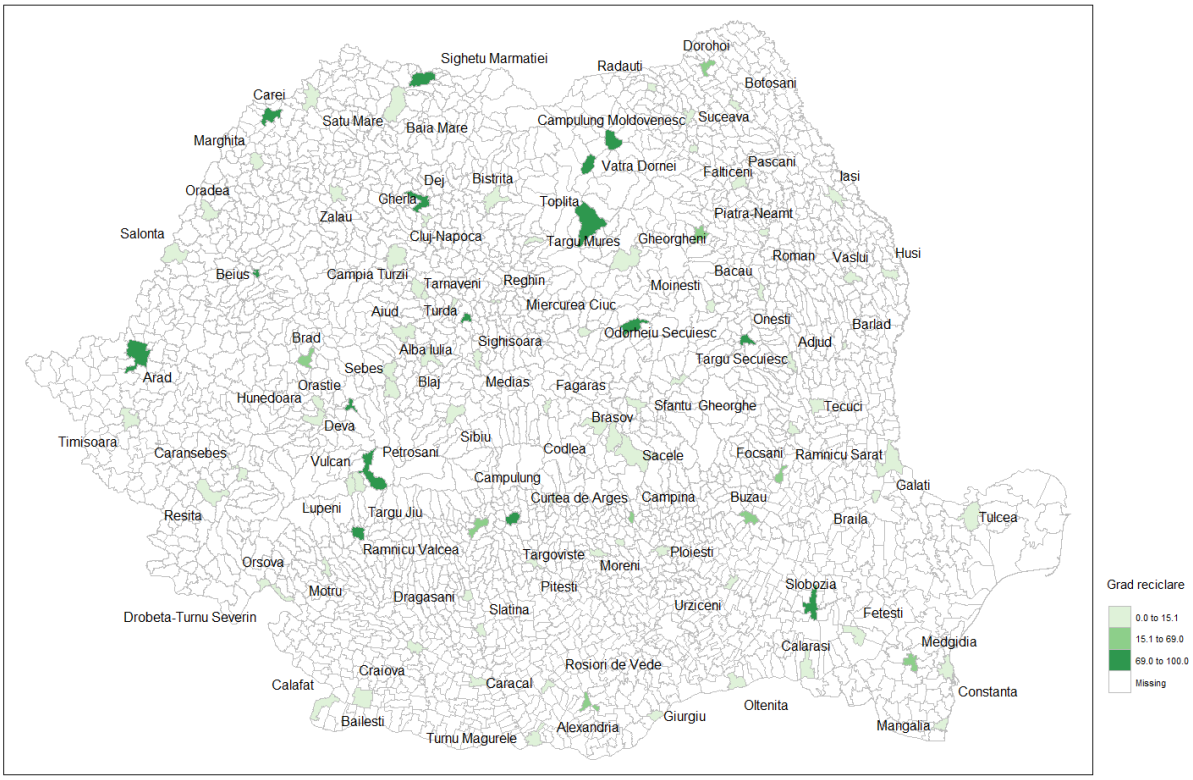


Figure no. 4: The recycling rate of mixed household waste, from the population, in 2020

Source: Made by the authors based on their own processing in R

Most municipalities in Romania register a recycling rate between 0-15.1%. In this interval are located both cities with a relatively low population density, and cities with a strong economic and social activity (Constanța, Timișoara, Cluj-Napoca, Brașov, Iași or Baia Mare). In the range of 15.1%-69% are cities such as Râmnicu Vâlcea, Medgidia, Brad, Dorohoi and Piatra Neamț, while cities such as Arad, Slobozia, Onești, Odorheiu Secuiesc, Târgu Mureș, Vatra Dornei, Câmpulung Moldovenesc, Curtea de Argeș, Petroșani, Târgu Jiu, Orăștie, Carei, Sighetu Marmației, Beiuș make up the third cluster, presenting values between 69% and 100% (Figure no.4).

4.2 Domestic and assimilated waste from economic units, trade, institutions, sanitary units, mixed collection

This part includes the recycling of household and assimilated waste from economic units collected in a mixture, excluding waste from the population.

