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Different Scenarios for the Development of the Circular Economy Based on the Deposit System The Case of Romania

Abstract. *The circular economy aims to minimise waste, make the most of resources, and create a closed-loop system where products and materials are reused, refurbished, remanufactured, and a recycled and deposit system may be a solution. Deposit systems align with the principles of the circular economy by promoting resource conservation, waste reduction, closed-loop systems, and extended producer responsibility. They represent a practical application of circular economy concepts in the management of specific product life cycles, contributing to a more sustainable and regenerative approach to consumption and production. Taking into consideration the fact that Romania is a relatively large country, with a still considerable number of rural population and a vast area, the implementation of deposit system should be applied in different manner specific for each area, county level individual explicit approaches. The present paper aims to find the proper scenarios for the successful implementation of deposit system, with the magnifying glass on the RetuRO system, specific for Romania.*

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1. Introduction

The Sustainable Development Goals (SDGs) and European policy are interconnected through joint efforts to address global challenges and promote a sustainable future. The SDGs are part of the United Nations 2030 Agenda for Sustainable Development, adopted in 2015. The European Union (EU) has also adopted these goals and integrated them into its policies and strategies, including its sustainable development strategy. The European Union's growth strategy includes specific objectives related to employment, innovation, education, poverty reduction, and environmental protection. These goals largely align with the SDGs.

As part of the Circular Economy Strategy, the EU adopted a Circular Economy Action Plan. It includes several legislative proposals and measures to promote recycling, waste reduction, and efficient use of resources. Moreover, the EU has adopted a series of waste directives that set specific targets for recycling and sustainable waste management. These directives include, among others, recycling targets for packaging and electrical and electronic equipment. Through these initiatives, the EU aims to transform its economy into a circular model, where resources are used efficiently, waste is reduced, and product life cycles are extended. The circular economy thus becomes a key element in achieving the objectives of sustainability and environmental protection established by European policy.

Deposit systems play a significant role in promoting the principles of the circular economy. The circular economy aims to minimise waste, make the most of resources, and create a closed-loop system where products and materials are reused, refurbished, remanufactured, and recycled. The connection between deposit systems and the circular economy lies in how deposit systems encourage the return, reuse, and recycling of products, fostering a more sustainable and circular approach to resource management. Some of the key connections between deposit systems and the circular economy are mentioned below:

Resource Conservation: Deposit systems encourage the return of products, such as beverage containers, for a refund. By doing so, they promote the reuse of these items instead of disposal. This aligns with the circular economy principle of conserving resources by extending the lifespan of products through multiple use cycles.

Closed-Loop System: Deposit systems contribute to the creation of closed-loop systems by ensuring that materials are collected, returned, and reintegrated into the production process. Instead of being treated as single-use, items with deposits are part of a system that encourages their return and reuse, promoting circularity.

Waste Reduction: One of the primary goals of the circular economy is to reduce waste. Deposit systems incentivise consumers to return items, reducing the likelihood of littering, and promoting responsible disposal. This aligns with the circular economy's emphasis on waste prevention and management.

Extended Producer Responsibility (EPR): Deposit systems are often part of EPR initiatives, where producers take responsibility for the end-of-life management of their products. EPR is a key aspect of the circular economy, as it encourages producers to design products that are more easily recyclable and to participate in systems that facilitate the circular flow of materials.

Behavioural Change: Deposit systems influence consumer behaviour by providing a financial incentive for the return of products. This shift in consumer behaviour aligns with circular economy principles, as it promotes a more sustainable and responsible approach to consumption and disposal.

Material Recycling: The returned items collected through deposit systems, such as bottles and cans, are typically sent for recycling. This supports the circular economy's emphasis on efficient material recycling and the creation of secondary raw materials.

Innovation and Design: To optimise the effectiveness of deposit systems, there is a need for innovation in product design and packaging. Circular economy principles encourage the development of products that are easily disassembled, repaired, or recycled. Deposit systems can drive this innovation by influencing how products are designed for circularity.

Deposit systems align with the principles of the circular economy by promoting resource conservation, waste reduction, closed-loop systems, and extended producer responsibility. They represent a practical application of circular economy concepts in the management of specific product life cycles, contributing to a more sustainable and regenerative approach to consumption and production.

