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CIRCULAR ECONOMY MODEL AS A COMPONENT OF THE CONCEPT OF SUSTAINABLE DEVELOPMENT

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In the XXI century the global problems of the development of human civilization, including those related to ecological imbalances, climate change, and global warming, are exacerbated dramatically. Risks of famine, lack of clean drinking water, difficult access to safe and cheap energy resources directly affect incomes, quality of life and its duration, determine the state and systemic problems of socio-economic development of the country. Since 2000, thanks to the efforts of the United Nations, the world has been actively disseminating and implementing sustainable development ideas, the essence of which can be summed up as the desire of current generations to ensure prosperity and high economic growth so as not to limit development opportunities and quality of life for future generations. Implementation of sustainable development tasks requires transition from extensive to intensive type of economic growth, use of the potential of international economic cooperation of all countries, in particular, in such important areas as resource saving and energy saving, exchange of innovative technologies in greening, organic farming and circular use of natural resources, accelerated transition to the development of "smart cities" and all kinds of "green economy".

In today's world with the problems of excess waste and shortage of resources, interest in extracting raw materials from waste has resumed. The concept of merging linear production lines into a closed cycle is promoted by the circular economy or the economy of a closed cycle [1].

Circular economy is an economic system of closed cycles, in which raw materials, components and products lose their value as little as possible, renewable energy sources are used, and systemic thinking is the basis [2].

The concept of circularity has a deep historical and philosophical origin. The idea of feedback and cycles in real systems is long-standing and has been echoed in various schools of philosophy. It became widespread in industrialized countries after World War II with the beginning of computer studies of nonlinear systems, where it was concluded that the world functions as a process of metabolism, not as a machine [2].

Today, with modern advances, digital technologies have the potential to facilitate the transition to a circular economy through a dramatic increase in virtualization, dematerialization, transparency, and feedback-driven intelligence [3].

More than 100 different definitions of the circular economy are used in the scientific literature and professional journals. This is due to the fact that this concept is used by a diverse group of researchers and specialists, when, for example, a doctor of philosophy and a financial analyst emphasize different aspects of the concept.

The variety of definitions also complicates the possibility of measuring the circularity of the economy [2]. Definitions often focus on the use of raw materials or changing the system. Resource-focused definitions often follow the "3R" approach: "Reduce" – reduction (minimum use of raw materials); "Reuse" - reuse (maximum reuse of products and components); "Recycle" - processing (high quality reuse of raw materials) [2].

Examples of this approach are MyWheels, which operates in the secondary car market, and WeGo, an online car-sharing platform. These companies reduce the need to buy a new car, which, in turn, helps to reduce the use of raw materials ("Reduce"). If the car's engine is broken, it can be repaired, and you can give away unnecessary parts for the manufacture or reconstruction of another car ("Reuse"). When parts can no longer be reused, metal, textiles and plastics are recycled to make a new machine ("Recycle") [2].

Definitions based on system change often emphasize three main elements: closed loops; renewable energy; system thinking [2].

Some researchers argue that social inclusion is also a necessary element of a circular economy in terms of systemic change.

In a circular economy, the cycles of movement of raw materials and products are closed by the example of the ecosystem. That is, there is no such thing as waste, because each residual stream can be used to make a new product. Toxic substances are eliminated and residual streams are divided into biological and technical cycle. Manufacturers take back their products after use with the help of intermediaries who provide services for the collection of used products, and restore it for consumption at a new useful life. Therefore, in this system, it is important not only to properly process materials, but also to ensure that products, components and raw materials remain high quality throughout all cycles [2].

Like raw materials and products, the circular economy also tries to conserve energy for as long as possible. The circular economic system operates on the basis of renewable energy sources. Since it is impossible to process energy, the concept of "energy cycles" is not used. Instead, the concept of "cascade-type energy flows" is used. An example of this is the joint production of heat and electricity.

