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## Article

# The characterization of the Romanian circular economy's potential, at county level

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**THE CHARACTERIZATION OF THE ROMANIAN CIRCULAR ECONOMY'S  
POTENTIAL, AT COUNTY LEVEL**

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**Abstract**

The complexity of the challenges faced by the world economy over the past decades is a clear indication that the linear economic model that starts with the exploitation of resources and ends with the disposal of waste is almost reaching its limits. These limitations are obvious in the following areas: resource exploitation, environment, economic added value of a unit of consumed resource, and also on the labour market. Under these circumstances, the circular economy model, which provides feasible solutions for all of these areas where the linear economic model shows its limitations, becomes an alternative to be taken into account. Although these challenges are global in nature, it is obvious that a functional global circular economy can be built incrementally starting from the interconnection of national circular economies that rely on interconnected regional circular economies. Using this hypothesis, in this paper we propose an indicator that can be used for a multi-criteria evaluation of the potential for developing a circular economy at national level, for the case of Romania. Our proposed approach allows the assessment of the county's potential based on a six-dimensional indicator and on 16 individual variables, built on a methodology similar to the one used for the indicator measuring the potential of an economy to attract foreign direct investment proposed by UNCTAD (United Nations Conference on Trade and Development) in WIR2012 (World Investment Report 2012). Thus, using the 16 variables collected for the period 2008-2014, the circular economy potential indicator was calculated based on the NIS and NTRO databases.

Among the most important empirical results are the identification of the concentration poles, which, in 2014, are represented by the city of Bucharest and by the counties: Brăila, Constanta, Mureş, Alba, Sibiu and Maramureş and the identification of areas with low potential, which are Oltenia, Muntenia and the central and north-eastern area of Moldova.

**Keywords:** circular economy, regional development, Romania, aggregated indicator.

**JEL Classification:** C43, Q01, O13, O44, Q57, R11

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## **Introduction**

In order to generate sustainable economic development across the globe, it takes not only time, but also realistic goals and effective resource optimization measures to eliminate waste as much as possible and to employ the practice of recycling in a more prolonged rhythm. The relationship between socio-economic development and the environment is influenced by the population growth, the environmental capacity to transform and other environmental factors through the acquisition, use, preservation and distribution of resources (Popescu et al., 2017).

In the research presented in this paper one has tried to place Romania in the broader European context and, at the same time, to analyse comparatively the potential of the Romania counties to develop a functional circular economy. The necessity of the approach proposed by the authors in this paper is based on the fears that the directions of development of the national economy through intensive and conventional means generated by certain market economy situations and somewhat sustained by certain EU policies push the Romanian economy model on the path of divergence from the principles of circular economy, which can ensure sustainability under the context of the current challenges.

Given that the entire conceptual framework of circular economy far exceeds the limits of recycling, which is now seen as the main component of this new economic model, one believes that the assessment of the potential for developing such an economy must be based on a multi-criteria methodology. Thus, to capture not only the concept of recycling, but also the reduction and re-use ones, a six-dimensional approach was brought forth in the present paper, including the educational and cultural dimensions. In order to increase the relevance of the research, a series of indicators at county level were identified, with the clear purpose of establishing the main poles where there is a high potential for the development and implementation of circular economy.

The need to develop such an economic model also comes from the approach proposed by the European Union, which on December 2nd, 2015 adopted a series of legislative measures consisting of an action plan for the Member States. The action plan covers all stages of the life cycle of the product, starting from conception, going through: material procurement, production and consumption and ending with waste management and development of the secondary raw material market.

At the same time, the European Commission revising the waste directives by increasing recycling targets can generate an incentive among Member States to increase the likelihood of circular economy implementation. Thus, these prospects are expected to stimulate global sustainable competitiveness that is driven by investment in the sector through the use of innovative technologies and also the creation of new jobs.

From a structural point of view, the paper contains three main sections, accompanied by an introductory part and a section of conclusions. After this introductory part, an overview of the concept of circular economy and its chronological evolution was made by placing it in the context of the most important directions followed by the literature. The following section presents, in a concise and clear way, the main objective of the study and also the methodology and data used to achieve it. In the third section, the main results of the empirical analysis are presented and their main social economic implications are also addressed.

## 1. General framework and review of speciality literature

Circular economy, compared to the current production and consumption model, leads to the optimization of resource use through increased transition efficiency from open cycles to closed cycles of materials and energy and less wasteful production processes (Frosch, 1992; Erkman, 1997; Gertler, 1997; Andersen, 2007). The development of circular economy implies the prevention of loss of material as presented by Mirabella et al. (2014) and supports the concepts presented by Park and Chertow (2014) on waste as a usable resource. The research performed by the Ellen Mac Arthur Foundation dismantles the concept of waste and argues that the use of end-of-life products should imply attention from the project stage. Also important in this sense is the integration of an eco-design that aims to reduce the environmental impact during the life cycle of the product.

