EVALUATION OF THE IMPLEMENTATION OF THE CIRCULAR ECONOMY IN EU COUNTRIES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract. The circular economy is interpreted as a stable economic system, which aims at eliminating the consequences and costs, as well as providing a constant cycle of necessary resources. That is why it is so important to conduct its assessment today. The object of the article is the state of the circulating economy of the leading countries of the world. The purpose of the article is to assess the possibilities and mechanisms of the circular economy in the context of the introduction of the European Union. The methodological basis is a system of mutually complementary general scientific and special methods of cognition. To assess the quality of the implementation of the circular economy, we have chosen the recycling method as the most relevant and easiest to use. The study examined the essence, progress, principles and main advantages of using the circular economy model in the context of implementing this model in 20 countries of the European Union, and the model for analysing the processing possibilities in the European Union as a basic tool for assessing the implementation of a circular economy are presented.

Keywords: circular economy, linear economy, stability, recirculation, manufacturing process, waste, process material.

JEL Classifications: A13, O11, O13, Q01, Q50.

Introduction

The rapid pace of expansion of industrial production over several decades of the middle of the twentieth century. caused the development of the world economy and improving the economic well-being of society. But such changes provoked an exacerbation of global problems in terms of environmental degradation, depletion of natural resources and climate change, which, in turn, marked the 21st century as a period of global environmental crisis. Awareness of the impact of economic activity on the state of the ecological system and the search for ways to ensure economic growth without harming the environment is an urgent problem and is in the focus of public administration. In this context, the main priority is the synthesis of economic development, social well-being and environmental safety – the formation and development of a circular economy determines the transformation of public administration mechanisms. The state policy of the circular economy is a tool for solving problems of an economic and environmental nature and is designed to ensure the reorientation of economic systems to sustainable development, as well as the use of waste as resources, contributes to economic growth. Reforming the domestic economic system in ensuring the provisions of the circular economy for the effectiveness and efficiency of such a process will certainly lie in the plane of government. The formation of an effective state policy of the circular economy and the mechanisms for its implementation will increase the competitiveness of the domestic economy, ensure environmental sustainability and achieve social consensus.

The circular economy is a new economic model in which the emphasis is on the reuse of materials, as well as on the creation of added value through the services of intelligent solutions. The circular economy suggests that the value chain is organized in such a way that the outputs of one chain become inputs for another, reducing

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dependence on new types of raw materials. In a global sense, the circular economy is very relevant, because, according to international organizations, the global value of the market of the circular economy is more than a trillion US dollars. Accordingly, now the private and public sectors are working at the international level to facilitate the implementation of initiatives to remove obstacles and create new solutions that would accelerate the transition to a circular economy.

The circular economy is an industrial system, it is restored or regenerated according to the plan and design. It replaces the linear concept of use with recovery, shifts towards the use of renewable energy sources, eliminates the use of toxic chemicals and seeks to eliminate waste through the excellent design of materials, products, systems and business models. The concept of a circular economy affects the creation of new jobs, security of supply, better quality of life, increased competitiveness, green growth and the implementation of re-industrialization. The circular economy presents a chance to create a stable saving of resources, to continue economic growth while remaining in the ecological constraints of the planet. The basic principle of the city's circular economy is that all products and material flows can be returned to the cycle after use, and become a resource for new products and services. The primary responsibility for creating a circular economy may be concentrated in industry, but local governments can play the role of intermediary and conductor. When traditional regulation makes innovation difficult, a municipality can help change the rules of the game, and this can increase investment opportunities for circular enterprises through spatial planning and economic policies (Garlapati et al., 2020).

Today the world population growth rate is rapidly increasing. This phenomenon has a significant impact on the environment. According to the EU report "Prospects for world population growth", by 2030 the world population will be 8.5 billion people, while in 2050 and 2100 this rate will be 9.7 and 10.9 billion, respectively. According to leading experts, in order to provide the entire Earth population with the necessary resources, by 2050 we will need such a volume of resources that corresponds to four such planets.

