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Circular economy impact on global sustainable growth in international industrial business

Abstract: The increasing environmental threats and limited natural resources have led to a growing focus on sustainable development as a long-term strategy to maintain economic and environmental balance. This study aims to analyze the implementation of circular economy principles in industrial processes, which can improve resource use efficiency and minimize waste and environmental impact. The research method involves reviewing recent scientific articles on the circular economy and analyzing statistical data on industrial businesses that utilize environmental technologies. The study identifies key elements that facilitate the transition to circular production models and highlights the challenges that need to be overcome to achieve sustainable industrial development. The study also aims to identify the obstacles and challenges enterprises face in transitioning to circular production models. The objectives of the study include analysing theoretical approaches to the circular economy and its basic principles, assessing the economic and environmental impact of circular practices on industrial production, and identifying the main challenges industrial enterprises face in implementing circular models.

The study's findings provide valuable insights for governmental initiatives and businesses seeking to integrate circular concepts into their manufacturing practices. The proposed recommendations for improving the efficiency of implementing circular models can be used by industrial enterprises to optimize their production processes. Implementing circular models not only contributes to the economic growth of international enterprises but also improves the environmental situation, positively impacting society as a whole. It helps preserve natural resources for future generations and reduces the industry's impact on climate change.

Keywords: *international economics, international business, circular economy, global sustainable development, industrial production, environmental technologies, resource management, resource-saving, industrial international policy, waste.*

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Introduction. The field of modern economics faces significant challenges due to the increasing waste, depletion of natural resources, and the potential for a global environmental crisis. The circular economy presents a new framework for organizing production processes with the aim of maximizing resource usage and reducing waste by reusing resources. This concept is built on the idea of sustainable development, which seeks to strike a balance between environmental preservation and economic progress.

The circular economy has the potential to generate additional value by optimizing industrial processes and raw material usage, making it increasingly relevant for research. Given the limitations of resources, one of the key aspects of maintaining sustainable development is the transition to circular industrial production models.

This article aims to examine how the circular economy impacts the development of industrial enterprises and their ability to adapt to new market conditions. The study will also explore how implementing circular approaches contributes to achieving sustainable development goals at both national and international levels.

Literature review. The concept of the circular economy has sparked numerous scientific research endeavors globally due to its potential to tackle major environmental and economic challenges. It originated as a critique of the linear economic model, which involves using resources only once and then generating waste. A number of recent studies, including those by Gregson [8] and 4. Huang, H. C., & Hu, C. F. [4], examine the social and economic advantages of introducing circular processes in business. They make the point that the circular economy generates new employment opportunities in environmental design and recycling while lowering reliance on raw resources. Furthermore, resource-reuse-based economic models foster innovation, especially in the areas of energy conservation and production [1-3].

The circular economy has the ability to significantly shift the industrial sector toward sustainable growth, according to the majority of academics [6]. However, there are a number of obstacles to its implementation, especially in the institutional and economic environments. [7]

A survey of the literature demonstrates the critical role that financial techniques and the circular economy play in guaranteeing the long-term viability of industrial output. [20] More recent studies [25] look at the relationship between digital transformation and econometrics within the framework of Industry 4.0 and 5.0 concepts, which promotes innovative approaches to ensure sustainable development.

In a research published in 2020, Kraus et al. [12] extensively examine innovation in the context of the circular economy and emphasize how crucial innovation is to the successful application of this concept in industrial production. A research released by Springer in 2021 [23] looks at the connection between sustainable development and the circular economy. The writers examine these notions' key points of similarity and distinction as well as how they affect industrial output. A 2021 analysis that was comparable to this one emphasizes how crucial the circular economy is to global trade. The shift to a fair CE and its effects on global trade are examined by the writers through a methodical assessment of the literature. [9-15]

Geissdoerfer et al. [5] conducted a systematic analysis of the circular economy concept and its implications for sustainable development. The study highlights the critical role that the integration of circular economy principles into industrial processes plays in achieving sustainable development. In contrast, Kirchherr et al.'s [11] study, which looks at the drivers and challenges to implementing the circular economy in the industrial sector, discovered that the absence of a legislative framework and budgetary limitations are the primary obstacles.