The circular economy promotes a more efficient and environmentally-friendly use of resources to implement a cleaner economy, characterized by a new innovative model (Ellen Mac Arthur Foundation, 2012; Stahel, 2014), as well as by expected equity effects in and between generations in terms of both the efficiency of the use of natural resources and the avoidance of the following situation: "A world where poverty is endemic will always be prone to ecological catastrophes and other vulnerabilities" (World Commission on Environment and Development, 1987).

The concept of circular economy is mainly mentioned in literature by developing three main "actions", that is the so-called "3R Principles": Reduction, Reuse and Recycling (Feng and Yan, 2007, Ren, 2007, Sakai et al., 2011, 2013; Lett, 2014). Reducing or the "resource efficient" concept means reducing inputs and increasing economic and social welfare at the same time (Ness, 2008). The principle of re-use refers to "any operation by which non-waste products or components are used again for the same purpose for which they were designed" (EU, 2008). Reuse of materials or components is beneficial in terms of environmental benefits because it requires less resources, less energy and less labour compared to the production of new products from materials extracted directly from nature (Castellani et al., 2015; WRAP, 2011). Waste recycling offers the opportunity to capitalize on the resources used and to reduce the amount of waste to be treated and/or eliminated, thus reducing the impact on the environment (Cagno et al., 2005, Lazarevic et al., 2012, Birat, 2015).

The concept of circular economy is often confused with the recycling process; nothing more wrong because this limiting vision may be the least sustainable solution compared to other circular economy principles of reduction and reuse in terms of resource efficiency and profitability in real terms. Considering exactly this confusion and the risks it involves, it is imperative to understand the complexity of the mechanism that must be put in motion for the development of a circular economy. Thus, it is obvious that the recycling capacity must be accompanied by many of the following characteristics of the community: economic power, high level of infrastructure, high level of education, high level of culture, openness of the economy, to increase the probability of development of a circular economic system.

Zero waste is an objective of the European Union policy as described in the Seventh Environment Action Program. Under Directive 1999/31, the European Commission has imposed on Member States to reduce the storage of "municipal biodegradable waste" to less than 35 % of the quantity produced in 1995. It is important to note that some EU Member States (Austria, Belgium, Denmark, Germany and the Netherlands) have already reached

the targets of the EU Waste Storage Directive. The example to follow is that of the Netherlands where only 3% of the total waste produced is still stored. The use of different instruments (taxes, restrictions and regulations) and awareness of the population and economic agents about this necessity have contributed to low rates of waste disposal. The most effective instrument of persuasion has been shown to be the increase in waste storage taxes. However, paradoxically, as Scharff (2014) claimed, the transition to a low storage has generated various side effects related to maintaining the economic, environmental and social sustainability of the remaining landfills, which made it impossible to dismiss them due to the need to minimize financial losses.

It is important to note that although the hierarchy between the 3R principles is acknowledged, the transition towards circular economy, in practice, seems to be more focused on recycling than on reuse, which is the main principle of circular economy. Reuse could help reduce the environmental impact as well as revitalize the competitiveness of local economies and improve the welfare of certain segments of the population (Castellani et al., 2015). Its greater role is essential given the limits and risks of recycling on the global market (Bilitewsky, 2012) to fully achieve the goal of absolute decoupling.

From the initial stage, the circular economy has been conceptualized as an alternative model to the neoclassical economy, both theoretically and practically, as it emphasizes the fundamental role of the environment, its functions, as well as the relations between the natural environment and the economic system. Moreover, the circular economy describes the environment as a source of inspiration for redesigning industrial activities. As a consequence, as in the natural environment, according to the reasoning designed, in the circular economy "no losses that can be associated with available energy or useful material can be accepted" (Frosch, 1992). Among the innovative principles of the concept of circular economy is that end-of-life residues should be capitalized either as material flows or as sources for energy production. Thus, their inclusion in the product and process design allows closing the material and energy cycle (complete cycle), maximizing waste utilization, minimizing the use of virgin materials and minimizing the release of environmentally harmful materials.

At national level, Romania reports a growth of 5.9% in the second quarter of 2017 compared to the same quarter of 2016, according to the National Institute of Statistics, being in the top of the European Union's economic growth. However, as long as Romania's economy does not develop in sustainable ways, it cannot have a high level of sustainability. With the help of the European Union's policies for implementing the circular economy model for the Member States, Romania also benefits from a legislative base that can be a first essential step towards achieving the objectives.

Among the most important milestones at European level, for developing the circular economy, it is worth mentioning the December 9th, 2015 when the European Commission adopted a legislative proposal on online sales of goods aimed at ensuring a more effective customer protection against defective products with the objective to contribute to their durability and repairability. This change will certainly protect consumers and motivate them to exercise their rights and will be a clear incentive to produce high quality and sustainable products. At the same time, on March 17th, 2016, the Commission proposed the introduction of a single market for fertilizers obtained from recoverable raw materials. The draft regulation lays down the rules on the free movement of all products marked with the EC certificate of conformity in respect of fertilizers and organic fertilizers.