The problems of implementing the principles of recycling and sorting today are becoming especially relevant in the context of environmental degradation in the world.

At the present stage, achieving sustainable economic growth has become an important item on the global agenda. Harmonious of sustainable development components, ensuring economic growth, social stability and ecological balance in the long term, it is possible to ensure using the concept of a green economy, which has recently received increased attention around the world. The transition from the traditional model of economic growth to green growth is becoming a global trend in which the green economy acts as an instrument for achieving sustainable development.

In the national sustainable development strategies of individual countries, the environmental component is mentioned in conjunction with economic growth, and the solution of the tasks of comprehensive greening of economic growth is assumed in the framework of the green economy concept. The introduction of the green growth concept should result in a transition to a low-carbon economy. It should be based on socially responsible business management, which implies the introduction of comprehensive programs and mechanisms for improving resource efficiency, developed taking into account the technologies available to the enterprise (waste management programs, energy efficiency programs, etc.). Its essential component is also socially responsible consumption, which implies a change in attitudes, thinking and human values in relation to nature (Bergh, 2020).

In order to protect the environment, ensure healthy and safe living and working conditions, as well as provide sufficient resources in the coming years, many developed countries (primarily Europe – Germany, Great Britain, France, Netherlands, Denmark, Sweden, etc.) linear to the circular economy.

Scaling up the global circular economy requires a combination business models, technological advances and innovations, as well as the joint efforts of stakeholders, including representatives of business and government.

To develop a circular economy, many countries began actively use various tools and mechanisms of public policy in order to ensure its comprehensiveness: from the introduction of technologies, financing and forms of doing business, to the formation of the willingness of society as a whole to change its habits and create new interaction schemes. However, achieving the set goal is impossible without changing the existing production strategies, taking into account the best world practices for introducing the concept of a circular economy providing a positive economic effect both for the manufacturer and for the consumer. This predetermined the relevance of the study, the presentation of which is structured as follows: in the second section we consider world experience in the development of the circular economy, in the third – the features of financial support, in the fourth presents innovative business models of the circular economy: varieties and best implementation practices.

In this article, the essence, progress, principles and main advantages of using the circular economy model in the context of implementing this model in 20 countries of the European Union are considered, and the model for analysing the processing possibilities in the European Union as a basic tool for assessing the implementation of a circular economy are presented.

1. Literature review

Today, the circular economy is becoming extremely relevant in the context of accelerating the pace of industrialization and globalization.

Given this, many scientists, as Sylkin et al. (2019), Kryshtanovych et al. (2020), Odrekhivckyy et al. (2019), Kirchherr et al. (2017), Giurco et al. (2014), Graedel and Allenby (1995), George et al. (2015), Di Maio and Rem (2015), Smol et al. (2017), Stahel (2016), Suzanne et al. (2020), Winning et al. (2017), Bocken et al. (2017), Bocke et al. (2017), Bucknall (2020), Commoner (1971) began to research this topic in the context of the features of implementation and determination of the basic mechanisms of this type of economy.

For example, Geissdoerfer et al. (2017) and Bucknall (2020) explored the paradigm of a new circular economy in the world. In this work, the basic principles of the restructuring of the production cycles of the leading countries of the world and the activities that are aimed at greening production are highlighted.

Of interest to our study are the scientific achievements of Ghisellini et al. (2016), which investigated the features of optimizing economic and environmental elements within the country. His work presents the basic principles of maintaining an unstable economic balance in the transition from the usual "non-ecological" to the modern "circular" type of economy.

An interesting addition to the aforementioned work is the scientific work of Lieder and Rashid (2016), which investigated the consequences, prospects and advantages that arose after the introduction of the principles of a circular economy in the production cycle of a country, region or an individual enterprise.

Today, there is a large number of scientific works in this area devoted to the definition of basic indicators and indices that can show the level of implementation and support of the principles and mechanisms of the circular economy in the world. Such authors include Scheepens et al. (2016) and Elia et al. (2017), who in their works investigated the level of implementation of the principles and mechanisms of the circular economy through the index method.