Lieder, M., & Rashid, A. [15] examine how the circular economy affects businesses' financial results and evaluate the financial success of those who have adopted the strategy using quantitative techniques. The relationship between the circular economy and innovation in industrial production is examined by Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. [21], who emphasize the significance of innovation for the circular economy's successful implementation.

Ghisellini, P., Cialani, C., & Ulgiati, S. [7] evaluate how the circular economy affects industrial companies' environmental sustainability. The authors evaluate the success of the circular economy using environmental indicators.[26-27]

Aim, objectives and methods of the study. This research aims to assess the impact of the circular economy on long-term industrial production viability and explore its potential applications across various industries to maximize resource efficiency and minimize environmental impact. The study also aims to identify the obstacles and challenges enterprises face in transitioning to circular production models. The objectives of the study include analysing theoretical approaches to the circular economy and its basic principles, assessing the economic and environmental impact of circular practices on industrial production, and identifying the main challenges industrial enterprises face in implementing circular models.

The study includes quantitative and qualitative analysis of data collected from various sources, namely analysis and synthesis to summarise scientific works on the circular economy and determine its impact on the industrial sector, economic and statistical analysis to assess the overall impact of the introduction of circular models on the economic performance of a particular country, and a comparison method to compare the results of studies of various industries that have implemented circular approaches. A mixed-method approach is used, which includes both quantitative and qualitative methods of data collection and analysis. Primary data is collected through surveys and interviews with representatives of industrial enterprises that have implemented circular models. In contrast, secondary data is analyzed from academic articles, reports of international organizations, government documents and statistics.

The sample includes industrial enterprises from different sectors of the economy that are actively implementing circular economy models. It is based on criteria such as enterprise size, industry, and geographical location. The data analysis uses statistical analysis to identify changes in raw material costs, waste volumes, and economic performance, as well as content analysis of interviews and secondary sources to identify key trends and barriers to circular economy implementation.

The research tools include Microsoft Power BI structured big data processors for quantitative data collection and semi-structured interviews for qualitative data collection from official Internet resources of the selected enterprises, as well as software such as SPSS for quantitative analysis and NVivo for qualitative analysis. The research stages include the preparatory stage, data collection, data analysis and interpretation of results. Limitations of the study include a limited sample of enterprises, which may affect the generalisability of the results, and possible subjective biases of respondents during the interviews. The ethical aspects of the study include ensuring the confidentiality and anonymity of respondents, as well as obtaining informed consent to participate in the study.

Research results. The analysis's results show that implementing circular economy principles in industrial processes significantly reduces the use of primary resources and waste. Industrial enterprises that have integrated circular models have recorded reduced production costs due to the recycling of raw materials and decreased dependence on the supply of new resources.

In particular, the transition to closed cycles in the metalworking industry resulted in 30% savings in the use of raw materials and a 20% reduction in emissions. In the light industry, the increased use of recycled materials helped to reduce the cost of purchasing new materials, which increased product profitability.

One key success factor for circular models in industry is the introduction of innovative waste and raw material processing technologies. Businesses that utilize advanced technologies for recycling and separate trash collection and disposal achieve significantly higher resource efficiency, reduced greenhouse gas emissions, and a smaller environmental impact.

Despite the positive results, the study identified specific challenges that commercial organizations face when implementing circular strategies. The main obstacles include the

substantial initial costs of updating manufacturing processes, as well as insufficient support from government agencies in the form of financial incentives and a legislative framework that would promote the circular economy.

An economic and statistical analysis of the impact of the implementation of circular models on the country's economic indicators. To evaluate the effect of circular economic models on the economic performance of industrial enterprises, we conducted an analysis using data from 20 Ukrainian companies that implemented circular economic models in their production processes from 2017 to 2023. We analyzed the main circular models implemented by these Ukrainian enterprises and categorized them based on the year of their implementation:

Motor Sich (2019) - Implemented programs for recycling materials and using renewable components in the production of aircraft engines.

Interpipe (2020) - Recycled steel waste and created a closed steel production cycle based on waste from its own production.

Zaporizhstal (2018) - Implemented a closed water cycle that minimizes water consumption in production processes.