Table no.3: The recycling rate of household and assimilated waste collected from economic units, trade, institutions, sanitary units, in a mixture, in 2020

Indicator	**Value**
Min	0%
Q1	0%
Median	0%
Mean	19.52%
Q3	7.52%
Max	66.67%
Coefficient of variation	10.19

Source: authors' computation

The value of the coefficient of variation is huge, a sign that the average (19.52%) is not representative of the analysed population, which is heterogeneous. 50% of the counties present the minimum value, not utilizing the waste collected from economic units, public/sanitary institutions, in the mix. Only 25% of the counties present values greater than or equal to 7.52%, the recycling rate of this type of waste is very low (Table no.3). However, there are counties that, at the city-municipality level, manage to ensure a complete recycling of this waste.

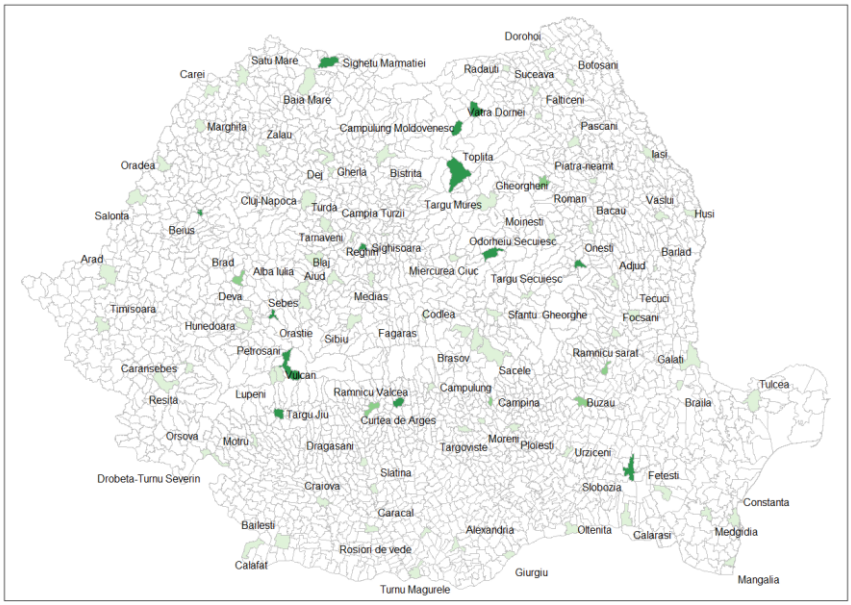


Figure no.5: Recycling rate of household waste from economic operators/public institutions, mixed, in 2020

Source: processing by the authors in R

As expected, most municipalities are in the 0-11% range. Perhaps the most important aspect that deserves to be discussed is the fact that the big cities of Romania are found in this interval. Therefore, the hypothesis of a poor management of household and assimilated waste at the level of these municipalities is developed. The municipalities of Buzău, Râmnicu Sărat, Piatra Neamț present a degree of recycling between 11% and 60.1%. The cities with the highest recycling rates of waste make up the interval number three, between 60.1% and 100%, are: Sighetu Marmației, Vatra Dornei, Câmpulung Moldovenesc, Petroșani, Târgu Jiu, Curtea de Argeș, Miercurea Ciuc, Târgu Mureș, Onești, Beiuș, Orăștie and Slobozia (Figure no.5).

Table no.4: Recycling rate of separately collected household and assimilated waste (except for construction and demolition waste)– Total, in 2020

Indicator	Value
Min	0%
Q1	1.66%
Median	57.4%
Mean	51.65%
Q3	100%
Max	100%
Coefficient of variation	0.86

Source: authors' computation

If, in the case of waste collected in a mixture, the situation at the level of cities-municipalities in Romania is not an extraordinary one, things change for the better when the discussion turns to the recycling of household and assimilable waste collected separately. Only 25% of the municipalities show values below the threshold of 1.66%, while half of the counties

show high values, over 57.4%. It is also a significant share, of 25%, which fully utilizes the separately collected waste (Table no.4). Unfortunately, the counties form a heterogeneous population, a sign that there are still important fluctuations at the level of waste recovery, even from the perspective of separate collection.