At the same time, the Commission proposed in November 2016 the implementation of Ecodesign, which provided for the initial design of a product to include repair and recovery processes for the materials used to manufacture it. Another notable moment was November 30, 2016, when the EC adopted the Ecodesign Plan 2016-2019 as part of the Green Energy for All Europeans, which can also make an important contribution to creating a higher-level economy of circularity. As ecodesign measures have so far focused on energy efficiency, the EC, through its work plan, has undertaken to consider more carefully the possibility of establishing product requirements relevant to the circular economy, such as sustainability, repairability, design for disassembly, the availability of information and the ease of re-use and recycling.

Food waste is a key area in the circular economy, therefore, on August 1, 2016, the Commission launched a stakeholder platform on the prevention of food waste by facilitating the donation of food and its use as feed.

The EC will also adopt a proposal to amend the directive on the restriction of the use of hazardous substances in electrical and electronic equipment (RoHS Directive), which increases the economic opportunity and cost-effectiveness of waste recycling from that equipment. The draft Directive also implements the main priority of the waste hierarchy, namely the prevention of waste. It is estimated that the measure will prevent the creation in the EU of more than 3,000 tonnes of hazardous waste per year. The extended life of electrical and electronic equipment would also lead to additional energy and raw materials savings.

In June 2016, guidelines were issued within the framework of the Common Implementation Strategy for the Water Framework Directive to better integrate water re-use through adequate planning and management. As water scarcity has worsened in some parts of the EU, the reuse of waste water treated in safe and cost-effective conditions is something valuable but insufficiently used in the means of increasing the water supply and mitigating the pressure on resources.

On November 9, 2016, the Commission proposed a voluntary protocol on the construction and demolition waste management industry. The purpose of the protocol is to improve the identification and collection of waste, as well as logistics, processing and quality management. The protocol will thus increase the confidence in the quality of recycled materials and encourage their use in the construction sector.

The Commission has integrated circular economy issues into the reference documents regarding the best available techniques that EU Member States have to reflect in issuing permits for industrial installations. This will help reduce waste generation, stimulate recycling and reduce the use of primary resources, thus bringing greater sustainability and competitiveness to industries covered by the Industrial Emissions Directive.

## **2. Methodology**

Within this section, the objective of the research will be presented and the proposed methodology will be presented in order to achieve the research goal. At the same time, within this section, the variables used in the research described in this article will be presented.

The objective of the research presented in this article is to identify an aggregated indicator called the Circular Economy Potential Indicator (CEPI) to quantify the potential for the development of a circular economy. In order to achieve this objective, Romania has been placed in a European context in terms of waste collection and recycling and identifying the counties that can be considered as development poles for the recycling sector at national level. Also, for the construction of the indicator, we used the most important dimensions that can be an indicator of the potential for the development of such an economy.

Given the purpose of the research, as stated in the previous section, the methodological approach will comprise three major stages. In the first stage, Romania will be placed in a European context by means of a comparative analysis carried out for the main indicators on waste recycling and waste collection, reported by Eurostat. In the second stage, the analysis will focus on Romania and will be carried out at county level. At this level, the evolution of the NACE 38 (Waste collection, treatment and disposal; recovery of recyclable materials) will be analysed. By aggregating the data from the National Trade Register Office database, the analysis is performed for the following dimensions of the economic sector: the number of companies in the selected NACE class, at county level, the turnover of the selected NACE companies at county level, the number of employees of the selected NACE class companies at the county level, the average number of employees of a NACE company selected at county level, the average turnover of a company in the NACE class selected at county level and the average turnover achieved by an employee of a NACE company selected at county level. Thus, at this stage both development poles (counties) of this sector and counties where the level of development of the sector is very low will be identified. These poles are identified both by the absolute size of the sector and by its relative size relative to the entire economy of the county.

In the third stage, a potential indicator based on a methodology similar to the one for the potential index for attracting foreign direct investment proposed by UNCTAD is being built. The proposed indicator methodology in this paper is thus based on the two-level approach proposed by UNCTAD (the full description is available in WIR2012, Box 1.3). At the first level, the most important dimensions in the evaluation of the potential of the phenomenon under analysis are identified. At the second level, for each of the proposed dimensions, the individual variables to be used in the general dimension assessment are identified. The inclusion of several individual variables for each dimension is necessary to increase the consistency of the indicator and also to ensure its stability by diminishing the impact of catastrophic developments. Thus, the potential indicator for the development of a circular economy (CEPI) at the county level is built to identify those areas where resources need to be concentrated for developing a circular economy so that elements of good practice tailored to local characteristics can be identified.