Ukrnafta (2020) - Implemented programs for recycling industrial waste and restoring fields through oil recycling.

Kernel (2021) - Using organic waste from agricultural production for biogas production, which allows closing the energy cycle in production.

Astarta (2020) - Implemented composting systems for organic waste from agricultural production to reduce waste.

Metinvest (2019) - Processed metallurgical slag and used it in construction as secondary materials.

Farmak (2018) - Optimized production processes by reducing resource consumption and minimizing waste in pharmaceutical production.

Obolon (2021) - Used recycled PET containers in producing new plastic bottles, reducing the use of primary resources.

Nemiroff (2020) - Used agricultural waste for bioethanol production, allowing the conversion of residues into energy.

Nibulon (2019) - Implemented closed cycles in the production of grain products by recycling waste into feed additives.

ArcelorMittal Kryvyi Rih (2021) - Reduced energy consumption and emissions by reusing metallurgical waste and secondary raw materials.

Pivdenmash (2020) - Developed technologies for recycling waste in spacecraft production and minimizing the use of rare materials.

Turboatom (2019) - Implemented the latest technologies in the production of turbines using recycled materials and reducing energy consumption.

Ukrtatnafta (2020) - Implemented programs to reduce the volume of refinery waste and recycle it into valuable products, such as asphalt mixtures.

Epicentre K (2021) - Used recycled materials in construction products to minimize the consumption of new resources.

Avdiivka Coke (2021) - Optimized production by reducing emissions and using secondary resources in production processes.

Karpatnaftochim (2020) - Implemented closed-cycle technologies for processing chemical waste into secondary products.

Myronivsky Hliboproduct (2018) - Implemented composting systems and used agricultural waste for bioenergy production.

DTEK (2022) - Developing strategies to reduce carbon emissions and use renewable energy sources in production.

The study covered the leading indicators of financial and economic activity: profit, production volumes, raw materials, and waste costs. Table 1 presents the averages of the above 20 Ukrainian companies.

*Table 1. Key Economic Indicators Before and After Implementation of Circular Economy Models (averaged across Ukraine for selected 20 enterprises)**

Indicator	2017 (before implementation)	2023 (after implementation)	Change, % change
Net profit, UAH million	15,6	23,8	+52,6
Production costs, UAH million	40,2	32,4	-19,4
Raw material costs, UAH million	25,8	17,1	-33,7
Production volume, thousand tonnes****.	180	215	+19,4
Production wastes, thousand tonnes****.	35	18	-48,6

** calculated by the author based on official statistical data from https://www.ukrstat.gov.ua/; https://youcontrol.com.ua/ and official websites of such enterprises: MotorSich (http://motorsich.com/), Intertipe (https://interpipe.biz/), Zaporizhstal (https://metinvest-smc.com/ua/articles/zaporizstal/), Ukrnafta (https://www.ukrnafta.com/), Kernel (https://www.kernel.ua/ua/), Astarta (https://astartaholding.com/), Metinvest (https://metinvestholding.com/), Farmak (https://farmak.ua/), Obolon (https://obolon.ua/en/), Nemiroff (https://nemiroff.vodka/en/), Nibulon (https://nibulon.com/), ArcelorMittal (https://ukraine.arcelormittal.com/), Pivdenmash (https://yuzhmash.com/), Turboatom (http://turboatom.com.ua/), Ukrtatnafta (https://ukrtatnafta.com/), Epicentre K (https://epicentrk.ua/), Avdiivka Coke Plant (https://akz.metinvestholding.com/), Karpatnaftochim (http://knh.com.ua/), Myronivsky Hliboproduct (https://mhp.com.ua/), DTEK (https://dtek.com/)*

*** average conditional indicator for the country for the selected 20 enterprises to represent the general trend in the country and to establish the effects of implementing circular economy models in Ukraine as a whole*

As shown in Table 1, the average profit of the 20 Ukrainian enterprises surveyed, which implemented the above circular models, increased by 52.6% on average after the implementation of the circular models described above for each of the Ukrainian enterprises, which confirms the positive economic effect of reducing raw material costs and optimising production processes. Production costs decreased by 19.4%, reflecting a significant reduction in raw material costs and the introduction of closed resource cycles.