The company RetuRO Sistem Garantie Returnare (SGR), established by the representative associations of beverage producers and traders, is the administrator of the guarantee-return system in Romania. The company was formed as a company based on the not-for-profit principle, which means that, through the constitutive act, it assumed the obligation to reinvest any profit exclusively in the development of the return guarantee system. The objective of the RetuRO company is to implement Romania's largest circular economy project – the guarantee-return system. To implement the return guarantee system, the following steps are required: development and implementation of the IT System, construction of sorting and counting centres, development of infrastructure and logistics network, contracts with merchants, management of manufacturers and retailers, information campaigns for consumers.

The guarantee-return system requires the population to pay a guarantee of 0.50 lei, about 0,1 euro, when they want to buy a drink (water, soft drinks, beer, wine, spirits) from a merchant. The system applies to non-reusable primary packaging made of glass, plastic, or metal, with volumes between 0.1 l and 3 l inclusive. The purpose of this system is to introduce packaging into a circular economy, helping Romania to reach the national collection and recycling targets established at European level, which require, for example, that by 2025, 77% of the PET placed on market, and by 2029 – 90%. In addition, the system will help to reach and even

exceed the new collection and recycling targets for the rest of the types of materials, namely 75% for glass and 60% for aluminium, starting from the year 2030.

Taking into consideration the fact that Romania is a relatively large country, with a still considerable number of rural population and a vast area, the implementation of deposit system should be applied in different manner specific for each area, county level individual explicit approaches. Moreover, the application and operationalisation of the system should have maximum results. Therefore, the research question is the following. Which are the proper scenarios for the finest implementation of RetuRO at the county level? In this regard, the present paper aims to find the proper scenarios for the successful implementation of the deposit system, with the magnifying glass on the RetuRO system, specific for Romania.

2. Literature review

The evolution of the Circular economy Concept

The concept of the circular economy has evolved over time, with roots in various disciplines such as environmental science, economics, and sustainability. The idea of minimising waste and maximising resource efficiency can be traced back to the waste hierarchy in the middle of the ‘70s (Gharfalkar, 2015), which prioritises waste management strategies in the following order: reduce, reuse, recycle, and dispose. This laid the foundation for thinking about a more sustainable approach to resource use. After that, architects William McDonough and Michael Braungart introduced the Cradle to Cradle (2010), which emphasises designing products with materials that can be perpetually recycled or safely returned to the environment, promoting a closed-loop system.

Industrial ecology emerged in the ‘80s as a field of study focusing on industrial systems and their relationship with the natural environment. It explored the idea of industrial systems imitating ecosystems, with waste from one process becoming input for another. Then, Walter R. Stahel in the 2000s (2016), often regarded as one of the pioneers of the circular economy concept, introduced the term "performance economy when he emphasised selling services rather than products and advocated for the idea that manufacturers should retain ownership of products to encourage repair, maintenance, and eventual recycling.

Thus, the circular economy gained significant adhesion through the work of the Ellen MacArthur Foundation, founded by British sailor Ellen MacArthur in the 2010s that popularised the concept and promoted its adoption across industries and sectors (2013). They introduced the idea of a circular economy as a restorative and regenerative system. As a natural consequence,

The European Union adopted a Circular Economy Action Plan, setting ambitious targets for waste reduction, recycling, and resource efficiency. This package aimed to stimulate the transition to a circular economy across member states.

The circular economy concept has gained global recognition, with businesses, governments, and NGOs increasingly embracing its principles. Various countries

and organisations have developed policies and initiatives to promote circular practices, and the concept continues to evolve as new technologies and strategies emerge. Moreover, in recent years, the concept has integrated digital technologies such as the Internet of Things (IoT), blockchain, and artificial intelligence to optimise resource use, enhance traceability, and facilitate circular supply chains. Scientists are interested in finding results for the most efficient implementation of all these desiderates and work together (Manea et al., 2021; Pătărlăgeanu et al., 2020; Stoian et al., 2022).

The evolution of the deposit system

The first bottle return systems were introduced in the late 19th century. Beverage bottles, particularly those for milk and soft drinks, were often reused, and consumers paid a deposit on the bottle, and when they returned the empty bottle, they received a refund.

In the mid-20th century, deposit systems became more widespread, especially for beverage containers, as many countries implemented bottle deposit programs to encourage the return and reuse of glass, and later, plastic bottles.