The six dimensions proposed for the evaluation of the potential are the following: 1) county's performance in the recycling sector (NACE 38 class), the economic strength of the county (the development level), the development level of the utilities' infrastructure, the urbanization level and its concentration, the development of the educational and cultural sector, and the development level of the touristic sector. The underlying hypothesis used (for including each dimension in the aggregated indicator) states that a high development level, characterized by a high value of the dimension's indicator indicates a high potential. Therefore, one expects that areas with high performance in the recycling sector, with a high economic development level, with a developed utilities' infrastructure, with a high level of

urbanization, with a high development level of both educational and cultural fields, and with a high attractiveness for tourists has a high potential for developing a circular economy.

The methodology used in the construction of the indicator is presented below, in three steps.

Step 1. As part of this step, the methodology for the construction of the potential index proposed by UNCTAD was adapted to the specificity of the circular economy sector. The identification of the measured dimensions, each with a specific indicator, implied the parallel analysis of the main socio-economic aspects that may be indicators of the potential for the development of a circular economy and the availability of data series.

Step 2. For each dimension identified in the previous step, based on the availability analysis, the individual variables that will be aggregated to construct dimension indicators are identified.

Step 3. In this step, three sub-stages were carried out as follows:

**3.1.** The 17 individual variables were scaled so that individual county values were included in the range [0,1]

$$z_{it} = \frac{x_{it} - \min U}{\max U - \min U} \tag{1}$$

- $x_{it}$  – value of the variable  $x$  for the territorial unit ( $i$ ) for the year ( $t$ )
- $\min U$  – a value less than the minimum values of the variable  $x$  for all territorial units and for all the periods  $t$  included in the analysis
- $\max U$  – a value greater than the maximum values of the variable  $x$  for all territorial units and for all the periods  $t$  included in the analysis

**3.2.** For each of the 6 dimensions identified, the dimension indicator is calculated by aggregating the equal weights of the variables included in the dimension.

$$I_k = \sum_{i=1}^m \frac{1}{m} * I_{ki} \tag{2}$$

**3.3.** The final indicator measuring the potential of developing a circular economy is calculated by aggregating the equal weights of the six dimensional indicators

$$CEPI = \sum_{i=1}^6 \frac{1}{6} * I_i \tag{3}$$

The system of equal weights in each stage, although having some limitations, was considered to be the most appropriate to allow for an easy calculation of the CEPI indicator over the next periods. The CEPI may also provide the basis for the emergence of more complex built-up indices in which the weights of individual dimensions or components can be correlated with their ability to indicate the potential for the development of circular economy.

Also, an important limitation of the proposed indicator is the subjectivity of the choice of dimensions and of the individual components. It is important to mention in this respect the limitation imposed by the existence of variables available at the county aggregation level.

The data used in this paper comes from the databases of the Trade Register Office (NTRO) and the National Institute of Statistics (NIS) (Tempo database). These cover the period



2008-2014. (Table no. 1) In 2014, a decision was made to truncate all data series, this being the last year for which data are available for the GDP indicator at the county level (it is introduced in the Tempo database by NIS in the month of December of a year for the year n-3). The proposed methodology also makes CEPI easy to calculate for the year 2015, at the time when all data was released, thus facilitating the use of this indicator in other activities as well.

**Table no. 1: Database used in the research**

Variable	Symbol	Aggregation level	Period	Source
Municipal waste recycling rate (%)		National	08-14	Eurostat
Packaging recycling rate (%)		National	08-14	Eurostat
Turnover (NACE 38 class)	I11	County level	08-14	NTRO
Number of companies (NACE 38 class)	I12	County level	08-14	NTRO
Number of employees*** (NACE 38 class)	I13	County level	08-14	NTRO
GDP*	I21	County level	08-14	NIS
Total number of companies in the economy***	I22	County level	08-14	NIS
Total number of employees in the economy***	I23	County level	08-14	NIS
Percentage of localities with access to the water network	I31	County level	08-14	NIS
Percentage of localities with access to the gas network	I32	County level	08-14	NIS
Percentage of localities with access to the sewerage network	I33	County level	08-14	NIS
Percentage of localities with access to the thermal energy network	I34	County level	08-14	NIS
The percentage represented by the population of the county capital	I41	County level	08-14	NIS
Urbanization rate of the county	I42	County level	08-14	NIS
Number of museums per 100,000 inhabitants	I51	County level	08-14	NIS
School population**	I52	County level	08-14	NIS
Tourist accommodation capacity***	I61	County level	08-14	NIS
Number of overnights**	I62	County level	08-14	NIS

Note: \* per inhabitant \*\*expressed per 100 inhabitants \*\*\*expressed per 1000 inhabitants

Source: National Institute of Statistics, 2017; National Trade Register Office, 2017