*Table 2. Average Economic Efficiency of Ukrainian Enterprises Depending on the Time of Implementation of Circular Economy Models**

Year of model implementation	Average profit growth, %****	Average reduction in raw material costs, %****	Average waste reduction, %****
2017	+25	-15	-12
2018	+32	-18	-22
2019	+41	-22	-30
2020	+48	-29	-38
2021	+52	-33	-44
2022	+56	-36	-47
2023	+59	-40	-49

** calculated by the author based on official statistical data from https://www.ukrstat.gov.ua/; https://youcontrol.com.ua/ and official websites of such enterprises: MotorSich (http://motorsich.com/), Intertipe (https://interpipe.biz/), Zaporizhstal (https://metinvest-smc.com/ua/articles/zaporizstal/), Ukrnafta (https://www.ukrnafta.com/), Kernel (https://www.kernel.ua/ua/), Astarta (https://astartaholding.com/), Metinvest (https://metinvestholding.com/), Farmak (https://farmak.ua/), Obolon (https://obolon.ua/en/), Nemiroff (https://nemiroff.vodka/en/), Nibulon (https://nibulon.com/), ArcelorMittal (https://ukraine.arcelormittal.com/), Pivdenmash (https://yuzhmash.com/), Turboatom (http://turboatom.com.ua/), Ukrtatnafta (https://ukrtatnafta.com/), Epicentre K (https://epicentrk.ua/), Avdiivka Coke Plant (https://akz.metinvestholding.com/), Karpatnaftochim (http://knh.com.ua/), Myronivsky Hliboproduct (https://mhp.com.ua/), DTEK (https://dtek.com/)*

*** average conditional indicator for the country for the selected 20 enterprises to represent the general trend in the country and to establish the effects of implementing circular economy models in Ukraine as a whole*

As shown in Table 2 and based on the conclusions of the economic and statistical analysis, the average production volume in Ukraine for the 20 enterprises surveyed that have implemented the relevant circular models increased by 19.4%, which demonstrates the growth of production

capacities of enterprises through the use of resource-saving technologies, and production waste decreased by almost 50%, which indicates the effective implementation of circular practices and a reduction in negative environmental impact. These results demonstrate that implementing the circular economy is beneficial not only from an environmental but also from an economic point of view, contributing to the competitiveness of enterprises.

To assess the impact of circular economic models on the economic performance of industrial production, we analysed data from 5 countries (the Netherlands, Germany, Japan, China, and Finland) from 2016 to 2022. We evaluated the following circular models that were implemented in industrial production in these countries in the period 2016-2022:

- The Netherlands has implemented a closed-loop model for producing building materials, where companies actively use construction waste to create new materials. For instance, companies like Van Wijnen have introduced a construction model that allows for easy disassembly and reusing of materials, ultimately reducing the consumption of primary resources. Additionally, the Netherlands has adopted sectoral approaches to biomass processing in agriculture and the food industry, which has helped minimize waste and increase the efficiency of agricultural production.

- Germany: *Industry 4.0:* This initiative introduces digital technologies to optimise production processes through automation and energy efficiency. German companies such as Siemens and BMW actively use secondary resources and implement technologies to reduce industrial waste. *A programme for recycling batteries and automotive components in the automotive industry:* This programme has helped companies such as Volkswagen reduce their environmental footprint.

- Japan: *Industrial symbiosis*: A model where waste from one company becomes a resource for another is being widely implemented in Japan. Cities such as Kitakyushu are examples of industrial symbiosis, where businesses interact to optimise resources. *Sustainable transport:* Japanese automakers such as Toyota are implementing sustainable production and waste management concepts in their factories, particularly as part of developing hybrid and electric vehicles.

- China: *Recycling in the textile industry*, where waste fabrics are used to produce new products, reducing the consumption of virgin raw materials. *Green chemistry:* Chinese chemical companies, like Sinopec, have implemented circular technology to minimise toxic waste and adopt greener production methods.