Over time, the deposit system concept expanded beyond beverage containers, for items such as pallets, automotive batteries, and electronic devices. Nowadays, in response to increasing concerns about environmental sustainability and plastic pollution, there has been a resurgence of interest in deposit systems. Many regions are reconsidering and modernising deposit programs to address contemporary challenges. Some modern deposit systems leverage digital technologies to enhance efficiency and consumer convenience, such as automated reverse vending machines which can accept returned containers, identify them, and provide instant refunds. Otherwise, many contemporary deposit systems are part of broader Extended Producer Responsibility initiatives, which place the responsibility for the end-of-life management of products on the producers, encouraging them to design products that are easy to recycle and participate in take-back systems. It is important to note that the evolution of deposit systems is ongoing, and new developments are likely as societies continue to grapple with issues related to waste management, resource conservation, and environmental sustainability.

Walls (2011) emphasised that the deposit system is the superior to alternative waste disposal policies. The studies went forward and even demonstrated that it is recommended that the deposit to be a little bit higher sometimes (Sanborn & Sheehan, 2009) in order to be a prove of the its importance.

The scientists are interested in discovering and providing information regarding the implementing cost of the deposit system (Suwanakul et al., 2019; Lavee, 2010) and also in finding the most suitable shape and legal framework of the deposit system ‘operation (Teodor et al., 2020). And why is that? Obviously, due to the fact that studies (Becerril & Bucklin, 2021) have proven that shifting only 20% of the total consumption of beverage from smaller to bigger plastic bottle, would annually reduce with 10.000 the PET production in United States. The relevance is given by

the fact that the packaging waste rises when growing the economy (Paneque et al., 2008).

Even if there are many possibilities for eco-innovation within waste domain and circularity, the social and economic pillar are countered as barriers to be overcome (Lizundia et al., 2022) in order to reach higher social development levels.

3. Research methodology

The analysis proposed in this paper is a geographical approach using several macro level characteristics of the Romanian counties. Romania is territorially and administratively divided into 41 counties, to which the municipality of Bucharest is added. Additionally, Romania is divided into 8 NUTS II development regions, which represent only a voluntary association of several counties and do not represent administrative territorial units.

It identifies areas with a high potential and areas with lower potential and does not use opinions of respondents clustered on socio-demographic criteria. As a consequence, the approach proposed assess differences between geographic groups created on a multi criteria mechanism and not between socio-demographic groups independent on their location. Thus, the socio-economic characteristics of the counties that were taken into consideration include five dimensions and 20 individual items. The five dimensions were constructed starting from the three dimensions: economic development, health, and education that are usually included in indicators measuring human development, which were augmented with two new dimensions, namely environment and infrastructure and circularity potential. All 20 items were harmonised (ratios between the key variable and a variable controlling for the size of the county) in order to obtain data comparable across counties.

$$Item\ harmonised_i = (Item_i)/(Size\ controlling\ variable_i) \quad (1)$$

Table 1. Dimensions and included items

economic development	education and culture	health	environment & infrastructure	circularity potential
I1.1*	I2.1*	I3.1*	I4.1*	I5.1**
I1.2	I2.2***	I3.2*	I4.2*	I5.2****
I1.3	I2.3*		I4.3*	I5.3*
I1.4**			I4.4*	
I1.5*			I4.5*	
I1.6*			I4.6*	

* - controlling for size was necessary for this variable and the variable Population was used
** - controlling for size was necessary for this variable and the variable No. of employees was used
*** - controlling for size was necessary, and the variable No of registered pupils was used
**** - controlling for size was necessary, and the variable No of registered companies was used

Source: Authors' own creation (2023).

Table 2 shows the 20 items and also the 4 variables used for standardisation were downloaded from the Tempo database of the National Institute of Statistics (2022).

