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POSSIBILITIES FOR APPLYING THE CIRCULAR ECONOMY CONCEPT TO INCREASE THE EFFICIENCY OF NATURAL RESOURCE USE IN THE REGIONAL ECONOMY

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Abstract. *The linear "take-make-dispose" economic model is straining regional economies and natural resources. The circular economy, which prioritizes resource retention and waste reduction, presents a promising alternative. This abstract explores the potential of applying circular economy principles to enhance natural resource efficiency in a regional context. We discuss key strategies like extending product lifecycles, promoting repair and reuse, developing innovative recycling technologies, and fostering collaborative consumption models. Implementing these approaches can yield both environmental and economic benefits, creating a more resilient and sustainable regional economy.*

Keywords: *Circular economy, regional development, natural resource efficiency, resource retention, waste reduction, product lifecycles, repair, reuse, recycling, collaborative consumption, sustainability, economic resilience.*

ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ КОНЦЕПЦИИ ЦИРКУЛЯРНОЙ ЭКОНОМИКИ ДЛЯ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ИСПОЛЬЗОВАНИЯ ПРИРОДНЫХ РЕСУРСОВ В РЕГИОНАЛЬНОЙ ЭКОНОМИКЕ

Аннотация. *Линейная экономическая модель «бери-используй-выбрасывай» создает нагрузку на региональную экономику и природные ресурсы. Экономика замкнутого цикла, в которой приоритет отдается сохранению ресурсов и сокращению отходов, представляет собой многообещающую альтернативу. В этом реферате исследуется потенциал применения принципов экономики замкнутого цикла для повышения эффективности использования природных ресурсов в региональном контексте. Мы обсуждаем ключевые стратегии, такие как продление жизненного цикла продуктов, содействие ремонту и повторному использованию, разработка инновационных технологий переработки и развитие моделей совместного потребления. Реализация этих подходов может принести как экологические, так и экономические выгоды, создавая более устойчивую и устойчивую региональную экономику.*

Ключевые слова: *циркулярная экономика, региональное развитие, эффективность использования природных ресурсов, сохранение ресурсов, сокращение отходов, жизненный цикл продукции, ремонт, повторное использование, переработка, совместное потребление, устойчивость, экономическая устойчивость.*

Circular economy (AI) is a model of economic development aimed at reducing waste, pollution and using resources. It is based on the principle of "waste as a resource" and strives to maximize the use of materials and energy throughout the life of a product or service. In contrast

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to the traditional linear economy based on the create, use, discard model, the circular economy focuses on saving resources and reducing the negative impact on the environment. As examples of the circular economy, we can cite the following:

Use of renewable resources: use of solar, wind and water energy instead of fossil fuels [1];

Manufacturing products from recycled materials: using recycled plastic to make new bottles or recycled metal to make new cars;

Repair and reuse of goods: instead of buying new goods, repair or reuse old ones;

Waste recycling: recycling waste instead of disposal;

The existing body of academic literature considers the implementation of AI at three levels: micro (single company or individual consumer), meso (eco-industrial park, supply chain) and macro (city, province, region, nation) [2] . However, this classification is not consistently used in the scientific community. Despite the inconsistency of the underlying levels of implementation, a regional level of AI adoption is beginning to emerge in the literature. Such practices are widely implemented mainly in European countries. This is due to their scale and managed economic systems, their proximity to environmental, social and economic issues and their ability to draw on the local expertise of relevant stakeholders.

One of the local scientists, Uktamov Khusnidin, proposed to base the model of the impact of circular economy innovations on the safety of industrial enterprises. ("3 R" (resource, processing, results)). The functional dependence of industrial enterprises in the 3 R model of the economic security system on the integrated parameters in the circular economy concept is carried out by combining the goals of energy efficiency and resource utilization profitability in the formation of preventive protection, and through this, a mechanism for ensuring the economic security of industrial enterprises has been developed [3].

According to Strat and other scholars, the regional circular economy (MAI) is the foundation of a functional global AI. National interconnected AIs must be in place to ensure the implementation of AIs at scale, but they can only be built in stages if interconnected regional AIs are in place. Synchronized efforts are required not only on the technical side, but also to provide a supportive management system that creates incentives, encourages innovation, and generates information. However, there is no consensus on the role that regions should play in AIs, especially in the academic literature; This is confirmed by the lack of a systematic literature review.