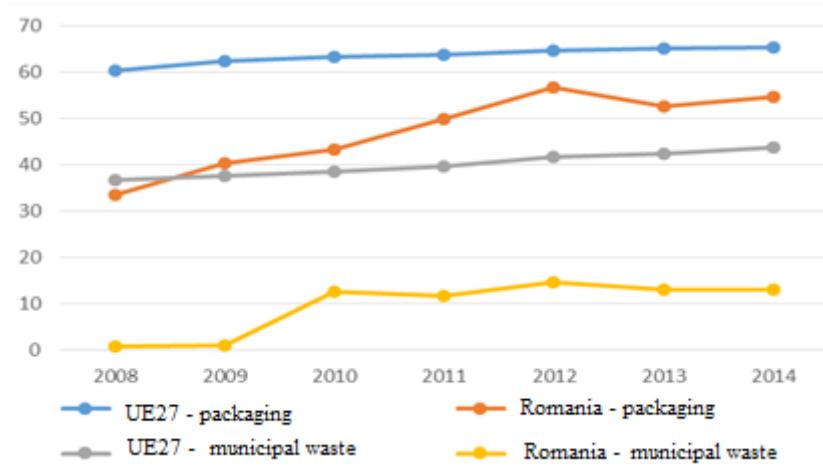
In order to ensure county comparability by including the county dimension (measured on the basis of the population on 1 January of each analysed year), the 16 individual variables are re-scaled and reported at 1, 100 or 1000 inhabitants.

Starting from such a potential indicator, a methodology can be developed to analyse the performance of the counties according to the existing potential.

### 3. Empirical results and discussions

Although circular economy is a complex phenomenon, recycling of the municipal waste and packaging can be considered as one of the main statements of the level of development of this type of economy. Thus, with regard to the general recycling rate of municipal waste, Romania recorded the largest increase over the period 2008- 2014, which was over 14.5 times. With all this spectacular growth, in 2014, Romania, with a 13.1% recycling rate, ranks antepenultimate in the European Union, outpacing only Malta and Slovakia. Also

noteworthy is the average 43.9% recycling rate of municipal waste, registered at the level of the European Union (Figure no.1). At the opposite pole, with rates above 50%, there are: Germany, the Netherlands, Austria and Switzerland (non-EU country).



**Figure no. 1: Recycling of municipal waste and packaging**

Source: Eurostat, 2017

Regarding the packaging recycling rate, it has grown 1.64 times, in Romania, over the same period of time, from 33.5% to 54.8%. The registered growth places Romania second at the level of the European Union (which registered a general increase of only 5% from 60.5% to 65.5%), being surpassed only by Cyprus. The 54.8% rate places Romania in the second part of the European ranking, surpassing only Liechtenstein, Malta, Croatia and Greece (Figure no. 2).

It is important to note that Romania, in 2014, was at about 29.84% of the EU average recycling rate for municipal waste and at 83.66% of the EU average packaging recycling rate.

At the level of the national economy, the evolution of the NACE 38 sector presented a downward trend over the analysed period. In 2014, the number of active companies was only 2904, which represents only 65.41% of the number of active companies in 2008. The decrease has led the sector to diminish its share in the total economy (total number of active companies) from 0.67% to 0.48%. The same trend was presented by the turnover of the companies in the sector, which in 2014 represented just over 67% of the value of the 2008 business turnover. The decrease pace of the importance of the domain in the total national economy is lower for this indicator, the decrease being from 0,95% in 2014 to 0,81% in 2008. A much lower decrease was recorded by the number of employees in the field, decreasing by just over 6%. Moreover, at the level of the national economy, the sector has increased its importance over the period from 0.87% to 1.04%. In terms of size of the average company, measured by turnover, the average size of companies in 2014 was nearly 3% higher than in 2008. Although the average company is larger, the average employee productivity, measured as a ratio between the total turnover and the total number of employees, dropped to around 71.7%. In terms of number of employees, over the 2008-2014 period the average size of the company increased from 9.6 to 13.7 employees, registering an increase of approximately 43.7%.