The circular economy requires not only closed material cycles and renewable energy sources, but also systemic thinking, as economic entities interact, creating a common network of activities. Therefore, when choosing a strategy, it is necessary to take into account the short-term and long-term consequences, as well as the impact of the entire value chain.

In a circular economy, raw materials circulate in two separate cycles: the biocycle and the technocycle. Distinguishing between these cycles helps to understand how raw materials can be used long and efficiently. The general rule is that the fewer stages of the process the material has to go through for reuse, the higher the quality of the material it can contain. The process of reusing organic materials is different from

reusing technical material. The latter is also called synthetic. Because of this difference in the reuse process, it is important that the organic and technical materials are properly separated from each other after use [2].

Technical materials such as fossil fuels (coal, oil, peat, methane hydrate, etc.), plastics and metals have limited availability and cannot be easily reproduced. It is important to manage properly in the technological cycle stocks of such limited materials.

In a circular economy, these materials are used, not consumed. After use, the materials are recovered from the residual streams at cost.

Organic materials such as wood, food and water can be incorporated into the ecosystem and reproduced through biological processes. In a biocycle, it is important to enable the ecosystem to do its job as well as possible. During this cycle, consumption can occur as long as the streams are not contaminated with toxic substances and ecosystems are not overloaded, which can then be regenerated.

Within the technological cycle, there are different levels of reuse. The rule of thumb is that the smallest or inner circle takes precedence over larger cycles, as it requires less processing, labor, energy, and new material to regain its original value.

Reuse in the technological cycle can be:

- maintenance and repair during use to extend the service life;
- reuse and redistribution, remarketing of goods;
- thorough restoration and repair of the product by the manufacturer;
- processing: obtaining parts or materials from the product for reuse [2].

Within a biocycle, reuse occurs in cascades, which means using a product or part of it to create another. When the product can no longer perform its original function, it is transferred for reuse. During cascading, the quality of the material decreases and energy is consumed [2].

. Cascading differs from conventional reuse and recycling in that it changes the functions and degree of recycling of the product. An example is a cotton T-shirt.

When reused, a worn-out T-shirt is sold second-hand, while when recycled, the T-shirt is shredded into cotton fibers, which are then spun into new yarn. Cascading is, for example, the use of old T-shirts as a filler for pillows [2].

For both the biocycle and the technocycle, the lifespan of the product should be as long as possible. Product lifespan can be extended in the following ways:

- ensuring the long-term use of the product, thereby "slowing down" the process, for example, by focusing on the emotional attachment to the product, long-term satisfaction of needs and adaptability of the product so that it can keep up with the times;
- ensuring consistent cycles of direct reuse, promoting product interchangeability and properly supporting products so that they can be used for a long time without repair [2].

For both the biocycle and the process cycle, residual streams that are not contaminated with other materials are the easiest to collect and reuse. Ensuring easy separation of materials from each other after use, residual streams are collected so that they are not contaminated with toxic substances, thus remaining the most useful.

As part of a biocycle, orange peels can serve as a good example. PeelPioneers collects orange peels from catering establishments and makes essential oils from them. If there are food residues in the skins, the essential oils will be contaminated and unsuitable for cosmetics, so the value decreases.

Plastic toys can serve as a good example within the technological cycle. If the toy is made entirely of polyester, it can be completely melted and reused. If the toy also has polyester components, they must first be separated before being processed with a high quality [2].

Circularity contributes to a more sustainable development of the world, but not all sustainability initiatives promote circularity.

Circularity focuses on the resource cycle, while sustainability is more about people, the planet, and the economy. Circularity and stability are related by visions, models and theories [2].

The idea of restoration design, developed by American professor John T. Lyle in the 1970s, is that processes in all systems can reuse their own energy and materials. Demand from society is also met within nature. Walter Stachel developed a vision of a closed-loop economy, including the principles of life extension, product repair and waste prevention. Selling services instead of goods is an important part of his thinking: everyone pays for the productivity of the goods. This leads to the concept of the economy of productivity.