The process of creating country-specific implementation and support strategies was investigated by Kalmykova et al. (2018) and Primc et al. (2020). In their work, they were able to create mechanisms of transition from the theoretical part of the implementation of the principles of the circular economy to their implementation in practice.

At regional level, circular economies in European countries have been explored by Silvestri et al. (2020).

The study of the circular economy is very relevant for European countries. Skrinjaric (2020) conducted an empirical assessment of the circular economy for individual countries. Our study involves evaluating a circular economy for a wider group of countries.

Modeling and application of individual models of circular economy was investigated by Cramer (2020) and Suzanne et al. (2020). Our research is focused more on the evaluation itself, which becomes a kind of prerequisite for further modeling.

As a result of the study of specialized literature, it was found that a large number of scientists do not pay attention to the compilation of ratings of the circular economy, and it is in our opinion that it is important to clearly clarify what exactly the circular economy is, how it differs from others and why the gradual determination of the ratings of its main indicators in countries who are already using it so important today.

In view of the aforementioned scientific works and after studying the main contributions of scientists to this field of economic science, in our opinion, it will be important to supplement the existing methods of assessing the implementation and provision of basic mechanisms of circular economy in the countries we are studying.

2. Research model

Closed-loop economy or circular economy is a model of economic development based on the restoration and rational consumption of resources, an alternative to traditional, linear, economics. It is characterized by the creation of new alternative economic approaches, the task of which is to minimize the negative human impact on the environment.

This type of economy is considered as part of the Fourth Industrial Revolution, which as a whole will increase the rational use of resources, including natural ones, the economy will become more transparent, predictable, and its development fast and systematic.

A transition to a circular economy can benefit countries by enhancing sustainability, creating jobs, protecting the environment and reducing emissions. At the same time, there are various assessments regarding the advantages and possible risks, the correlation and structure of which in a given territory necessitates a differentiation of approaches to the introduction of this concept in countries with different levels of development.

At the same time, the understanding and degree of relevance of circular economy issues varies significantly across countries and depends on the specifics of the natural, human, physical (artificial) and institutional capitals of each country, its level of development and socio-economic priorities, and the environmental culture of society.

On the one hand, a circular economy is the destiny of states with a strong economy and highly developed technology and production culture. There is a certain risk that developed countries and companies will use the model of the circular economy, introducing their technological advantages as an excuse for gaining access to markets and guarantees for maintaining the occupied share.

On the other hand, lower-income developing countries can be considered more circular than developed, in the sense that parts are recovered from most discarded items for recycling and repair. The question is how to turn these processes into an opportunity for sustainable development. The presence of circular processes in developing countries, most of which are related to sorting and reuse

of 3-turns, provides so-called "growth points" that will allow governments, the private sector and other interested parties to promote innovative models.

The circular economy model has grown from the concept of sustainable development and has been gaining popularity since the late 1970s. This has become an extremely active area of academic research with recent excellent examples like.

In December 2015, the EU Commission adopted the EU Action Plan for the Circular Economy, identified plastic circulation as a key priority, and committed itself to "prepare a strategy addressing the challenges posed by plastics throughout the value chain and taking into account their entire life-cycle". In 2017, the Commission confirmed that it would focus on the production and use of recycled plastic and work towards ensuring that all plastic packaging is recycled by 2030. The European Commission has adopted an ambitious cycle "Economic Package", which includes activities that will help stimulate the transition of Europe to a circular economy, strengthen global competitiveness, promote sustainable economic growth and create new jobs.

The circular package of the economy consists of a Plan of EU actions for a circular economy, which establishes a concrete and ambitious action program, with measures covering the entire cycle: from production and consumption to waste management and the market for secondary raw materials, and the appendix to the action plan defines the time frame when actions will be completed. The proposed measures will contribute to the "closure" of the product life cycle through greater processing and reuse, which will benefit both the environment and the economy.

