

Rational environmental management as a guideline for the economic transformation of production relations

Andrey Pizhurin^{1*}, Oksana Goncharova², Lioubov Sazhneva³, and Cristian Salazar⁴

¹Moscow State University of Civil Engineering, 26, Yaroslavskoe shosse, Moscow, 129337, Russia

²Armavir State Pedagogical University, Armavir, Krasnodar region, Russia

³ITMO National Research University, ITMO University, 197101. 49 Kronverksky Avenue, Saint Petersburg, Russia

⁴Escuela Superior Politécnica de Chimborazo (ESPOCH), Facultad de informática y electrónica, Panamericana Sur km 1 1/2, Riobamba, 060155, Ecuador

Abstract: The article considers the conceptual foundations of rational nature management as a key reference point for the economic transformation of production relations. In the conditions of the modern world economy, characterised by the growing environmental crisis and limited natural resources, rational nature management is the most important factor of sustainable development. The authors analyze historical aspects of the evolution of production relations and identify the main stages of integration of environmental criteria into economic models. The aim of the study is to identify optimal mechanisms and tools that promote the harmonization of economic activity with environmental requirements. The study considers approaches to the formation of environmentally-oriented production processes and natural resource management at the level of enterprises and the national economy as a whole. It also analyses examples of successful integration of environmental principles into production practices in various countries and regions. Special attention is paid to the analysis of legislative and regulatory frameworks that ensure the implementation of the principles of rational nature management in the economy. The article offers recommendations for improving government policy and corporate strategies in the field of ecology; it also discusses the prospects for further development of environmentally oriented production models.

1 Introduction

In today's world, issues of sustainable development and environmental management are becoming increasingly important. Economic growth and production activity often face the need to balance environmental aspects with the resource needs of society. Environmental management is an important tool in achieving this balance, contributing not only to the conservation of natural resources, but also to the efficiency of production processes [1].

* Corresponding author: nadya.gavr@inbox.ru

The purpose of this study is to consider the key aspects of environmental management as a reference point for the economic transformation of production relations. The relevance of the topic is determined by the need for sustainable development and environmental protection in the context of growing environmental challenges. The work considers the conceptual foundations, historical aspects and practical aspects of integrating environmental criteria into economic strategies and policies.

Also, the impact of environmental management on various aspects of the economy is analyzed, recommendations for optimizing production processes with regard to natural resources are presented, and the prospects for the development of environmentally-oriented production models are considered.

2 Materials and Methods

To write the article, an extensive analysis of modern scientific literature on the topic was carried out. The key concepts, theories and approaches to rational nature management, its impact on the economy and sustainable development were identified. It was also investigated the evolution of production relations taking into account the impact on natural resources at different historical stages, identified the main points and changes in the attitude to nature management in different economic systems.

In addition, different environmental management policies and approaches in different countries and regions have been compared, and their effectiveness and applicability in different contexts have been assessed.

We analyzed the economic mechanisms and instruments that facilitate or hinder the implementation of environmental management. The economic benefits and costs of the transition to sustainable environmental management have been assessed.

3 Results

In the conditions of the modern world economy, which is facing an increasing environmental crisis and limited natural resources, rational environmental management becomes a key element of sustainable development [2]. The interaction of human activity with the natural environment leads to resource depletion, environmental pollution and climate change, which threatens not only economic progress, but also the very existence of humanity.

Environmental stewardship involves the optimal use of natural resources, taking into account their limitations, and the conservation of biodiversity. This includes the introduction of efficient technologies that minimise waste and emissions into the environment, as well as the development of resource management strategies at the scale of both individual enterprises and the national economy.

The main goal of environmental management is to ensure the sustainability of economic development while preserving natural ecosystems and their ability to regenerate themselves. This requires an integrated approach that includes not only economic and technological measures, but also political support, education and public awareness.

Thus, environmental management is necessary to overcome the challenges of the current environmental crisis and to ensure sustainable development at both global and local levels. This implies the creation of conditions for the life and development of future generations, preservation of environmental sustainability and equitable distribution of natural resources [3].