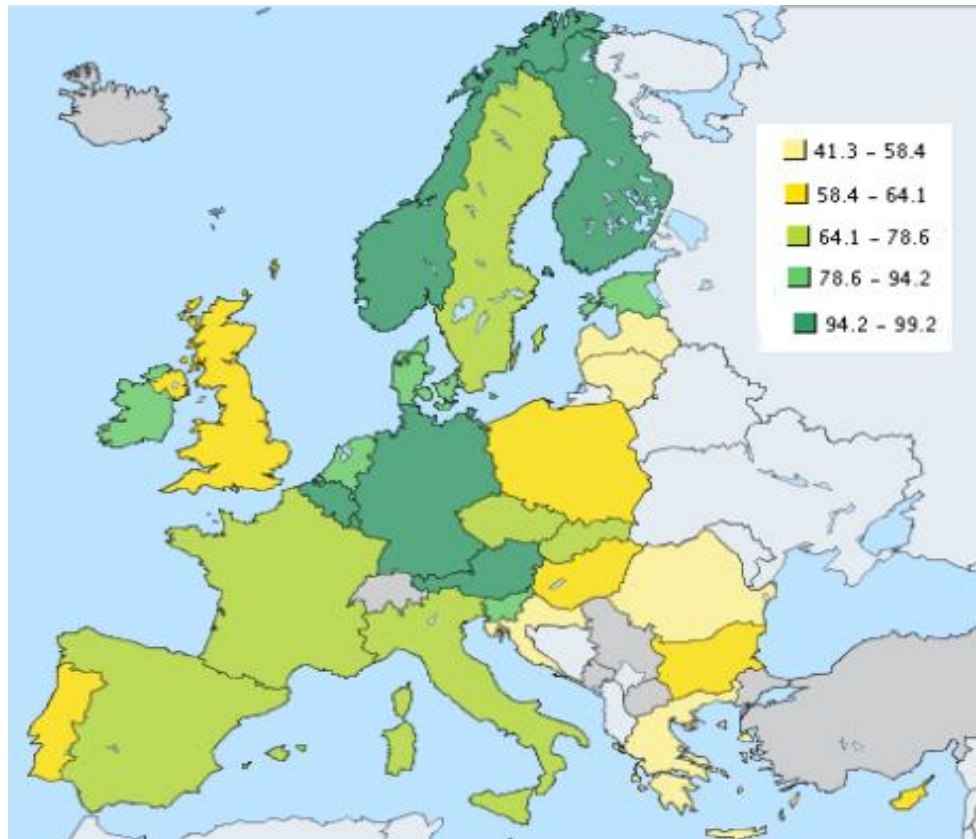


Figure no. 2: Packaging recycling rate (2014)

Going forward, the analysis of the activity of the NACE 38 companies from a geographic point of view clearly indicates the fields of development of the sector but also the areas with potential for future development. In terms of turnover, in the year 2014, the counties: Arad, Argeş, Buzău, Constanţa, Galati and Bucharest concentrate almost 50% of the national activity. Counties with similar levels of development are visible in Figure no. 3. Regarding the importance of the sector in the economy of the county, more than 2% of the economic activity is registered in this area in 2014, only in the counties: Arad, Brasov, Gorj and Mehedinti.

In 2014, approximately 57% of the companies in the sector were located in the following counties: Arges, Brasov, Cluj, Constanta, Dolj, Galati, Hunedoara, Ilfov, Mures, Bucharest, Prahova and Timis. The only county in which the number of active companies in the sector represents more than 1% of the total number of companies in the county is Gorj County (Figure no.4).

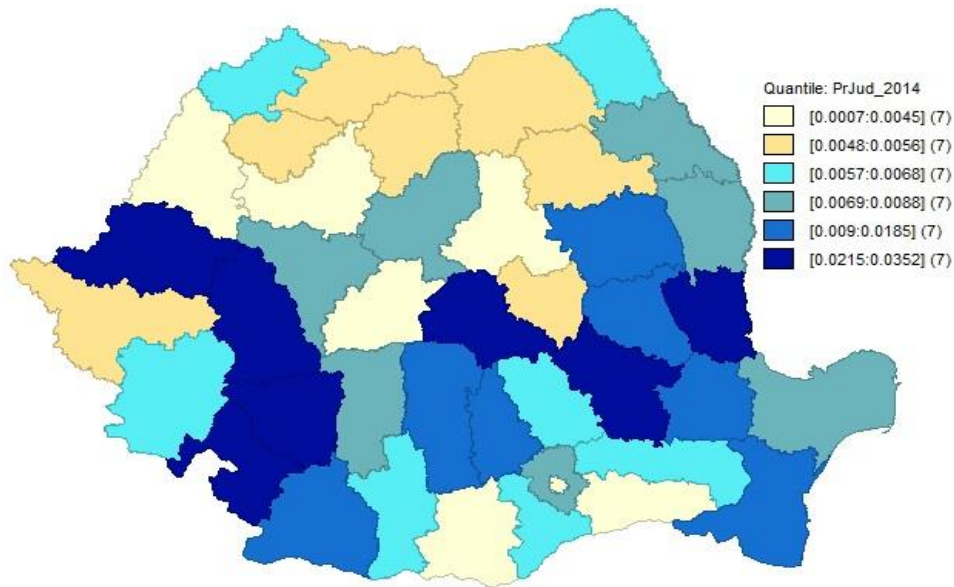


Figure no. 3: The percentage represented by the turnover of the NACE 38 companies in the total turnover of the county companies (2014)