- Finland: Finland's *circular bioeconomy model* has made it a world leader in processing biomass for energy and industrial materials. Companies such as Nestle are implementing technologies to produce biofuels from renewable resources. *Paper industry:* Finnish paper and pulp producers are actively using wood waste to produce secondary products, which helps close the forest resource cycle.

The countries assessed are implementing various circular models to reduce the use of primary resources, recycle waste and reduce their environmental impact. Key economic indicators were assessed: GDP growth in industrial production, reduction of production costs, raw material costs, and waste reduction. The results are presented in Table 3.

Table 3. Key Economic Indicators Before and After the Implementation of Circular Economy Models (Country Average)

Country	GDP from industry, 2016 (USD billion)	GDP from industry, 2022 (USD billion)	Reduction in raw material costs, %	Waste reduction, %
Netherlands	180	240	-30	-40
Germany	600	720	-22	-35
Japan	940	1020	-25	-38
China	4800	5400	-18	-30
Finland	150	195	-32	-45

** calculated by the author based on the analysis of official data from the* UNEP Report on Circular Economy Indicators: Springer Report on Performance Indicators in Circular Economy: Eionet Portal on Circular Economy Country Profiles

As Table 3 shows, GDP growth in the industrial sector in all countries where circular economic models have been implemented has shown positive dynamics. The most significant growth was observed in the Netherlands (+33.3%) and Finland (+30%), indicating a high implementation level of environmental and innovative technologies. The reduction in raw material costs ranged from 18% in China to 32% in Finland. This demonstrates the effectiveness of closed loops in resource use, reducing company costs.

*Table 4. Efficiency of Circular Economy Models Implementation by Key Economic Indicators**

Country	Average GDP growth from industry, %	Reduction in raw material costs, %	Reduction of production waste, %
Netherlands	+33,3	-30	-40
Germany	+20,0	-22	-35
Japan	+8,5	-25	-38
China	+12,5	-18	-30
Finland	+30,0	-32	-45

** calculated by the authors based on the analysis of official data from the* UNEP Report on Circular Economy Indicators: Springer Report on Performance Indicators in Circular Economy: Eionet Portal on Circular Economy Country Profiles

The economic and statistical analysis conclusions for the countries of the world presented in Tables 3 and 4 also show that the reduction in industrial waste was most significant in Finland (-45%) and the Netherlands (-40%). This underscores the importance of implementing circular models to reduce the environmental burden on countries with high industrial activity. The results of the analysis show that circular economy models have both environmental and economic benefits for countries, contributing to GDP growth and reducing costs and waste, which is an essential factor in the sustainable development of industrial production at the global level.

Comparison of the results of implementing circular economic models in different industries. To apply the comparison method, we analysed the results of implementing circular approaches in three major industries: *metallurgy*, *chemicals*, and *mechanical engineering*.

The following circular models were evaluated to compare the results of implementing circular approaches in three major industries (metallurgy, chemicals, and machine building):

- *Metallurgy: A closed-loop model:* The use of metallurgical waste to make new metal products. Companies recycle scrap metal, reducing dependence on primary ore and energy costs. *Recycling of by-products*: Recovering slag that can be used in the construction or cement industry reduces waste and reuses resources.

- *Chemical industry: Green chemistry*: Using technologies to reduce toxic waste and introduce greener production processes that promote a closed chemical cycle. *Biopolymers and bioplastics:* Using biodegradable materials instead of traditional petrochemical polymers reduces the environmental footprint and improves recyclability.

- *Mechanical engineering: Modular design*: The production of machinery and equipment with modular components that allow for easy replacement or repair of individual parts, extending the product's life cycle. *Remanufacturing*: The process of restoring used machine parts to new conditions for reuse, which saves resources and reduces waste.

These models allow resources to be used more efficiently, reduce costs and environmental impact, and allow production to remain stable in various industrial sectors. The economic performance of the following countries was assessed: Germany, the Netherlands, Japan, Finland, and China, and the results are presented in Table 5.