Table 2. Descriptive statistics of the items after controlling for size

Items - Descriptive Statistics	Average ($\bar{x}$)	St. dev ($\sqrt{s^2}$)	Median (Me)	Skew (s)	Kurt (k)	Count (n)
Item 1.1	0.382	0.084	0.380	1.59	5.38	42
Item 1.2	3325.024	498.021	3140.500	2.27	5.99	42
Item 1.3	46027.095	19240.757	40877.998	3.48	16.37	42
Item 1.4	0.037	0.020	0.034	0.72	0.33	42
Item 1.5	0.008	0.003	0.008	2.21	7.00	42
Item 1.6	0.009	0.003	0.008	2.14	6.59	42
Item 2.1	0.170	0.033	0.162	1.22	1.87	42
Item 2.2	0.072	0.006	0.071	0.63	0.84	42
Item 2.3	0.174	0.153	0.138	2.18	6.74	42
Item 3.1	0.006	0.002	0.006	0.90	2.03	42
Item 3.2	0.003	0.002	0.002	1.98	3.54	42
Item 4.1	0.423	0.339	0.390	1.36	3.05	42
Item 4.2	0.005	0.002	0.005	-0.02	0.11	42
Item 4.3	0.002	0.001	0.002	0.11	-0.94	42
Item 4.4	0.685	0.998	0.568	5.97	37.57	42
Item 4.5	0.522	0.133	0.547	-1.65	4.67	42
Item 4.6	1.511	0.731	1.394	1.72	6.35	42
Item 5.1	0.019	0.005	0.018	0.83	0.32	42
Item 5.2	0.006	0.002	0.006	0.52	0.19	42
Item 5.3	0.378	0.196	0.325	2.21	6.26	42

Source: Authors' own creation using primary data from (National Institute of Statistics of Romania, 2022).

Although comparability across counties was attained after the construction of the 20 items, one further step was taken and each item was transformed into a z score. Using the z scores, we have sequentially two approaches for constructing a single index. The first approach was based on PCA and the second one was based on the equal weights within dimensions and equal weights between dimensions derived from Nardo's approaches.

The first proposal is a stepwise approach including: 1) PCA analysis on the 20 items of z scores; 2) construction of the selected PCs using the initial items and the rotated component matrix; 3) aggregation of the PCs in a single index using the % of recovered variance as weights; 4) rescaling of the index using the min and max so that the value for each unit is between 0 and 1.

The second proposal is a stepwise approach including: 1) arithmetic average of the items within each dimension; 2) aggregation of the average dimensions in a

single index using again a simple arithmetic mean and 3) rescaling of the index using the min and max so that the value for each unit is between 0 and 1.

$$z\ score = (x_i - \overline{x})/s \quad (2)$$

$$\left||a-b|\right|_2^2 = \sum_i (a_i - b_i)^2 \quad (3)$$

The first approach involved a first stage PCA, where three valid PCs were identified.

$$t_{k(i)} = x_i * w_k \quad (4)$$

$$w_1 = arg\ max_{||w||=1} \left\{ \sum_i (t_1)^2{}_{(i)} \right\} \quad (5)$$

$$t_{(i)} = (t_1 \dots \dots \dots t_l)_{(i)}\ principal\ components\ scores \quad (6)$$

$$w_{(k)} = (w_1 \dots \dots \dots w_p)_{(k)}\text{-}\ coefficients \quad (7)$$

$$x_{(i)} - initial\ variables \quad (8)$$

Using the Kaiser-Meyer-Olkin test, we have obtained a borderline result which encouraged moving forward with the approach. We have confirmed that some underlying factors can be identified for the 20 initial items (test value 0.677 is a little lower than 0.7 but with a Significance level under 0.01).

Table 3. KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.677
Bartlett's Test of Sphericity	Approx. Chi-Square	744.284
	df	190
	Sig.	.000

Source: Authors' own creation (2023).

The five important principal components identified with eigenvalues over 1 explain cumulatively over 77.0% of the initial variance.

Table 4. Principal Components

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var	Cumulative %	Total	% of Var	Cumulative %	Total	% of Var	Cumulative %
1	7.657	**38.284**	38.284	7.657	38.284	38.284	6.601	33.006	33.006
2	3.347	**16.733**	55.017	3.347	16.733	55.017	3.353	16.766	49.772
3	1.995	**9.974**	64.992	1.995	9.974	64.992	1.863	9.315	59.087
4	1.380	**6.900**	71.891	1.380	6.900	71.891	1.803	9.015	68.102
5	1.027	**5.133**	77.024	1.027	5.133	77.024	1.784	8.922	77.024
6	.933	4.667	81.691						
7	.729	3.645	85.336						
8	.610	3.048	88.384						
9	.550	2.748	91.132						
10	.451	2.257	93.389						
11	.377	1.884	95.273						
12	.217	1.084	96.357						
13	.208	1.038	97.395						
14	.146	.730	98.125						
15	.127	.633	98.758						
16	.090	.451	99.209						
17	.065	.324	99.533						
18	.050	.251	99.784						
19	.033	.166	99.951						
20	.010	.049	100.00						

Source: Authors' own creation (2023).