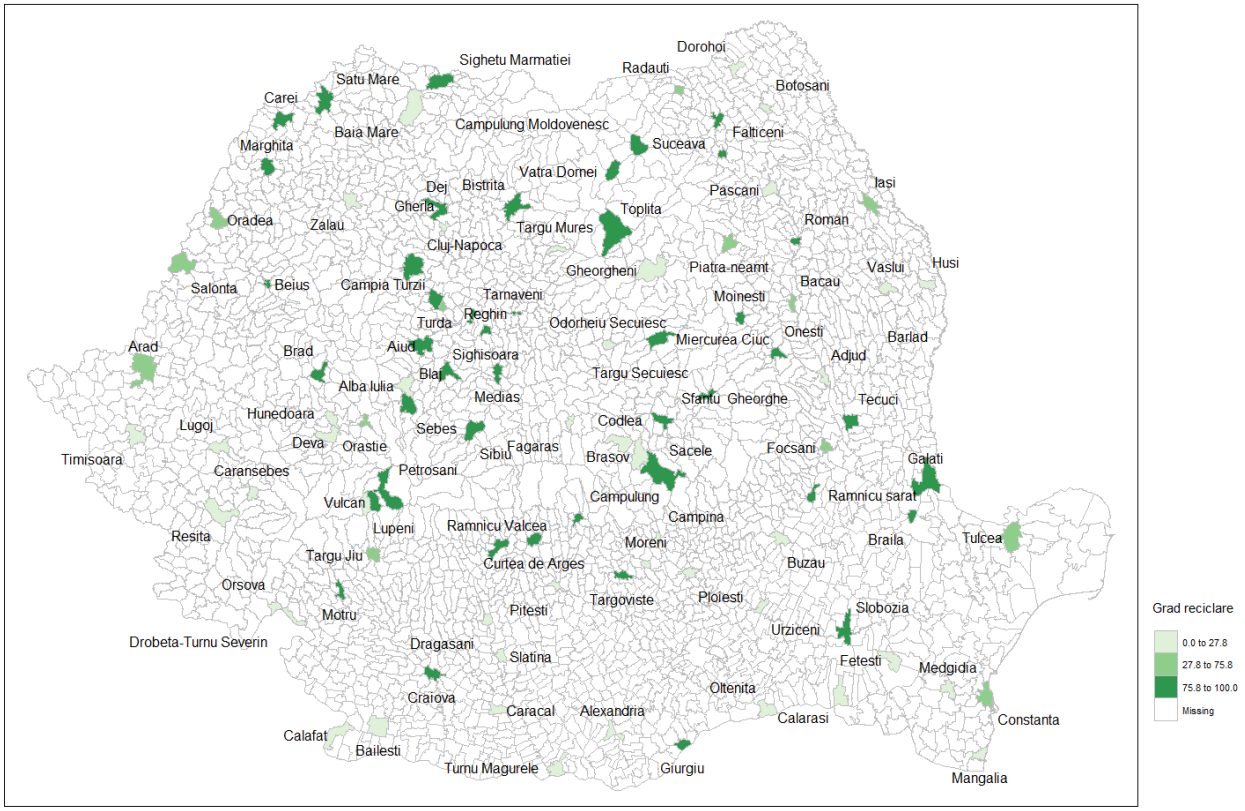


Figure no.6: Recycling rate of household waste collected separately in total in 2020

Source: processing by the authors in R

Even if most municipalities register a recycling rate of at least 27.8% for separately collected household and recyclable waste, there are several municipalities, especially in the south (Turnu Măgurele, Băilești, Calafat, Caracal, Alexandria, Slatina, Ploiești, Călărași, Oltenita) and the east of the country (Fetești, Medgidia, Mangalia) show relatively low values, ranging from 0-27.8%. There are many municipalities with a recycling rate of over 75.8% (Giurgiu, Slobozia, Galați, Brăila, Motru, Craiova, Marghita, Satu Mare, Cluj-Napoca, Râmnicu Vâlcea, Tecuci, etc.), most of them making part of the central development region of the country (Săcele, Mediaș, Sighișoara, Reghin, Târnăveni, Blaj, Alba Iulia, Dej, Târgu-Mureș, Sfântu Gheorghe, Târgu Secuiesc, Miercurea Ciuc, Odorheiu Secuiesc or Sibiu) (Figure no.6).

4.3 Spatial autocorrelation

Spatial autocorrelation determines the association relationship between neighbouring territorial units. This test is used to verify the typology of the relationship between municipalities with the common border from the perspective of recycled waste. This relationship will be identified based on the Moran spatial autocorrelation test. The probability of guaranteeing the results is 95%.