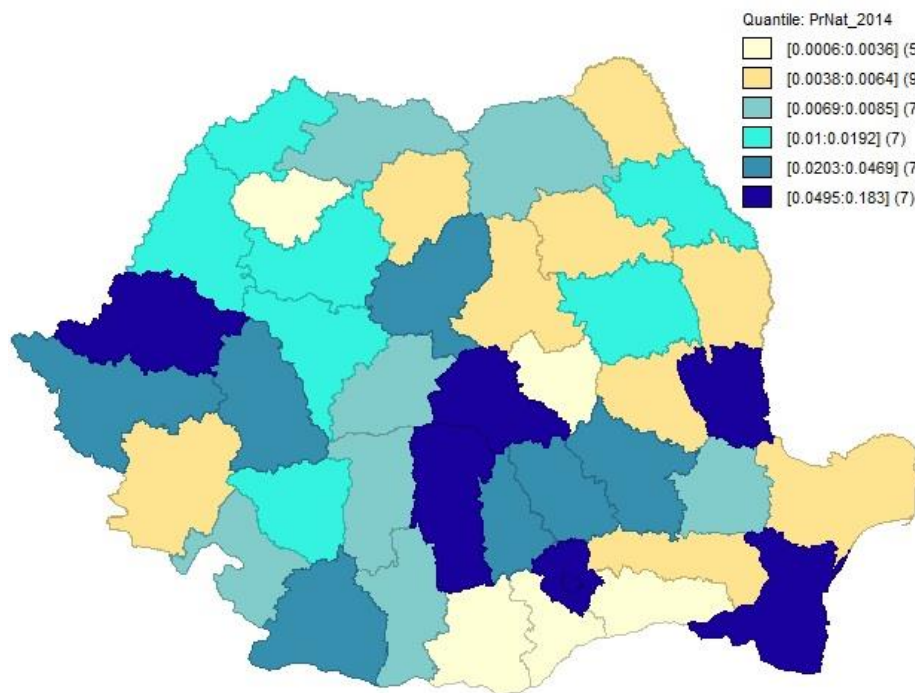


Figure no. 4: The percentage represented by the turnover of NACE 38 companies at the county level, from the national total (2014)

From the labour force point of view, in 2014, over 47% of the sector workforce was located in the following counties: Arges, Brasov, Cluj, Constanta, Ilfov, Bucharest, Mures, Prahova and Timis. From the point of view of the size of the domain in the county economy, in 2014, over 2% was only in the following 4 counties: Botosani, Buzau, Gorj and Vaslui.

Given that the assessment of the potential of a region (county) to develop a circular economy needs to be based on a multi-criteria approach that measures as far as possible the main socio-economic dimensions, we propose a six-dimensional approach in this paper. *The first proposed dimension* is represented by the "performance of the recycling sector" and it is measured on the basis of the following three indicators: number of active companies in the NACE 38 class, number of employees of the active companies of the NACE 38 class, turnover of the companies in class 38. This dimension is essential in estimating the potential because it can be a good indicator of the present capacity. *The second dimension* is represented by the economic power of the county, measured by the aggregation of the variables that are aimed at: GDP per capita, number of employees/1000 inhabitants and number of companies/1000 inhabitants. This dimension has been included in the methodology of the potential indicator as it is more likely that a circular economy will develop in a strong economic area. *The third dimension* measures the county's infrastructure in terms of access to utilities. The hypothesis behind the inclusion of this dimension is based on the idea that the existence of a developed infrastructure (access to utilities) indicates both a high level of socio-economic development and attention to the environment. *The fourth dimension* measures the urbanization level and its concentration by aggregating two indicators that measure the percentage of the population located in the urban area and the size of the main urban agglomeration at the county level. The inclusion of this dimension is based on the hypothesis that there is a greater probability of developing a circular economy in urban areas, given the concentration of resources, the population and the higher infrastructure level. *The fifth dimension* included measures the level of education and culture, aggregating one indicator for each of these two aspects. The use of this dimension is based on the assumption that the higher education and culture of the population is essential in the development of a circular economy because the benefits and the need for such an economy are much easier acknowledged by such population. *The last dimension (sixth)* used in the calculation of the potential indicator is represented by the size of the tourism sector because the environment is one of the most important tourism resources and it is thus expected that the areas where tourism is an important economic sector will be much more inclined towards the possibility of developing a circular economy.

In the first step of the methodology the values of all 16 initial variables for all counties and for each year were rescaled so that values between 0 and 1 were obtained. During the second step, for each dimension an aggregated indicator was constructed, using equal weights (arithmetic mean) for all initial variables included in that group. In the third step, for each county, the value of CEPI was computed by aggregating the values of the six dimension indicators, using equal weights (arithmetic mean).

Following the aggregation, based on the presented methodology, the 16 individual variables, grouped in six dimensions, the distribution of the potential indicator for 2014 resulted, presented in Figure no 5.