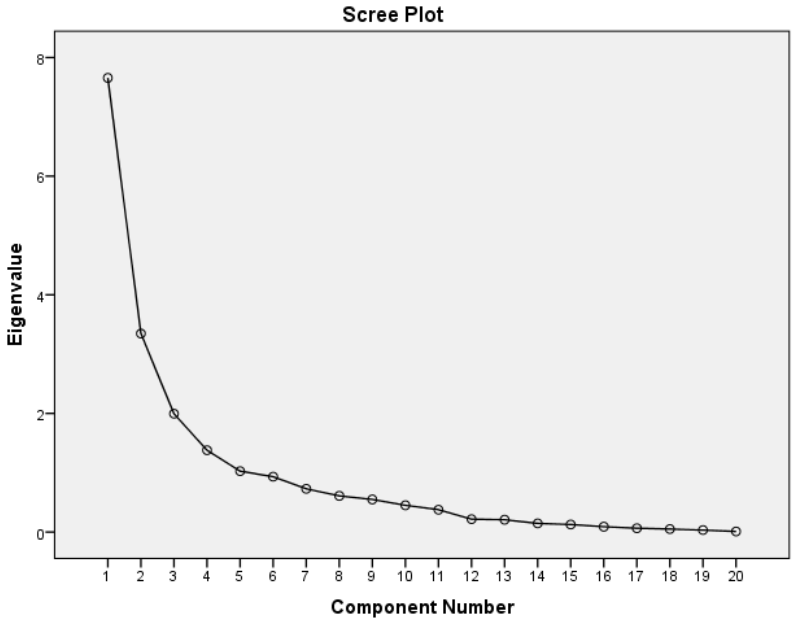

Figure 1. Eigenvalues of the PCs
Source: Authors' own creation (2023).

Using the Varimax rotation, the correlation between the newly developed 5 PCs and the initial components was identified. The complete results are presented in Table 5 but the components can be interpreted as follows. The first PC is mostly correlated with dimension 1, economic development and with dimension 3 health, but includes some items from dimensions 2, 4 and 5 since it recovers over 38% from the initial variability. The second PC is also strongly related to the economic development and the environment and infrastructure component. The third PC is strongly connected with only two items, one from education and culture, and the second one from the environment and infrastructure set. The fourth PC focuses on infrastructure, while the last is a mix between education and circularity potential.

Table 5. Rotated Component matrix (20 items vs 5 PCs)

Rotated Component Matrix					
	Component				
	1	**2**	**3**	**4**	**5**
I1.1_z	**.867**	.153	-.127	.218	-.059
I1.2_z	**.812**	.386	-.164	-.029	-.226
I1.3_z	**.934**	.151	-.135	-.017	-.067
I1.4_z	-.257	**-.571**	.044	-.471	-.017
I1.5_z	.582	**.753**	-.131	-.107	.088
I1.6_z	.579	**.731**	-.106	-.004	.095

Rotated Component Matrix					
	Component				
	1	2	3	4	5
I2.1_z	.338	-.407	-.140	.449	**-.490**
I2.2_z	-.164	-.313	**.873**	.026	-.139
I2.3_z	**.894**	-.087	-.092	-.021	-.187
I3.1_z	**.753**	-.190	.108	.025	-.240
I3.2_z	**.704**	.050	-.070	-.167	-.066
I4.1_z	-.272	-.026	**.815**	.197	.006
I4.2_z	-.312	-.375	.086	**.637**	.219
I4.3_z	.115	.099	.185	**.863**	.112
I4.4_z	-.144	**.897**	-.064	-.094	.221
I4.5_z	**-.737**	-.049	.314	-.165	-.023
I4.6_z	.116	**-.600**	.378	.009	.188
I5.1_z	-.067	.224	-.098	.082	.820
I5.2_z	-.337	-.201	-.015	.237	**.726**
I5.3_z	**.833**	.112	-.061	.047	-.086

Source: Authors' own creation (2023).