Until recently, the model of the circular economy was not so popular among politicians and scientists. The impetus for such active use was the formation of a large number of regulatory documents on the implementation and provision of this model by countries such as China, Japan, Germany, France, Canada and the Netherlands. As a result, Germany became the first country to introduce the concept of a circular economy into its own system of governing the country. The primary basis for this was the adoption in 1996 of the "Law on the closed cycle of substances and the proper management of waste." In Japan,

the 2002 "Law on Creating a Community Based on Waste Management", adopted in 2002, began the implementation of the circular economy model. In China, the implementation of the circular economy began in 2009. In addition, the European Commission in 2015 formulated and officially adopted the Action Plan for the implementation of the circular economy. Today, this model is a priority for most countries of the European Union.

In 2017, the European Commission and the European Economic and Social Committee launched a joint European platform for stakeholders in the circular economy (European Circular Economy Stakeholder Platform). The platform was created to exchange best practices, strategies, knowledge and commitments for the transition to a circular economy and aims to facilitate the transition from a linear economic model to a circular one by strengthening the cooperation of stakeholders and identifying social, economic and cultural barriers to the development of a circular economy.

Despite a wide range of scientific and practical works on this issue, there are many problems in this area that cannot be unambiguously resolved due to rapid economic development. They require further research and improvement.

Figures 1–3 show schematically the fundamental differences between the three primary concepts of the production cycle, which are the basis for existing models of economy.

For a long period of time, the traditional economic model had a "linear" spatial structure model, according to which primary raw materials were used to produce products, and all by-products (for example, plastic containers, wrapping paper, etc.) are simply thrown away. For many years this process has been the most optimal for mass production under conditions of a high level of accessibility of all the necessary resources and materials at the lowest cost. Relatively recently, a revolution took place in this area with a transition to the foundations of a circular economy, in which all materials that went through the production cycle should be reused. If new primary materials are needed to continue the production process, their extraction process should be as environmentally friendly and safe as possible. Thus, the main paradigm of the circular economy is the
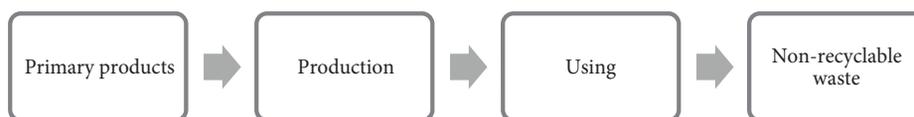

Figure 1. Scheme of the production cycle of a linear economy (development by authors)
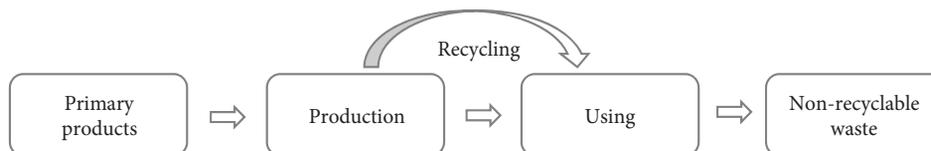

Figure 2. Scheme of the production cycle of a reuse economy (development by authors)
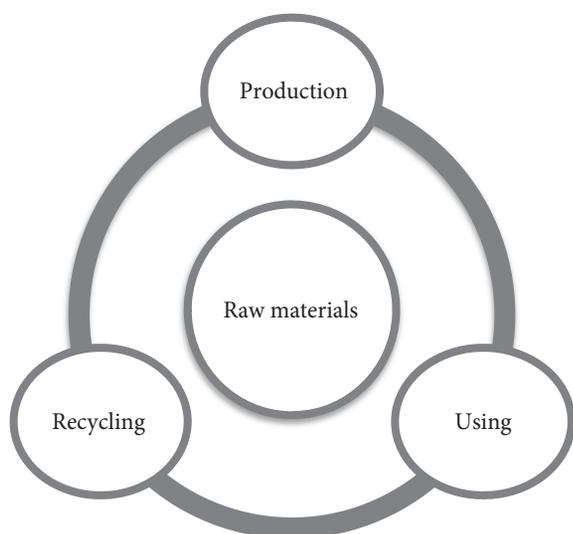
Figure 3. Scheme of the production cycle of a circular economy
(development by authors)

greening and optimization of the impact of human activities on the environment through the use, processing and minimization of production waste.