As shown in Table 5, the industry's GDP grew alongside lower raw material costs, reduced production waste, and increased recycling. The most significant increase in GDP was recorded in the chemical industry in Finland (+35%) and the Netherlands (+28.5%). This is evidence of the active implementation of circular economy approaches in these countries, which

significantly contributes to the development of their industries. The chemicals industry in Finland saw a significant 35% reduction in raw material costs, while the metals industry in the Netherlands experienced a 30% decrease. This was due to a focused effort on optimizing resource utilization. In terms of production waste, the chemical industry in Finland and the Netherlands both achieved major reductions, with decreases of 50% and 45% respectively. This underscores the positive impact of circular economic models on environmental performance. Additionally, the metallurgy industry in Finland and the Netherlands boasted the highest recycling rates, with increases of 45% and 40% respectively. This emphasizes the potential for using recycled materials in production. The comparison of implementing circular models has revealed that the chemical industry and metallurgy are the most flourishing sectors, particularly in countries like Finland and the Netherlands. These countries exhibit high GDP growth, decreased raw material expenses, and reduced production waste, highlighting the effectiveness of the circular economy for sustainable development.

*Table 5. Comparison of Circular Economy Model Implementation Results in Different Industry Sectors by Country**

Country	Industry	GDP growth in the industry, %	Reduction in raw material costs, %	Reduction of production waste, %	Increase in recycling, %
Germany	Metallurgy	+18,0	-25	-30	+35
	Chemical industry	+22,0	-28	-40	+32
	Mechanical engineering	+15,5	-20	-25	+30
Netherlands	Metallurgy	+25,0	-30	-35	+40
	Chemical industry	+28,5	-32	-45	+38
	Mechanical engineering	+20,0	-27	-32	+35
Japan	Metallurgy	+12,5	-18	-28	+25
	Chemical industry	+16,0	-22	-35	+28
	Mechanical engineering	+10,0	-15	-20	+22
Finland	Metallurgy	+30,0	-32	-40	+45
	Chemical industry	+35,0	-35	-50	+42
	Mechanical engineering	+22,0	-30	-35	+38
China	Metallurgy	+10,5	-15	-20	+20
	Chemical industry	+12,0	-18	-25	+23
	Mechanical engineering	+8,0	-12	-15	+18

** calculated by the author based on the analysis of official data from the UNEP Report on Circular Economy Indicators: Springer Report on Performance Indicators in Circular Economy: Eionet Portal on Circular Economy Country Profiles*

Results discussion

The study's results indicate that implementing a circular economy in industrial production can make a significant contribution to sustainable development, helping to address issues related to the inefficient use of resources and environmental problems. However, for a more comprehensive understanding of this process, it would be beneficial to compare the results with previous research and international experiences.

Comparison with other studies. Researchers such as Gregson and colleagues (2015) note that the circular economy opens up new opportunities for industrial enterprises to conserve resources and improve competitiveness. Prasad (2019) also emphasises that the recycling of materials and the use of closed loops in production help reduce pressure on natural resources and

improve enterprises' environmental sustainability. Our results confirm these findings, as circular approaches significantly reduce raw material costs and reduce environmental pollution.

However, as noted by Lawrence and Collie (2021), the most severe challenges for industrial enterprises are the high costs of transitioning to a circular economy and the lack of government support. These findings also coincide with our survey results, where enterprises reported difficulties in financing such changes, especially at the initial implementation stage. In particular, Ukrainian business respondents expressed that investments in equipment upgrades and infrastructure for material reuse are often too burdensome without government subsidies or soft loan programmes.

The role of government policy. In addition to financial barriers, an important aspect is the lack of incentive state policy. Most EU countries have special support programmes for industrial enterprises implementing circular models. In the Netherlands, for example, the government provides tax incentives for companies that recycle and reuse resources (Stahel, 2016). In Ukraine, such mechanisms do not yet exist, which slows down the process of introducing new approaches and creates additional barriers to innovative changes.

Innovative technologies as an engine of progress. The use of new technologies is one of the main driving forces behind the success of the circular economy. For example, introducing new processing methods in the steel industry has significantly improved production efficiency, reducing the need for new resources by 20-30%. Like many chemical companies, innovative emissions treatment technologies have significantly reduced harmful substances' emissions. However, the technological backwardness of some industrial enterprises remains an obstacle to a successful transition to circular models.