After having the PCs, we went further and computed the aggregated index, in the first approach and complemented it with the aggregated index for the second approach, where the individual items were averaged in two stages.

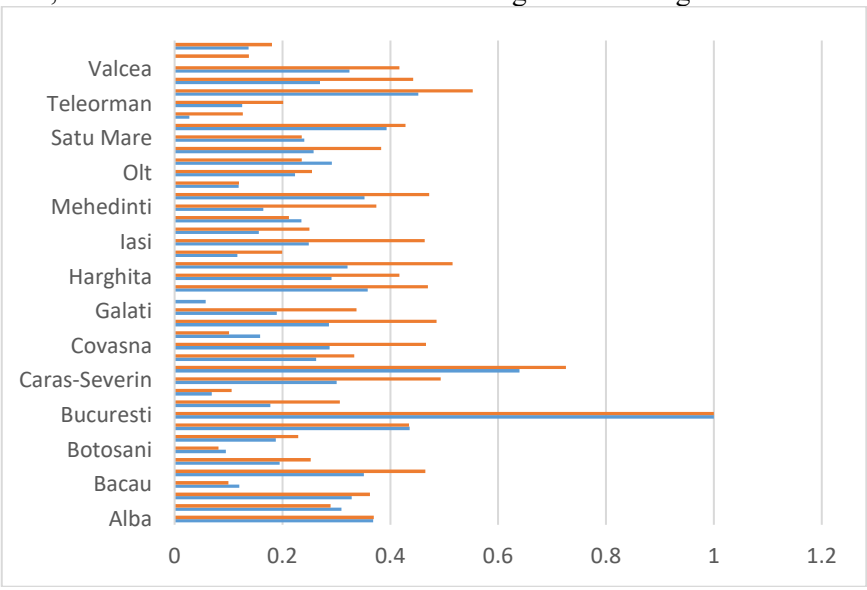

Figure 2. Rescaled distances between each county and Bucharest in the two approaches (PCA+HCA vs simple HCA)

Source: Authors' own creation (2023).

4. Results and discussion

The two approaches have generated indices with two distributions with a relative similarity degree. The average value of the index is 0.26 in the PCA approach with a standard deviation of 0.1717 which leads to a 66.0% coefficient of variation. In the same time the average value for the index is 0.33 in the double layer average approach with a standard deviation of 0.1885 which leads to a 56.4% coefficient of variation. The second approach leads to a higher level of homogeneity in the values of the index.

Using the values of the aggregated index for each of the approaches, we have created four clusters with similar number of items: 10 first and second and 11 the third and fourth clusters. Thus, the components of the four clusters resulted for the two approaches are presented in the following table (Table 6):

Table 6. The distribution of counties in the four clusters in the two approaches

CLUSTER 1		**CLUSTER 2**	
INDEX PCA	**INDEX_WE**	**INDEX PCA**	**INDEX_WE**
Bucuresti	Bucuresti	Valcea	Iasi
Cluj	Cluj	Hunedoara	Tulcea
Timis	Timis	Arad	Brasov
Brasov	Hunedoara	Caras-Severin	Sibiu
Sibiu	Caras-Severin	Prahova	Harghita
Alba	Dolj	Harghita	Valcea
Gorj	Mures	Covasna	Salaj
Mures	Gorj	Dolj	Mehedinti
Bihor	Covasna	Tulcea	Alba
Arges	Bihor	Constanta	Arges
CLUSTER 3		**CLUSTER 4**	
INDEX PCA	**INDEX_WE**	**INDEX PCA**	**INDEX_WE**
Salaj	Galati	Ilfov	Teleorman
Iasi	Constanta	Vrancea	Ialomita
Satu Mare	Buzau	Teleorman	Vrancea
Maramures	Arad	Bacau	Vaslui
Olt	Olt	Neamt	Suceava
Bistrita-Nasaud	Bistrita-Nasaud	Ialomita	Neamt
Galati	Ilfov	Botosani	Calarasi
Braila	Satu Mare	Calarasi	Dambovita
Buzau	Prahova	Giurgiu	Bacau
Mehedinti	Braila	Suceava	Botosani
Dambovita	Maramures	Vaslui	Giurgiu

Source: Authors' own creation (2023).

For deciding between the different implementation scenarios, one can identify based on the provided results the following typologies of units using two dimensions: dimension 1: cluster, and dimension 2: stability for the two approaches.