In general, circular savings contribute to reuse and extend service life through repair. According to the European Commission, "in a circular economy, the cost of products and materials lasts as long as possible. Waste and resource use are minimized. It brings economic benefits by fostering innovation, growth and job creation. It "restores, modernizes, modifies and turns old goods into new resources by processing materials".

The circular economy in its general definition is a model of economic development, the basic part of which is the rationalization of the use of primary resources and their restoration. This concept is based on the 3R approach: reduction, reuse and recycling.

The circular economy allows manufacturers to focus on the production of more durable, repairable, more environmentally friendly products without substances, harmful to health and the environment, and consumers – to use expensive goods on a rental or leasing basis without the need to buy, and, accordingly, and dispose of obsolete goods.

The construction of a circular economy should be based on the introduction of circular economy practices at various levels of the functioning of the economic system (macro, meso and micro). At the same time, at each level, individual goals and objectives are formed, as well as mechanisms for their achievement. The systematization of individual consequences of the introduction of the circular economy model indicates the presence of significant institutional, economic and social effects on the economic system, as well as on the environment.

According to the Ellen MacArthur Foundation, the following basic principles of a circular economy exist:

Design principles for the use of waste and pollution. This principle should not be stochastic, but should be implemented on an ongoing basis to minimize the negative impact on the environment.

Strengthening mechanisms by the maximum preservation of materials and primary raw materials in the production cycle.

Formation of regenerative natural systems. Since in nature there is no such thing as "waste", then in production it is necessary to adhere to the principle that any secondary raw materials can be reused.

Thus, the main advantages of the circular economy model are: 1) optimal waste disposal; 2) innovative and resource-saving methods of production and consumption; 3) energy savings due to a closed production cycle; 4) reduction of negative environmental impact; 5) protecting the economy from a lack of resources.

They also include the following principles: preservation of the resource base – including resources, the volumes of which are by far the smallest and closest to zero; cost reduction for industries; opening up new business opportunities in the context of a new economy system; the construction of new generations of innovative environmental enterprises with the creation of new jobs with the subsequent strengthening of the principles of social equality and integration.

3. Data

According to the POLITICO Index of the Circular Economy, in 2018 Germany, the UK and France were the countries with the most developed circular economies, which have reliable recycling systems and a high level of innovation in the sectors of the circular economy. The following indicators were used to rank countries: municipal waste and food waste (per year per person), municipal recycling rate, share of goods sold suitable for recycling, material reuse rate, patents related to the circular economy (since 2000), investments in circular sectors of the economy.

It is also worth noting the fact that countries that have high indicators in the table presented by us do not take the place of primacy in the context of the overall greening of the economy. Given this, the POLITICO index is significantly different from the overall performance indicators of environmental activities. This indicator estimates a large number of indicators for the implementation of greening the economy, including both the level of air, water and soil pollution, and the qualitative and quantitative characteristics of emissions through production and agriculture. This phenomenon is partially due to the fact that some methods that successfully operate in the process of general greening the economy do not have such a large positive effect on strengthening the implementation and ensuring a circular economy. For example, the process of burning waste for energy production in the Scandinavian countries reduces the total volume of waste disposal, but at the same time does not have a positive impact on the indicators of reuse and recycling, therefore it is not part

of the implementation of the circular economy model and does not significantly affect the country's ratings presented above. Despite the fact that Denmark, the Netherlands and Sweden occupy good positions in the field of processing and production of secondary raw materials, their performance is lower due to the high level of waste. Meanwhile, nine countries from Central and Eastern Europe are countries that produce less waste, but at the same time, recycling is not so actualized and developed.