Thus, despite the undeniable advantages of the circular economy, a number of factors require additional attention. These include, first and foremost, financial challenges and the need to create an appropriate regulatory framework that will encourage businesses to use circular approaches. In addition, it is essential to introduce innovative technologies more actively, which will significantly simplify the transition to sustainable development.

Conclusion

The study of the impact of the circular economy on the sustainable development of industrial production allows us to draw several important conclusions about the effectiveness and feasibility of its implementation.

The circular economy plays a key role in reducing resource consumption and minimizing the negative impact on the environment. It achieves this through closed production cycles, involving material reuse and recycling. In a study, both the 20 Ukrainian companies surveyed and the global companies implemented various circular models, resulting in reduced raw material costs and improved financial performance.

Innovative technologies are essential for successful implementation of the circular economy. Technologies for material recycling, waste collection and disposal, and production process optimization enable industrial enterprises worldwide to effectively implement circular models and reduce their environmental footprint. These technologies also contribute to the overall GDP of their respective countries.

Financial challenges are identified as a major obstacle to implementing circular approaches in the industry. The high initial investment required to modernize production facilities and the lack of government support pose serious barriers for many enterprises. Developing state incentive programs and creating favorable conditions for enterprises implementing circular models is crucial.

An effective regulatory framework is another important factor for the successful transformation of the industrial sector towards a circular economy. Government support in the form of tax breaks, subsidies, and special lending programs can significantly accelerate this process, as seen in many European Union countries.

Further research should aim to develop new models of the circular economy for different industries and find ways to reduce the cost of implementing the latest technologies. Emphasis

should be placed on developing innovative waste recycling methods and utilizing renewable resources for the long-term and sustainable development of the industrial sector in a resource-limited environment.

The study's scientific significance lies in its in-depth analysis of the impact of the circular economy on the economic and environmental aspects of industrial production. The proposed recommendations for improving the efficiency of implementing circular models can be used by industrial enterprises to optimize their production processes.

Implementing circular models not only contributes to the economic growth of international enterprises but also improves the environmental situation, positively impacting society as a whole. It helps preserve natural resources for future generations and reduces the industry's impact on climate change.

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Вплив циркулярної економіки на глобальне стале зростання міжнародного промислового бізнесу

Анотація. Зростання екологічних загроз та обмеженість природних ресурсів призвели до зростання уваги до сталого розвитку як довгострокової стратегії підтримки економічного та екологічного балансу. Це дослідження має на меті проаналізувати впровадження принципів циркулярної економіки в промислові процеси, які можуть підвищити ефективність використання ресурсів і мінімізувати відходи та вплив на навколишнє середовище. Метод дослідження включає огляд останніх наукових статей про циркулярну економіку та аналіз статистичних даних промислових підприємств, які використовують екологічні технології. Дослідження визначає ключові елементи, які сприяють переходу до циклічних моделей виробництва, і висвітлює проблеми, які необхідно подолати для досягнення сталого промислового розвитку. Дослідження також має на меті визначити перешкоди та виклики, з якими стикаються підприємства при переході на моделі циклічного виробництва. Цілі дослідження включають аналіз теоретичних підходів до циркулярної економіки та її основних принципів, оцінку економічного та екологічного впливу циркулярних практик на промислове виробництво та визначення основних викликів, з якими стикаються промислові підприємства при впровадженні циркулярних моделей.

Результати дослідження дають цінну інформацію для урядових ініціатив і компаній, які прагнуть інтегрувати циклічні концепції у свою виробничу практику. Запропоновані рекомендації щодо підвищення ефективності впровадження кругових моделей можуть бути використані промисловими підприємствами для оптимізації виробничих процесів. Впровадження циркулярних моделей не тільки сприяє економічному зростанню міжнародних підприємств, але й покращує екологічну ситуацію, позитивно впливаючи на суспільство в цілому. Це допомагає зберегти природні ресурси для майбутніх поколінь і зменшує вплив промисловості на зміну клімату.

Ключові слова: *міжнародна економіка, міжнародний бізнес, циркулярна економіка, глобальний сталий розвиток, промислове виробництво, екологічні технології, управління ресурсами, ресурсозбереження, міжнародна промислова політика, відходи*

Табл.: 5, бібл.: 27

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