The history of the evolution of production relations and the integration of environmental criteria into economic models reflects changes in society's attitude towards the environment

and natural resources. The Industrial Revolution began in the late eighteenth and early nineteenth centuries and was a turning point in industrial relations. New technologies and production methods were developed, leading to a dramatic increase in production, but also to significant environmental impacts, including air, water and soil pollution.

In the mid-nineteenth century, economic science began to develop, leading to the formation of the first economic models. At that time, economic theories mainly focused on production growth and income growth, often ignoring environmental issues.

In the middle of the 20th century, an ecological approach to production and development began to emerge. The first serious environmental crises, such as pollution of rivers and oceans, declining biodiversity and climate change, were noted. This drew the attention of the public and authorities to the need for integrating environmental criteria into economic models.

At the end of the XX century and the beginning of the XXI century, the integration of environmental aspects into economic models began. Leading economists and politicians recognised the need of taking into account environmental externalities, developed new economic instruments, such as environmental taxes and emission trading quotas, and began to introduce the principles of sustainable development into national strategies [4].

Nowadays, the importance of integrating environmental criteria into economic models is becoming increasingly clear due to the threats of climate change, extinction of species and exhaustion of natural resources. Modern economic models increasingly include the analysis of environmental risks and opportunities, which contributes to the development of more sustainable and effective development strategies [5].

Thus, the integration of environmental criteria into economic models has come a long way from the beginning of industrialization to the current challenges of global sustainable development. This process is ongoing and requires further improvement of economic instruments and approaches to achieve harmony between economic growth and nature conservation.

4 Discussion

The following aspects can be considered to identify the best mechanisms and instruments to help harmonize economic activities with environmental requirements.

1. Environmental taxes and fines. The introduction of tax and penalty measures for companies that violate environmental standards incentivizes the use of clean technologies and emission reductions.

2. Subsidies and government incentives. Providing financial incentives and subsidies to companies that adopt environmentally friendly technologies and production methods.

3. Environmental certifications and regulations. Establishment of mandatory environmental standards and certifications for products and production, which helps to reduce harmful effects on the environment.

4. Environmental legislation. Development and implementation of strict environmental regulations and standards those are mandatory for enterprises to comply with.

5. Banning the use of certain technologies and substances. Limiting or completely banning the use of hazardous chemicals and technologies that negatively affect the environment.

6. Assessment of environmental impacts. Implementation of methods and models to quantify the environmental impacts of production processes and products.

7. Value of biodiversity losses and ecosystem services. Integrate biodiversity loss and ecosystem service values into economic calculations and decision-making.

The purpose of the implementation of these measures, their advantages and use cases are presented in table 1.

Table 1. Measures to reduce the load on the environment

Description of the measure	Goal	Results to be achieved	Example
Environmental taxes and fines	The introduction of taxes and fines for companies that violate environmental standards in order to encourage the use of clean technologies and reduce emissions into the environment.	Reducing the negative impact on the environment through economic incentives for enterprises to introduce environmentally friendly technologies and comply with standards.	Carbon tax in the EU countries.
Subsidies and state benefits	Provision of financial subsidies and benefits to enterprises introducing environmentally friendly technologies and production methods.	Supporting and stimulating the transition to environmentally friendly technologies, reducing the cost of implementing environmentally friendly solutions.	Renewable energy subsidy programme in Germany (Energiewende).
Environmental certifications and regulations	Establishment of mandatory environmental standards and certification of products and production in order to reduce the harmful impact on the environment.	Ensuring a high level of environmental safety of products and production processes, stimulating environmental responsibility of enterprises.	ISO 14001 certification in international practice.
Environmental legislation	Developing and implementing strict environmental regulations and standards that are mandatory for all businesses.	Regulation and control of environmental safety of enterprises, increasing responsibility for compliance with environmental requirements.	The Clean Air Act in the USA.
Prohibition of the use of certain technologies and substances	Limiting or completely banning the use of hazardous chemicals and technologies that adversely affect the environment.	Reducing environmental risks by avoiding the use of the most harmful substances and technologies.	Ban on the use of CFCs (chlorofluorocarbons) under the Montreal Protocol.
Environmental Impact Assessment	Introduction of methods and models to quantify the environmental impact of production processes and products.	Ensuring that the environmental impact of production processes is accurately recorded and analyzed to facilitate decision-making aimed at reducing this impact.	Environmental Impact Assessment (EIA) in the EU countries.