The concept of AIs was introduced to science more than 50 years ago by Boulding. the work of The first schools of thought began to form the theoretical foundations of this inevitable transition from a linear economy to a new economic model. The work of Pearce and Kerry Turner (1990) played an important role in the introduction of AIs, with the concept used to explain the functioning of the economy by taking into account the consequences of the environment-economy relationship [4]. In addition, Nohra et al. (2020) introduced the concept of environmental efficiency derived from the Cradle-to-Cradle principle and industrial ecology into the paradigm of AIs [5]. Van den Berghe and Vos (2019) [6] revisited Wachsmuth's (2012) seminal work on three ecologies of urban metabolism, namely human ecology, (urban) industrial ecology, and (urban) political ecology, and finally as a result, the operational concept of circularity within industrial ecology was also revised [7].

The following are the foundations of AIs: industrial ecology (SE), industrial symbiosis (SS) and ecological industrial parks (ESP).

Industrial ecology is an applied science that studies the interaction between industry and the environment. It covers a wide range of topics including:

Air, water and soil pollution due to industry;

Use of natural resources in industry;

Impact of industry on climate;

Environmental consequences of industrial accidents;

Industrial ecology is important in ensuring sustainable development of industry. It helps businesses reduce their environmental impact and improve their environmental performance.

The main tasks of industrial ecology are:

Assessing the impact of industry on the environment: Industrial ecology uses a variety of methods to assess the impact of industry on the environment, including pollution monitoring, modeling, and data analysis.

Developing ways to reduce the impact of industry on the environment: Industrial ecology develops ways to reduce the impact of industry on the environment, such as waste treatment, waste recycling and the use of renewable energy sources.

Promotion of environmental principles in industry: Industrial ecology promotes environmental principles in industry such as sustainable development and responsible consumption of resources.

Industrial ecology is closely related to other fields of science such as ecology, engineering, economics and law. It is an important part of sustainable development and plays a key role in environmental protection.

Here are examples of industrial ecology in practice:

A business can install a waste treatment system to reduce air pollution.

A business can use renewable energy sources such as solar or wind power to reduce greenhouse gas emissions.

A business can implement a recycling program to reduce the amount of waste sent to landfill.

Industrial ecology is an important field of science and practice. It helps businesses reduce their environmental impact and promotes sustainable development.

Industrial symbiosis is a model of cooperation between enterprises aimed at reducing waste, pollution and resource use. It is based on the principle of "waste as a resource" and strives to maximize the use of materials and energy throughout the life of a product or service.

Unlike the traditional linear economy based on the "make, use, throw" model, industrial symbiosis strives to conserve resources and reduce negative impacts on the environment.

Industrial symbiosis can take many forms, including:

Waste transportation: One enterprise can transfer its waste to another enterprise as raw material or fuel. For example, a paper mill may transfer its waste wood to a coal mill.

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Recycling and Recycling: Businesses can join together to recycle waste to reduce the amount of waste sent to landfills. For example, beverage companies may band together to recycle aluminum cans.

Resource sharing: Businesses can share resources such as water, energy or infrastructure. For example, power generation facilities may share power grids.

Industrial symbiosis has a number of advantages, including:

Reduce waste and pollution: Industrial symbiosis helps reduce the amount of waste and pollution entering the environment.

Conservation of resources: industrial symbiosis helps to conserve resources like minerals, water and energy.

Increased economic efficiency: Industrial symbiosis can increase economic efficiency because it reduces production and waste disposal costs.

Industrial symbiosis is an important strategy for sustainable development. It helps us reduce our impact on the environment and build a more sustainable future.

Some examples of industrial symbiosis are:

In the Netherlands, Heineken works with DSM to recycle beer waste into animal feed.

In the UK, Unilever is partnering with Veolia to turn food waste into fertiliser.

In China, Sinopec is partnering with China Petroleum & Chemical Corporation to share oil transportation infrastructure.