In the cradle-to-cradle model developed by Michael Braungart, materials in industrial and commercial processes are considered as raw materials for technological and biological reuse. The design is developed literally "from cradle to cradle", which means that the design process takes into account the entire life cycle of the product and the raw materials used. Technical raw materials do not contain any components that are harmful to the environment; biological raw materials are completely biodegradable.

Industrial ecology is the science of material and energy flows, where waste in industrial cycles serves as a raw material for further process. Production processes are built in a way that resembles environmental processes.

Biomimicry is an approach developed by Janine Benus, in which inspiration comes from nature. Biomimicry imitates the ideas of nature and applies them to decisions in human society.

Green economy, as defined by the UN Platform for Security environment is an economy that leads to increased welfare and increased social equality, while significantly reducing environmental risks and environmental deficits [2].

The Blue Economy, developed by Günther Pauli, is an economic philosophy that derives its knowledge from the way natural systems are formed, produced, and consumed. This knowledge is applied to the problems we face and is transformed into solutions for the local environment with specific physical and environmental properties.

A biologically based economy is an economy that does not run on fossil fuels, but on biomass as a raw material. In a biologically based economy, we are talking about the use of biomass for non-food purposes.

The Donut Economy, developed by Oxford economist Kate Raworth, is a model for measuring the Earth's prosperity based on the Sustainable Development Goals and

planetary boundaries (global characteristics of the Earth that can determine the existence of humanity on the planet). Many planetary boundaries are directly related to open cycles, which are associated with the formation of greenhouse gases, toxic substances, eutrophication, etc. [2].

In addition, it is worth paying attention to how the circularity meets the UN Sustainable Development Goals (SDGs). The SDGs, also known as the Global Goals, are a general call for action to end poverty, protect the planet, and ensure peace and prosperity for all people in the world. The SDGs entered into force in January 2016, and have been the basis of UNDP policy and funding for the next 15 years [2]. 17 SDGs are as follows:

1. Overcoming poverty.
2. Overcoming hunger, achieving food security, improving nutrition and promoting sustainable agricultural development.
3. Ensuring a healthy lifestyle and promoting well-being for all at any age.
4. Ensuring comprehensive and equitable quality education and encouraging lifelong learning opportunities for all.
5. Ensuring gender equality, empowerment of all women and girls.
6. Ensuring accessibility and sustainable management of water resources and sanitation.
7. Ensuring access to low-cost, reliable, sustainable and modern energy sources for all.
8. Promoting progressive, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. Creating sustainable infrastructure, promoting inclusive and sustainable industrialization and innovation.
10. Reduction of inequality.
11. Ensuring openness, security, sustainability and environmental sustainability of cities and other settlements.
12. Ensuring the transition to rational models of consumption and production.
13. Take urgent action to combat climate change and its consequences.
14. Conservation and sustainable use of oceans, seas and marine resources for sustainable development.
15. Protection and restoration of land ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing the process of land degradation and stopping the process of biodiversity loss.
16. Promoting a peaceful and open society for sustainable development, ensuring access to justice for all and creating effective, accountable and participatory institutions at all levels.
17. Strengthening the means of implementation and intensification of work in the framework of the global partnership for sustainable development [4].

These 17 Goals are the success of the Millennium Development Goals; in addition, among other priorities, they also cover new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice.

Goals are interrelated – the key to success in one of them is to address issues that are generally related to others. They are comprehensive and indivisible and provide a

balance of three dimensions of sustainable development: economic, social and environmental [5].

The circular economy is also a way to achieve the Sustainable Development Goals. The results of a review of various literature and research show that the circular economy can directly contribute to the achievement of a significant number of CSR.