According to Ecopreneur, the Netherlands, Scotland, Slovenia, France, Belgium and Finland lead in the «circular way». Others (e.g. Italy and Portugal) have recently made significant strides. Although some (for example, Cyprus, Greece, Malta and Romania) are only at the very beginning. At the same time, some leaders (including the Netherlands) have to go the most difficult way, since they produce the largest amount of waste per person, of which Romania is the best (Table 1–2).

Having this in view, Ecopreneur in its normative and evidence-based documents issued the following recommendations for all member states of the European Union on the implementation and maintenance of a model of a circular economy within the country.

1. Start the "Green Deal on Circular Procurement" program.
2. Create circular "hubs" for the ongoing support of companies that use separate models of the circular economy.
3. Create national route maps that will demonstrate the processes of realization of the circular economy.
4. Improve the policy of monitoring and implementing increased responsibility for entrepreneurs in the field of improvement
5. The introduction of low VAT rates to ensure the implementation of repair services, resale of goods and the passage of contracts for social reasons.
6. Creating a New "Green Deal Course".
7. Transfer of investments from the incineration of household waste, etc.

Table 1. Ecopreneur rating of the circular economy of the EU Member States in 2019 (Part 1) (development by authors)

EU member countries	Belgium	Italy	Latvia	Denmark	Finland	Lithuania	Malta	Greece	The Netherlands	Cyprus
Eco-innovation index resource efficiency	14	2	19	8	24	15	4	23	11	21
POLITICO's CE index	8	5	23	13	22	20	27	26	12	28
Fraction of SMEs minimizing waste, %	5(75)	6(74)	23(35)	19(49)	16(55)	27(20)	11(62)	22(37)	7(65)	29(25)
Per capita municipal waste production, kg	10(419)	17(497)	9(410)	28(783)	19(504)	12(444)	24(593)	11(498)	21(520)	27(640)
Per capita total waste incineration with energy recovery, kg	23(485)	8(91)	4(63)	26(651)	28(1037)	9(96)	8(48)	3(13)	25(622)	7(87)
Recycling rate – municipal waste, %	4(54)	10(45)	2(25)	9(48)	12(42)	8(48)	28(7)	26(17)	5(53)	25(17)
Recycling rate – packaging, %	1(82)	11(67)	23(58)	2(79)	16(65)	7(70)	28(37)	20(60)	4(73)	21(59)
Circular material use rate, %	2(21)	5(17)	23(4)	13(8)	17(5)	20(5)	18(5)	28(1)	1(29)	24(2)

Table 2. Ecopreneur rating of the circular economy of the EU Member States in 2019 (Part 2) (development by authors)

| EU member countries	Bulgaria	Czech Republic	Portugal	France	Germany	Romania	Hungary	Slovenia	United Kingdom	Sweden
Eco-innovation index resource efficiency	27	25	13	12	10	22	18	20	6	7
POLITICO's CE index	24	4	16	3	1	18	15	7	2	14
Fraction of SMEs minimizing waste, %	26(28)	9(64)	15(55)	2(83)	12(60)	34(31)	21(40)	18(51)	3(82)	4(76)
Per capita municipal waste production, kg	8(404)	3(339)	15(474)	20(514)	26(633)	1(261)	6(379)	13(457)	18(483)	11(443)
Per capita total waste incineration with energy recovery, kg	5(65)	10(98)	15(113)	19(247)	24(529)	17(126)	12(105)	13(112)	14(112)	27(920)
Recycling rate – municipal waste, %	18(32)	17(38)	19(31)	13(42)	1(67)	27(13)	16(35)	2(58)	11(44)	6(49)
Recycling rate – packaging, %	17(64)	3(75)	19(61)	13(66)	5(71)	24(56)	27(50)	8(69)	15(65)	9(68)
Circular material use rate, %	22(4)	15(7)	25(2)	3(20)	8(11)	27(22)	16(6)	11(9)	4(17)	4(17)
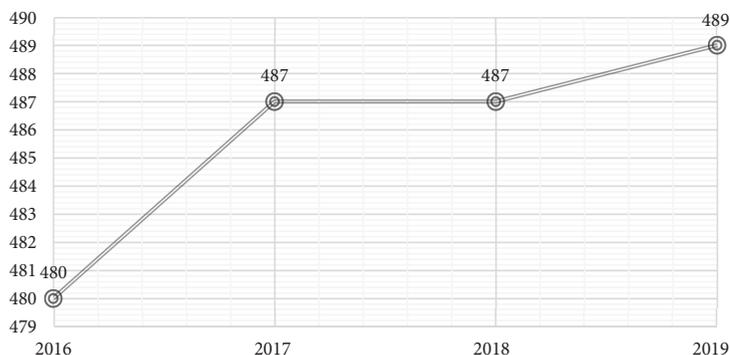
Figure 4. Scheme of the production cycle of a circular economy (development by authors)