Thus, the combination of the above mechanisms and tools can contribute to the harmonization of economic activity with environmental requirements, promoting sustainable development and conservation of natural resources.

The formation of environmentally-oriented production processes and management of natural resources at the level of enterprises and national economy includes various

approaches and strategies aimed at sustainable use of natural resources and reducing the negative impact on the environment [6].

At the enterprise level, the formation of environmentally-oriented production processes and the management of natural resources include a variety of approaches aimed at the sustainable use of natural resources and reducing the negative impact on the environment.

First of all, the introduction of environmental management systems, such as ISO 14001 standards, allows enterprises to effectively manage environmental aspects of production. This includes controlling emissions of harmful substances, waste management and improving the energy efficiency of production processes. Regular environmental audits and certification help to ensure compliance with environmental standards and continuous improvement of environmental practices [7].

Technological innovations are becoming an integral part of modern industry, playing an important role in reducing the negative environmental impact of enterprises. In the context of global environmental problems and climate change, the introduction and development of innovative solutions is becoming a priority task for businesses. One of the key areas of such innovations is the introduction of green technologies, which not only improve the environmental sustainability of production, but also increase its economic efficiency.

Green technologies cover a wide range of approaches and solutions aimed at minimizing the environmental impact of industrial activities. One prominent example is the use of energy-efficient production lines, which can significantly reduce energy consumption. Through the use of improved machinery and automated energy management systems, businesses can not only reduce their operating costs, but also reduce their carbon dioxide (CO₂) emissions, a major contributor to global warming.

An equally important aspect is the transition to renewable energy sources such as solar and wind energies. Traditional energy sources based on fossil fuels are accompanied by significant emissions of greenhouse gases and other pollutants. In contrast, solar and wind energy are clean and inexhaustible sources, the use of which allows businesses to significantly reduce their environmental footprint. Installing solar panels on factory rooftops, using wind turbines and other similar solutions can not only meet the energy needs of a company, but also reduce its dependence on non-environmental fuels.

Thus, technological innovation in green technologies is becoming a crucial tool for businesses seeking sustainable development. They not only contribute to significant reductions in carbon dioxide and other harmful emissions, but also open up new opportunities for growth and improved business competitiveness in an increasingly environmentally conscious environment.

Waste management and recycling represent key components of the environmentally sustainable development of modern industry and society as a whole. In the context of growing consumption and increasing production activities, businesses are faced with the need for effective waste management in order to minimize negative environmental impacts. This aspect of environmental responsibility is becoming increasingly important in the context of global efforts to reduce humanity's ecological footprint.

Improving resource efficiency and implementing recycling techniques are central to minimizing the waste that is generated during production. Efficient resource management involves adopting advanced technologies and optimizing production processes to reduce the amount of materials and energy consumed. For example, businesses can use materials more sustainably by implementing resource and raw material management systems that reduce surplus and waste. This not only helps minimize the amount of waste, but also reduces raw material costs, making production more economically viable.

Recycling of waste, in turn, is an important element of sustainable resource management. Recycling methods allow waste to be used as a secondary raw material for the production of new products, which significantly reduces the need to extract and utilize

primary natural resources. For example, recycling of plastic, paper, glass and metals helps to reduce landfill disposal and also reduces the harmful air emissions associated with the production of these materials from virgin resources. Thus, recycling not only reduces environmental impacts, but also helps to create a closed-loop production cycle where waste is converted into valuable resources.

In addition, effective waste management includes the introduction of innovative disposal and recycling techniques such as composting of organic waste, recycling of construction materials and the use of biotechnology to treat complex and hazardous waste. Such approaches allow businesses to use their resources more efficiently, minimizing the amount of waste to be land filled or incinerated. These technologies require significant investment and infrastructure development, but they pay for themselves by reducing waste management costs and environmental risks.

Interaction between government, business and society also plays an important role in waste management and recycling. Legislative initiatives aimed at promoting recycling and waste reduction, as well as the active participation of consumers in the waste sorting and recycling processes contribute to the creation of a more environmentally responsible society. In this context, educational programmes and information campaigns also play an important role by raising public awareness of the importance of waste management and recycling.