According to a study by Patrick Schroeder and Kartika Anggraeni, the strongest links and synergies between the circular economy model and the Sustainable Development Goals lie in SDG 6 (Clean Water and Good Sanitation), SDG 7 (Renewable Energy), and SDG 8 (Decent Work and Economic growth), SDG 12 (Responsible Consumption) and SDG 15 (Preservation of Land Ecosystems), which has both direct and indirect impacts. SDG 1 (Overcoming Poverty), SDG 2 (Overcoming Hunger) and SDG 14 (Preservation of Marine Ecosystems) can be achieved through the circular economy indirectly [6].

To the extent that a circular economy can help achieve the Sustainable Development Goals, SDGs can also contribute to the promotion of closed-loop economics. Progress in the implementation of many other SDGs that are not directly related to the circular economy will be useful for implementing the practice of this model. Of particular importance in this are SDG 16 (Peace and Justice), SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure) [6].

The circular economy model is based on the following principles:

- Energy and resources are gold. At first it seems that the essence of a circular economy is to get rid of waste, but in reality the model is based on the idea that there is no such thing as waste. To do this, products are designed to last a long time, thanks to quality materials, so that they are optimized for the reuse cycle.

Narrow production cycles distinguish the circular economy model from simple recycling and recycling, where large amounts of embedded energy and labor are lost. The ultimate goal is to preserve and increase natural capital by controlling final stocks and balancing the flow of renewable resources;

- following the natural cycle and design. In the model of circular economy there are technical and biological cycles. Consumption occurs only in biological cycles, where biologically based materials (food, natural tissues, etc.) are designed to return to the system through processes such as anaerobic digestion and composting. These cycles regenerate living systems, such as soils and oceans, that provide renewable resources for the economy. In turn, technical cycles recover products (such as washing machines), components (such as motherboards), and materials (such as limestone) through strategies such as reuse, repair, or recycling. Finally, one of the goals of the circular economy is to optimize the use of resources through the circulation of products, components and materials that are used most usefully at any time in both technical and biological cycles;

- all with renewable energy. The energy required to power this cycle must be renewable in nature in order to reduce resource dependence and increase the resilience of systems [7].

Over the past few years, the topic of the circular economy has significantly increased interest and continues to gain momentum. The non-profit organization Circle Economy researched the use of the terms "circular economy" and "circular principles"

among more than 20 governmental and non-governmental organizations, universities, consulting companies, etc. and based on the results identified 7 key elements underlying the circular economy:

1. Design for the future – calculating the prospects of systems during design, the use of appropriate materials, design for the appropriate service life and development for future use.

2. Integrating digital technologies – tracking and optimizing the use of resources and strengthening links between supply chain actors through digital technologies, Internet platforms and technologies that provide insight. Preserving and expanding what has already been done is maintaining, repairing, upgrading the product as long as it is in use to maximize their service life and give them a second life through return strategies where possible.

3. Giving priority to regenerative resources – ensuring efficient use of renewable, reusable, non-toxic resources as raw materials and fuel.

4. Use of waste as a resource – use of waste streams as a source of secondary resources and recovery of waste for reuse and recycling.

5.Business model review – consideration of opportunities to create greater product value and focus on business models that rely on the interaction between goods and services.

6. Collaboration to create shared value – collaboration throughout the supply chain, within companies and with the public sector to increase transparency and create shared value [8].

Circularity and sustainability are linked by visions, models and theories such as regenerative design, productivity economics, cradle-to-cradle model, industrial ecology, biomimicry, green economy, blue economy, bio-based economy, donut economy etc., which generates more and more new discussions.

Implementing the concept of sustainable development requires reliable tools. Economic incentives have always been the most effective mechanisms for change, which is why the creation of a conceptually new economic model is an important step towards achieving sustainable development. The concept of merging linear production lines into a closed cycle, called a circular economy, has become relevant. This model is based on the introduction of closed production cycles, the use of renewable energy sources and resources and systems thinking. The circular economy is also a way to achieve the 17 UN Sustainable Development Goals in both direct and indirect ways.

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