4. Results and discussions

The circular economy allows manufacturers to focus on the production of more durable, repairable, more environmentally friendly products without substances, harmful to health and the environment, and consumers – to use expensive goods on a rental or leasing basis without the need to buy, and, accordingly, and dispose of obsolete goods.

The construction of a circular economy should be based on the introduction of circular economy practices at various levels of the functioning of the economic system (macro, meso and micro). At the same time, at each level, individual goals and objectives are formed, as well as mechanisms for their achievement. The systematization of individual consequences of the introduction of the circular economy model indicates the presence of significant institutional, economic and social effects on the economic system, as well as on the environment.

Thus, we are trying to evaluate the introduction of a circular economy in the EU in terms of reuse through modeling. Using Eurostat CE data in the EU (Table 3), the dependence of trade in processed raw materials (in tons) (Y) on factors such as: 1) the degree of processing of municipal waste, % (X_1), 2) the degree of processing e-waste, % (X_2), 3) recycling of biowaste, kg per capita (X_3), 4) utilization rate of round materials, % of the total use of materials (X_4). These dependence indicators were chosen because they best characterize the state of the circular economy in the aggregate of the selected countries and are a clear reflection of the success of innovation in the optimization and implementation of green economy programs. For modeling, the built-in LINEST function in Microsoft Excel was used.

The obtained simulation results are presented in the Table 4.

As a result of calculations, the model will have the following form (1):

$$Y = 10\ 436\ 498.52 - 68\ 939.22\ X_1 - 65\ 122.19\ X_2 + 111\ 263.56\ X_3 - 667\ 691.69\ X_4. \tag{1}$$

The coefficient of determination is 0.9, which indicates a close relationship between the factor and the characteristics of the result. The Fisher criterion confirms the adequacy of the model to the statistics of the general set,

Table 3. Ecopreneur rating of the circular economy of the EU Member States in 2019 (Part 2) (development by authors)

Indicators	2016	2017	2018	2019
Recycling rate of municipal waste, % (X_1)	44.70	46.00	46.20	47.00
Recycling rate of e-waste, % (X_2)	35.80	41.40	41.40	41.40
Recycling of biowaste, kg per capita (X_3)	75.00	80.00	81.00	83.00
Utilization rate of round materials, % of total material use (X_4)	11.70	11.90	11.70	11.70
Trade in processed raw materials, tonne (Y)	5543513	5488276	5829336	5917284

Table 4. Ecopreneur rating of the circular economy of the EU Member States in 2019 (Part 2) (development by authors)

A_4	A_3	A_2	A_1	A_0	
−667 691.69	111 263.56	−65 122.19	−68 939.22	10 436 498.52	Model coefficients
188 331.17	36 255.94	24 965.88	60 118.72	1 391 564.80	Standard coefficient errors (Si)
R² = 0.9			98 448.09		
F = 9.01			4.00		
349 375 971 986.82			38 768 107 383.18		

that is, with probability $P = 0.95$ and degrees of freedom $k1 = m = 4$, $k2 = nm - 1 = 4$, the tabular value of the F distribution is 6.39. The actual value is $F = 9.01$, that is, the actual value is greater than the table value. This condition is for linking variables to the entire data set.