The easiest interpretation of the two dimensions is as follows:

- Cluster 1 – high level of development and potential for the five initial dimensions.
- Cluster 2 – medium high level of development and potential for the five initial dimensions.
- Cluster 3 – medium low level of development and potential for the five initial dimensions.
- Cluster 4 – low level of development and potential for the five initial dimensions.
- Stable county – county that is included in the same cluster in both approaches.
- Oscillating county – county that switches cluster between approaches.

Table 7. The distribution of counties based on the two dimensions

	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
Stable counties	6	3	7	10
Oscillating counties	4	7	4	1

Source: Authors' own creation (2023).

Cluster 1 presents a high level of development and potential for the five initial dimensions, namely economic development, education and culture, health environment and infrastructure, circularity potential and include six stable counties and four oscillating counties. The six stable counties are included in the same cluster in both approaches, namely: Bucharest, Cluj, Timis, Gorj, Mures and Bihor. These counties are located in five regions: Bucharest-Ilfov Region, two counties in the Nord-West Region, West Region, South-West Region, and Centre Region. The four oscillating counties from Cluster 1 are Brasov, Sibiu, Alba, and Arges. The four counties are located one in the South-Muntenia Region and three of them in Centre Region.

Cluster 2 presents medium high level of development and potential for the five initial dimensions, namely economic development, education and culture, health environment and infrastructure, circularity potential and include three stable counties and seven oscillating counties. The three stable counties are Valcea, Harghita, and Tulcea, located in three different regions: South-West Region, Centre Region and South-East Region. The seven oscillating counties are: Hunedoara, Arad, Caras-Severin, Prahova, Covasna, Dolj, and Constanta, located in 5 different regions: three counties in the West Region, South Region, South-West Region, South-East Region, Centre Region.

Cluster 3 presents a medium low level of development and potential for the five initial dimensions, namely economic development, education and culture, health environment and infrastructure, circularity potential and include seven stable counties and four oscillating counties. The seven stable counties are Satu Mare, Maramures, Olt, Bistrita-Nasaud, Galati, Braila, and Buzau located in 3 regions as follows: three of them are located in Nord-West Region, three of them are located in

South-East Region and one is located in South-West Region. The four oscillating counties are: Salaj, Iasi, Mehedinti, and Dambovita, located in 4 different regions: Nord-West Region, Nord-East Region, South-West Region, and South Region.

Cluster 4 presents low level of development and potential for the five initial dimensions, namely economic development, education and culture, health environment and infrastructure, circularity potential and include ten stable counties and one oscillating county. It is found that the most stable counties are included in Cluster 4, unfortunately, counties that present low level of development: Vrancea, Teleorman, Bacau, Neamt, Ialomita, Botosani, Calarasi, Giurgiu, Suceava, Vaslui. All 10 stable counties included in Cluster 4, are part of two of the poorest regions of Romania, namely the North-East Region and the South-Muntenia Region, with the exception of Vrancea county which is part of the South-East Region.

Therefore, based on our stepwise approach, we identify 26 stable counties and 16 oscillating ones. This distribution could lead to several scenarios of implementation for the RetuRO System, adapted to each typology of county. The development of scenarios adapted to each type of county is more necessary as the distribution of counties based on the two dimensions demonstrates that there are still very large economic, social, and ecological disparities between the counties of Romania.

The application and operationalisation of the guarantee-return system could have maximum results if different policies and messages are used in communication, considering the disparities between counties. Counties have different opportunities to apply this system determined by the geographical area, traditions, level of education, recycling infrastructure, and for a good application of the guarantee system, political decision-makers should adapt their policies and techniques for applying this system in depending on the county.

It is possible that the population from counties having a low level of development is more active in this system, considering that the guarantee-return system requires the population to pay a guarantee of 0.50 lei, about 0.1 euro, when they want to buy a drink (water, soft drinks, beer, wine, spirits) from a merchant, amount that can be received back for each returned package. In order for this to be possible, it is necessary for the policies in this area to aim at better informing the population and to create an adequate infrastructure for this purpose.

Some techniques and approaches that could be used for different policies and messages used in communication for the identified typologies are as follows.

- More emphasis on the education;
- More emphasis on the awareness of the system;
- More emphasis on the environmental aspects;
- More emphasis on the individual impact;
- More emphasis on the monetary reward of the system.