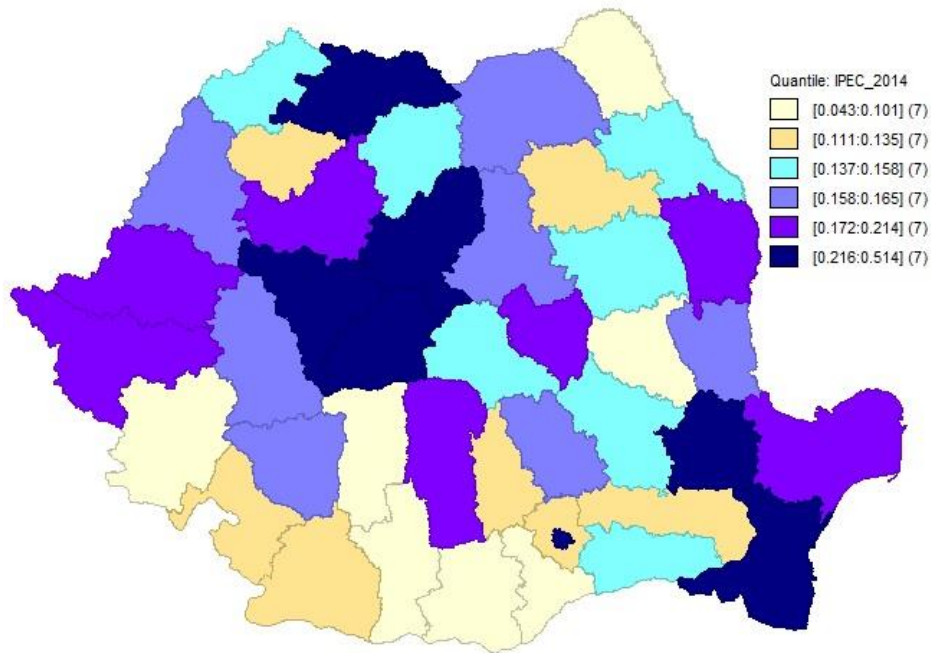


Figure no. 5: CEPI distribution (2014)

As expected, Bucharest, due to the economy, infrastructure and population concentration, is the area with the greatest potential in this field. The area in the south-eastern part of the country is also notable, where Brăila and Constanța also displayed high values for CEPI in the year 2014. The third area with high potential in this field is the central area of the country, which includes counties: Mureș, Alba, Sibiu and the northern part of Maramureș County. It is also obvious that the southern and eastern areas (Oltenia, Muntenia and Moldova) are areas with low potential in this sector.

It is also important to observe that the potential of Bucharest and Constanța (first two ranked in 2014) decreased over the 2008-2014 period. Over the analysed period, the Alba County had a contrary development, with a growth over 45%. With the exception of Alba County, the only counties that have registered an increase in the potential indicator over this period are: Arad, Arges, Brasov, Buzau, Covasna, Gorj, Mures, Olt and Satu-Mare.

**Conclusions**

From the point of view of the proposed approach, this paper can be included in the vast literature on regional development as well as in the literature on circular economy.

The rapid depletion of resources and the significant impact on the environment are among the most important indicators of the fact that the linear economy model, extensively practised in most of the countries in the world, is reaching its limits. Its replacement with a new model must be one of the main concerns of today's decision-makers. In this context,

the circular economy, which proposes a significant saving of resources and a reduction of the footprint on the environment, becomes a worthwhile option.

Using a step by step approach, based on a SWOT analysis, the final section was structured so that the main limitations, the main results and also future research opportunities were clearly presented. Thus, before presenting the most important results of the research, we will address the most important limitations of this paper. The choice of dimensions and individual variables for the CEPI methodology can be considered a weakness of the proposed approach as their selection was based on the literature of the field, on the experience and the expertise of the authors and also on the availability of data. Furthermore, the second limitation of the research is represented by the availability of data because no data at the county level were identified so that the physical value (or monetary value) of the recycling and reuse levels (two of the dimension of the circular economy) could be estimated.

Among the most important results, we have to mention the contraction of the recycling sector at national level in terms of the number of companies, which decreased over the time horizon of 2008-2014 by about 35%. The same downward trend in the sector was also visible in terms of turnover and number of employees in the industry. Regarding the potential for the development of a circular economy, the proposed CEPI indicator allows for clear identification of concentration poles (areas with increased potential) and low potential areas. Thus, the areas with high potential in 2014 are: Bucharest, Braila County, Constanta County, Mures County, Alba County, Sibiu County and Maramures County. On the other hand, the southern part of the country and the eastern part of the country (the central and north-eastern part of Moldova) are areas characterized by limited potential in the development of a circular economy. It is also noteworthy that over the period 2008-2014 the overwhelming majority of the counties in Romania, registered a decrease in the development potential of a circular economy, thus diverging from the objectives of the European Union. The only counties that have presented an upward trend of the indicator during the period studied are: Alba, Arad, Arges, Brasov, Buzau, Covasna, Gorj, Mures, Olt and Satu-Mare.

As far as the future opportunities and research directions are concerned, we consider that refining the indicator by introducing new dimensions or new individual variables could be an important desideratum. Also, in order to increase the practical utility of the approach proposed in this paper, one considers that the adaptation of the indicator for the most important urban agglomerations in Romania and its annual monitoring could be the starting point for building a coherent migration strategy of the economy from the linear paradigm to the circular one.

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