We have reviewed the obtained coefficients of model (1) for statistical significance for assessing factors. The value of t-statistics for degree $n = 9$ is $t = 2.26$ (probability $P = 0.95$), then according to the formula: $t_i = \dfrac{a_i}{S_i}$, where $i = 1.5$; a_i – the coefficients of the multidimensional model that determine the parameters of t-statistics; S_i – is the standard of error rate. Accordingly, $t_0 = 3.55$; $t_1 = -1.15$, $t_2 = -2.61$, $t_3 = 3.07$, $t_4 = -3.55$. Comparisons of the obtained ti values with the tabular value show that they are modularly larger than the tabular value t other than t_1, which indicates that the coefficient A_1 is not statistically significant.

Therefore, the factor coefficients demonstrate to us those how many units the resulting attribute Y (Trade in processed raw materials) will change, which is measured in tons if one of them changes by 1 (each in units of measurement). For example, as a result of an increase in the coefficient X_4 (Utilization rate of round materials) by 1%, the coefficient Y (Trade in processed raw materials) will decrease by 667 691.69 tons. This can be explained by the fact that as processing speeds increase, more and more processed raw materials remain for domestic use.

Conclusions

Today's living conditions (population growth rates), features of the economic management methodology in the context of its environmental context (greenhouse gas emissions, soil erosion, etc.), the consequences of environmental disasters caused by climate change on the planet, give a clear idea that the existing mechanisms for managing natural resources and waste management are absolutely or relatively inefficient and cause fatal harm to the environment. The circular economy cannot be interpreted only as a methodology, it is rather a philosophical category that reveals the possibility of making a profit when introducing environmental methods of dealing with natural resources and waste disposal rules. While previously these methods were considered unnecessary and non-profit, and basically a model of the economy of the type "produce-create-use-throw" was implemented. In the context of a circular economy, the main indicators of the economy are strengthened and at the same time, the unnecessary use of natural resources is eliminated.

Specific economic instruments (for example, strengthening the boundaries of producer responsibility, introducing green economy reforms, as well as creating "environmental" taxes) should be used to strengthen the activity of the circular economy, and in the future to form new production and use models, as well as new rules waste management.

Today, the EU member states are not only actively working towards the formation of a legal framework for the transition from the existing linear economy to the new methodology of the circular economy, but have been actively introducing it into their own system of government for several years. Using specialized ratings, we made a thorough analysis and determined that countries such as the Netherlands, Scotland, Slovenia, France, Belgium and Finland are leaders in this process.

As one of the methods for assessing the opportunities and mechanisms of the circular economy in the context of implementation in the European Union, recycling models were used. The study proved that the pace of waste processing has a significant impact on the process of trade in raw materials. Thus, the product life cycle increases, and the volume of indirectly generated waste is significantly reduced. Given this, this study can be considered as another step towards the formation of a sustainable paradigm for the implementation and maintenance of a circular economy in the world.

This article analyzed the model of the circular economy as the latest mechanism for the implementation of the production cycle. To better understand the main advantages of using a circular economy model, it was compared to other economic models. It was proved that the main difference between the circular economy system from previous forms is that it is optimized for the modern environmental and economic needs of the world today.

The article has limitations, since the study examined countries that, to one degree or another, introduced the principles of greening and optimizing their own production system and economy. It is worth noting that these countries were selected in the context of the fact that they have already achieved some success in the process of implementing the principles of a circular economy, as a result of which they can be a clear display of the benefits of implementing this model.

In the future research perspective, attention should be paid to the development of the gradual adaptation of the circular economy system for the economic systems of individual countries. This is due to the fact that today the basic principles of the circular economy are non-specific and non-specialized, and most countries, as they decide to implement the principles of the circular economy, form local and not always completely successful implementation methods that can sometimes harm their economic system. Given this, the formation of specifying mechanisms for adapting the principles of the circular economy is no less relevant today.

Author contributions

The authors contributed equally.

Disclosure statement

The authors do not have any conflict of interest.

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