Each of these scenarios aims at optimising the results of the implementation of the public policy and intends to boost its operation. A better perspective of the individual requirement of the county provides public authorities with the most appropriate instruments for the implementation of RetuRO. In the end, this is the

shortest pathway to RetuRO success: to discover and apply the best solution for a public policy.

5. Conclusions

The amount of waste is an important problem that has a significant impact on the population due to human activities related to economic development and resource consumption. In this context, the circular economy approach plays an important role in the development and well-being of the population.

The circular economy involves actions at all stages of the life cycle of products and can contribute to rethinking the problem generated by huge amounts of waste. Various countries and organisations have developed policies and initiatives to promote circular practices, and the concept continues to evolve as new technologies and strategies emerge.

The efficient collection and recovery of waste will allow its transformation into resources that can be reintroduced into the economic system as secondary raw materials, which leads to ecological as well as economic advantages. A particularly important role in circular practices is played by storage systems that became more widespread in the second half of the 20th century. RetuRO is one example in this direction.

In order to provide the optimum solution for RetuRO implementation at the county level, we cluster Romanian counties into 4 parties and proposed specific implementation scenarios for each type. Therefore, based on our stepwise approach, we identify 26 stable counties and 16 oscillating ones. This distribution could lead to several scenario of implementation for the RetuRO System, adapted to each typology of county: more emphasis on the education, or on the awareness of the system, or on the environmental aspects, etc.

Further research may include characteristics in rural and urban areas, specific information about types of generated waste, and more.

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Annex

Items	Tempo table	Year	Title of the indicator
Item 1.1	FOM103D	2022	Civilian employed population by activities of the national economy at the CAEN Rev.2 section level, sexes, macro-regions, development regions and counties
Item 1.2	FOM106E	2022	Average monthly net nominal salary gain by activities of the national economy (sections

Items	Tempo table	Year	Title of the indicator
			and divisions) CAEN Rev.2, sexes, macro-regions, development regions and counties
Item 1.3	CON103I (GDP TOTAL) / POP106A (TOTAL POPULATION)	2020	GDP PER CAPITA/YEAR ron
Item 1.4	SOM101A	2022	Unemployed registered at the end of the month, by categories of unemployed, sex, macro-regions, development regions and counties
Item 1.5	INT101O	2021	Active enterprises, by activities of the national economy at the CAEN Rev.2 section level, size classes according to the number of employees, macro-regions, development regions and counties
Item 1.6	G	2021	Wholesale and retail trade; repairing cars and motorcycles
Item 2.1	SCL103D	2022	School population, by education levels, counties and localities
Item 2.2	SCL104A	2022	Teaching staff, by education levels, sexes, macro-regions, development regions and counties
Item 2.3	ART112A	2022	Spectators and auditors at artistic performances in counties and localities
Item 3.1	SAN102B	2022	Beds in health facilities by categories of health facilities, forms of ownership, macro-regions, development regions and counties
Item 3.2	SAN104A	2022	Medical personnel by categories, forms of ownership, sexes, macro-regions, development regions and counties (doctors)

Items	Tempo table	Year	Title of the indicator
Item 4.1	AGR101A	2014	The surface of the land fund according to the mode of use, by counties and localities - Forests and other forest vegetation
Item 4.2	GOS106B	2022	The total length of the simple drinking water distribution network, by counties and localities
Item 4.3	GOS110D	2022	Total simple length of sewage pipes by residence, macro-regions, development regions and counties
Item 4.4	POP106A	2022	Population of the county/urban capital
Item 4.5	POP106A	2022	Population of the county/rural capital
Item 4.6	AGR101B	2014	The surface of the land fund according to the mode of use, by counties and localities
Item 6.1	FOM103D	2022	Civilian employed population by activities of the national economy at the CAEN Rev.2 section level, sexes, macro-regions, development regions and county
Item 6.2	INT101O	2021	Active enterprises, by activities of the national economy at the CAEN Rev.2 section level, size classes according to the number of employees, macro-regions, development regions, and counties E Water distribution; sanitation, waste management, decontamination activities
Item 6.3	GOS111C	2004	The quantity of urban solid waste deposited, by macro-regions, development regions and counties

Source: Authors' own creation using primary data from (National Institute of Statistics of Romania, 2022)