Industrial symbiosis is becoming more and more popular all over the world. It is an important tool for achieving the Sustainable Development Goals.

Ecological Industrial Parks (ESP) are special industrial zones aimed at sustainable development and minimizing environmental impact. They were created taking into account the principles of circular economy and industrial symbiosis**.**

ESP is characterized by the following features:

Physical Proximity of Enterprises: Enterprises in ESP are located close to each other, which facilitates interaction and sharing of resources.

Advanced Infrastructure: ESP has an advanced infrastructure that enables businesses to use resources efficiently and reduce their environmental impact.

Joint initiatives: Enterprises in ESP cooperate with each other in the field of environmental protection and sustainable development.

ESP has a number of advantages, including:

Reduce waste and pollution: ESP helps reduce waste and pollution as businesses can share resources and share infrastructure.

Saving Resources: ESP helps save resources as businesses use them more efficiently.

Improved economic efficiency: ESPs can increase economic efficiency because they reduce production and waste disposal costs.

ESPs are becoming more and more popular all over the world. They are an important tool for achieving the Sustainable Development Goals.

Here are examples of eco-industrial parks:

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In the Netherlands, EIP Chemelot brings together more than 100 companies that produce chemicals, fertilizers and other products. EIP Chemelot is one of the largest and most successful ecological industrial parks in the world.

In the UK, the Teesside Energy Park EIP brings together energy-related businesses such as oil refining, power generation and renewable energy. EIP Teesside Energy Park aims to become a leading center for low carbon energy.

In China, the EIP Zhangjiagang Eco-Industrial Park brings together enterprises related to light industry, including textiles, clothing and footwear. EIP Zhangjiagang Eco-Industrial Park is one of the largest eco-industrial parks in China.

Presented in the literature as a policy tool and an academic theory, SE concerns the impact on the biophysical environment of related changes in industry, technology, society, and the economy. According to Mirata and Emtaira, the discipline of SE encourages new ways of solving environmental problems at regional and local levels. Within SE, two main spatial approaches are important: eco-industrial parks (ESP) and SS [8].

According to Taddeo (2016) [9], SE offers sustainable approaches for local development, which is mainly manifested through the creation of ESPs, which are global reference models for the delivery of SE at the local level. From an organizational perspective, ESPs can emerge spontaneously from bottom-up initiatives or from a top-down planned approach, the former being more durable and more likely to succeed. SS refers to synergistic activities between companies, where the waste of one company includes materials, energy, services and facilities that can be input to another company. According to Savini (2019), the prototypes that created the latest models of AI date back to the late 1970s, when industrial production groups began to invest in SS and successful industrial design. Nevertheless, research on SS is considered to be theoretically fragmented [10].

Despite the already presented theoretical connections between AIs and the concept of SS, scholars take the connection between these two concepts as unique. For example, the following features of SS are listed: one of the most effective tools for transitioning to the system of AIs; AI development mechanism; One of the main strategies for creating AIra; a very useful tool for waste sharing and AI development and networking; regionally bound activator; early prototype of rotary production; Along with Eco-Industrial Parks, a mechanism to implement AI at the regional level and an approach that reinforces the idea of AIs.

Thus, scientists have established a relationship between SS and AIs according to the level of implementation. More precisely, SS is mainly viewed as a meso-level approach to implement the transition to AI systems.

Overall, our research found that industry and academic ecosystems are supportive and interested in SS, but regulatory and cultural challenges are the main barriers identified.

According to Scarpellini et al., the contribution of local and regional authorities to AI implementation and transition is crucial; therefore, AIs should be transferred to regional environmental planning.

The progress towards AIs in a region depends on various aspects, including industry structure, regional business, level of innovation, regional and local level legislative profile.

However, the holistic nature of planning – encompassing environmental, social and economic factors – can lead to situations where economic aspects take precedence over local development.

In general, regional adoption of AI is underexplored and in its early stages. This is based on the lack of research in this area when examining the available scientific literature. This means that the interest of researchers in this field is awakening. It should also be noted that there is little local research on this concept. At the same time, the close relationship between industrial symbiosis and the circular economy is based on various studies.

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