Based on the guaranteed probability, the two hypotheses will be tested:

H_0: there is no autocorrelation

H_1: significant autocorrelation

Table no.5: The p-value for testing spatial autocorrelation across recovered waste types

Indicator	**P-Value**
Household waste from the population, mixed collection	0.38
Domestic and assimilated waste from economic units, trade, institutions, sanitary units, mixed	0.54
Household and assimilable waste collected separately (except construction and demolition waste) – Total	0.51
Household and assimilable waste collected separately (except construction and demolition waste) - Paper, cardboard	0.29
Household and assimilable waste collected separately (except construction and demolition waste) – Glass	0.54
Household and assimilable waste collected separately (except construction and demolition waste) – Plastic	0.20
Household and assimilable waste collected separately (except construction and demolition waste) – Biodegradable	0.32
Household and assimilable waste collected separately (except construction and demolition waste) – Wood	0.22

Source: processing by the authors in R

As for all indicator disaggregations the associated p-value is greater than the α=0.05 significance threshold associated with a 95% probability, there is insufficient evidence to reject the null hypothesis. Therefore, there is no spatial autocorrelation. The lack of spatial autocorrelation is generated by waste management at the level of town halls and local councils. In other words, the waste recycling rate at the city-municipality level is independent, being a strictly local public administration issue. Also, the lack of spatial autocorrelation facilitates the development of public policies at the local level in accordance with the particularities of each city-municipality (Table no.5).

4.4 Disparities regarding waste recycling at the municipal level

As could be seen so far, there are extremely large discrepancies in terms of waste recycling in the city-municipalities. This fact is mainly due to the local administration and economic operators who manage the waste management process within the city municipality. However, these discrepancies do not show the same distribution for each category of waste collected. To have an exhaustive analysis, the Gini coefficients were calculated for a series of new disaggregations of the indicators (Paper and cardboard, plastic, glass, wood, biodegradable waste).

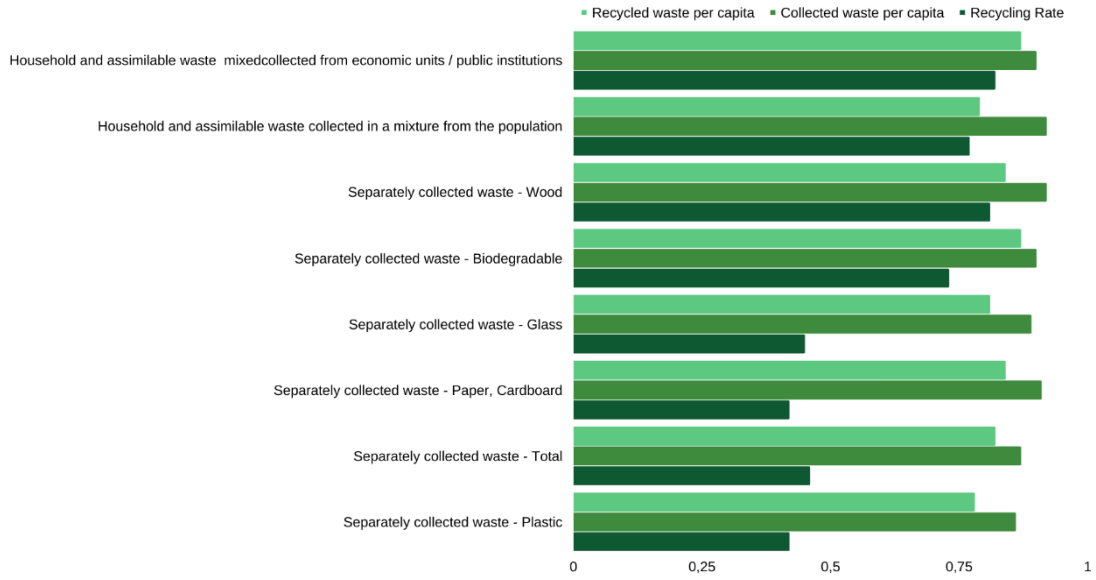


Figure no. 7: The value of the Gini coefficients in Romania, in 2020, by type of waste

Source: Done by the authors in Excel based on R processing

The biggest gaps are registered for the amount of waste recycled per capita and for the amount of waste collected per capita, the gaps being significantly equal, regardless of the waste collection method. When it comes to the waste recycling rate, it can be said that there is a major difference, determined by the way household waste is collected (Figure no. 7). The smallest differences regarding the degree of waste recycling are recorded in the case of separately collected waste, with plastic, paper and cardboard being the most recycled waste. At the opposite pole, mixed waste from public institutions and the population, biodegradable waste and separately collected wood waste led to the increase of disparities between cities-municipalities in Romania. These differences are somewhat explainable, because most recycling centers are focusing on three main pillars of waste: plastic, paper and glass, the

recycling capacity of the other types of waste being relatively low. In addition, the wood must achieve a series of quality characteristics to be able for recycling.