Waste management and recycling therefore represent an important aspect of environmental sustainability that contributes to the reduction of environmental impact and the rational use of resource. The introduction of advanced technologies and effective interaction between the various factors involved in the process help to minimize production waste, reduce the consumption of natural resources and create the basis for sustainable development in the long term.

Environmentally oriented marketing and active community relations are becoming increasingly important elements of the sustainable development strategy of modern enterprises. With society's growing concern about environmental issues and increased focus on sustainable consumption, companies are realizing the need to integrate environmental principles into their marketing strategies and public relations practices. These measures not only enhance the reputation of the enterprise, but also have a positive impact on its competitiveness by attracting the attention of environmentally conscious consumers and maintaining their loyalty.

One of the key tools of environmentally oriented marketing is the use of eco-labeling and product certification. Labels such as 'eco-friendly product', 'biodegradable', 'energy-efficient' and others help to distinguish a company's products from competitors by emphasizing their compliance with high environmental standards. Environmental certification confirms that a company's products or services meet certain environmental criteria set by independent bodies.

This helps to increase consumer confidence, especially among those who seek to reduce their negative impact on the environment through a more responsible choice of goods and services.

For companies, eco-labeling is becoming not just a tool for product promotion, but also an important element of the overall sustainability strategy. With the growing demand for environmentally friendly products, certified goods occupy an increasingly important position in the market. This allows enterprises not only to strengthen their competitive position, but also to open access to new markets where requirements for environmental friendliness of products are mandatory. In addition, environmental certification helps a company to improve internal processes and standards, which in the long term leads to cost reduction and an increase in overall business efficiency.

However, environmentally oriented marketing is not limited only to product labeling and certification. An open and transparent information policy of the company also plays an important role. Modern consumers demand from business not only quality goods and services, but also accountability in environmental responsibility. Engaging in an open dialogue with the public, publishing environmental reports, disclosing information on measures to reduce the environmental footprint and improve sustainability of production - all this contributes to building trust and support from the public.

Active interaction with the public includes not only the provision of information, but also participation in socially significant initiatives related to environmental protection. This might include partnership projects with non-governmental organizations, participation in environmental actions, support for environmental awareness and educational programmes. Such initiatives help not only to improve the company's image, but also to create positive changes in society, supporting the transition to a more sustainable lifestyle.

Environmentally-oriented marketing also helps to raise consumer awareness of important environmental issues and opportunities to address them. Companies that actively promote environmental initiatives and solutions help shape consumers' more responsible product and service choices by influencing grassroots behaviour. As a result, consumers become more aware of the environmental impact of their purchases and consumption and tend to make more environmentally friendly choices.

Thus, environmentally oriented marketing and active community relations play an important role in the sustainable development of enterprises, helping them to attract and retain environmentally conscious consumers, strengthen their reputation and make a meaningful contribution to solving global environmental problems. The introduction of an open and transparent information policy, the use of environmental labeling and certification, active participation in public initiatives allow companies not only to achieve their commercial goals, but also to contribute to the sustainable development of society as a whole [8].

References

1. M. Javid, *Sustainability* **11**, 3359 (2019)
2. Wu, J.; Zhang, Y.; Shi, Z. *Sustainability* **13**, 6245 (2021)
3. Rougier, E.; Combarrous, F. Emerging capitalisms and institutional reforms in developing countries. In *The Diversity of Emerging Capitalisms in Developing Countries*; Rougier, E., Combarrous, F., Eds.; Palgrave Macmillan: Cham, Switzerland, 2017; pp. 413–435.
4. Guo, C.; Wang, J.; Liu, H. *Beijing Univ. Technol.* **20**, 13–21 (2020)
5. S. Wensi, *Nankai Econ. Stud.* **6**, 181–200 (2020)
6. Mitra, A.; Sharma, C.; Veganzones-Varoudakis, M.-A. *J. Policy Model.* **38**, 353–371 (2016)
7. Czernich, N.; Falck, O.; Kretschmer, T.; Woessmann, L. *Broadband Infrastructure and Economic Growth. Econ. J.* **121**, 505–532 (2011)
8. Edquist, H.; Goodridge, P.; Haskel, J. *Econ. Innov. New Technol.* **30**, 262–283 (2021)