5. Conclusions

Through the analysis in territorial profile, this research presents an element of originality. So far, this is the only study carried out at the level of cities-municipalities in Romania. Starting from the results of this article, based on the studies already in the specialized literature, a series of directions can be identified for the development of the circular economy at the national level.

The current state of the circular economy in Romania is not an encouraging one. The lack of a strategy at the national level has left its mark on the lack of coherence regarding the transition from a conventional model of the economy to a circular model, at least from the perspective of waste management. However, the circular economy has a huge potential to make resource consumption more efficient in the production process. Also, another positive impact that the development and use of related concepts of the circular economy on a large scale can generate is the protection of the environment. Moreover, the main results of research confirm the idea stated by Dobre-Baron et al. (2022) of using 4R concept.

Starting from that, to achieve its maximum potential, the circular economy imperatively requires the reconfiguration of the conventional economic model. Therefore, to benefit from the positive aspects of a circular economy model, a complex strategy at the legislative level is needed, which provides the framework for the development of the key elements of the circular economy. Starting from the current level of the circular economy in Romania, a relatively low one, specific to a chaotic strategic framework, the legislature and the executive in Romania should consider a series of key elements.

First, for Romania to be able to recover the gap compared to the consolidated level of the European Union, a sustained increase in the productivity of concepts related to the circular economy is needed. That is why it is fundamental that the decision-makers in the central public administration focus on supporting the research-development sector and technical and technological progress. To support these two defining sectors in the transition from a conventional economic model to a more sustainable, circular model, public fiscal policies are needed to attract investment, both foreign direct investment and investment with domestic capital. Supporting investments in these two sectors would generate new jobs, as European Comission stated in 2015, for qualified personnel in the research and development process of the circular economy, thus reducing the export of highly qualified labour to Western European states. Later, based on Tofgard et al. (2015) theory, having at its disposal a highly qualified workforce, a budget capable of supporting the complexity of research and development activity and a technical and technological progress, Romania's economy can recover the economic gaps

compared to the average of the European Union, and why not, compared to the most developed western states.

On the other hand, Romania is defined as a country rich in natural resources, especially in non-renewable natural resources, although, paradoxically, Romania does not register the level of economic development proportional to the wealth in resources it has. Therefore, the use of circular economy concepts on a large scale at the level of economic activities in Romania can lead to the efficiency of the production process and the reduction of the irrational consumption of raw materials, idea promoted also by Tartiu et al. (2022) and European Commission (2022). Thus, Romania can increase its economic productivity and, moreover, can become much more economically competitive at the European and international level, but also a sustainable nation from the point of view of the relationship defined by the concept of sustainable development (environment -social-economic).

In addition to the analysis of the situation of the municipalities regarding the indicators of the circular economy, this study also presents the relationship of association between the neighbouring territorial units. It was thus found that, from a theoretical point of view, communication between neighbouring localities or counties regarding circular practices is not at the expected level or it's even missing. On the other hand, the lack of spatial autocorrelation can facilitate the development of public policies at the local level in accordance with the particularities of each city-municipality, which would lead to their increased efficiency, but this will also create a difficulty in consolidating data at an aggregate level. The same conclusion is also provided by the analysis of the disparities between the municipalities, which are very large regarding the recycling rate, which reflects the lack of alignment of policies in the field, the local administration being forced to take its own measures which, often, cannot be applied and in the case of other localities. Consequently, any public alignment policies will either be applied with difficulty or will have to comply with a high level of detail to cover all the exceptions that have arisen and to leave no room for interpretation.

The limits of the research are caused by the method of data, an online questionnaire, based on the self-registration of the town halls. Another cause that substantially limits the opportunity to use the results of this study is represented by the uniqueness of the study, more precisely, the spatial analysis of waste management. Thus, due to the lack of similar scientific approaches, the results of this study cannot be evaluated from the perspective of data coherence, but also of the identification of possible association links with other variables of interest associated with the circular economy concept. That is why, in the future, in order to achieve all the desiderates of circular economy, the current state of the circular economy in Romania will be analyzed in accordance with the provisions of the National Circular Economy Strategy, developed by the Ministry of Environment in 2022. In addition, an analysis is required in-depth study of the causal relationship between the circular economy concept and other socio-economic variables.

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