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STAGES OF INDUSTRIAL ENTERPRISES' TRANSITION TO A GREEN ECONOMY UNDER MANAGEMENT TRANSFORMATION

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Abstract. This article examines the process of industrial enterprises' transition to a green economy and analyzes the stages of managerial transformation that emerge throughout this transition. The study conceptualizes the ecological modernization of industrial enterprises as a phased and systematic process, highlighting the role of green technologies, energy efficiency, and digital management systems in facilitating sustainable transformation. Furthermore, the research identifies the key factors influencing green transformation and proposes recommendations for enhancing the sustainable development of industrial enterprises.

Keywords: green economy; industrial enterprises; transformation stages; energy efficiency; sustainable development.

Аннотация. В статье рассматривается процесс перехода промышленных предприятий к зеленой экономике и анализируются этапы трансформации систем управления, возникающие в ходе данного перехода. Экологическая модернизация промышленных предприятий рассматривается как поэтапный и системный процесс. Особое внимание уделяется роли зеленых технологий, энергоэффективности и цифровых систем управления в обеспечении устойчивой трансформации промышленности. Выявлены основные факторы зеленой трансформации и предложены рекомендации по обеспечению устойчивого развития промышленных предприятий.

Ключевые слова: зеленая экономика; промышленные предприятия; этапы трансформации; энергоэффективность; устойчивое развитие.

INTRODUCTION

In the contemporary era, climate change, the intensification of environmental challenges, and the inefficient use of natural resources have necessitated the development of new approaches to economic growth. In particular, the industrial sector is regarded as one of the most environmentally impactful sectors of the economy due to its high energy consumption and substantial volume of emissions released into the environment [1]. Consequently, ensuring environmentally sustainable production processes and improving resource efficiency in industrial enterprises have become issues of increasing strategic importance.

The concept of the green economy represents one of the most significant approaches to achieving environmental sustainability alongside economic development. This concept emphasizes improving energy efficiency in production processes, adopting environmentally friendly technologies, reducing waste generation, and promoting the rational use of natural resources. As a result, it enhances not only the economic performance of enterprises but also their capacity to ensure environmental sustainability and ecological safety [2].

The transition of industrial enterprises toward a green economy is generally implemented as a gradual and phased transformation process. Initially, enterprises are encouraged to reassess their production processes in response to external factors associated with environmental risks and resource scarcity. In the subsequent stages, environmental management systems, innovative technologies, and modern management approaches are introduced, enabling enterprises to develop comprehensive strategies for sustainable development.

The primary objective of this study is to analyze the transformation stages experienced by industrial enterprises during their transition to a green economy and to identify the characteristics of changes in management systems that occur throughout this transformation process.

LITERATURE REVIEW

The process of green transformation in the industrial sector has become an increasingly important component of economic development strategies in many countries. In particular, reducing carbon emissions, improving energy efficiency, and modernizing industrial production processes in accordance with environmental standards are recognized as key priorities for achieving sustainable development in the global economy. Research indicates that decarbonization policies implemented in the industrial and energy sectors play a critical role in ensuring long-term economic sustainability [3].

The transition of industrial enterprises toward a green economy is typically characterized as a multi-stage transformation process. During the initial stage, enterprises identify challenges related to environmental risks and the inefficient use of natural resources. At this stage, organizations focus on assessing the environmental impacts of their production processes, analyzing energy consumption, and evaluating the efficiency of existing technological operations in order to identify opportunities for improvement.

The subsequent stage involves the implementation of environmental management practices within industrial enterprises. This process includes improving energy efficiency, minimizing waste generation, promoting the rational use of resources, and adopting environmental management systems to enhance the environmental performance of production activities. International experience demonstrates that the ecological modernization of industrial production is closely associated with supportive government policies, investment incentives, and the adoption of advanced technologies [4].

The main transformation stages of industrial enterprises in their transition to a green economy are summarized in Table 1.

Table 1
Transformation Stages of Industrial Enterprises in the Transition to a Green Economy¹

Stage	Period	Key Characteristics	Management and Technological Directions
Stage 1: <i>Ecological and economic drivers</i>	2000–2010	Climate change, increasing CO ₂ emissions, scarcity of natural resources, and high levels of energy consumption emerged as major challenges for industrial development.	Identification of environmental risks, analysis of energy consumption, and assessment of the environmental impacts of production processes.
Stage 2: <i>Adoption of green technologies</i>	2011–2020	Improvement of energy efficiency, implementation of environmental management systems (ISO 14001, EMS), and initial measures to reduce industrial waste.	Introduction of environmental management systems, efficient utilization of resources in production, and environmental monitoring.
Stage 3: <i>Innovation-driven management transformation</i>	2021–2024	Modernization of production processes through digitalization, automation, and innovative management approaches.	Implementation of digital management systems, production automation, and promotion of corporate social responsibility (CSR) and green investments.
Stage 4: <i>Strategic green development</i>	2025–2030	Pursuit of carbon neutrality, increasing the share of renewable energy, promotion of green innovations, and development of industrial clusters.	Adoption of low-carbon production technologies, modernization through public–private partnerships, and enhancement of green export potential.

¹ Developed by the author based on the conducted research and the analysis of scientific literature.

As shown in Table 1, the transition of industrial enterprises to a green economy is implemented through a series of sequential and interconnected stages. During the initial stage, environmental and economic factors encourage enterprises to reassess their production processes. In the subsequent stages, environmental management systems are introduced, with particular emphasis on improving energy efficiency and optimizing resource utilization.

The third stage is characterized by a deeper transformation process, during which industrial enterprises begin to adopt innovative technologies, digital monitoring systems, and automated management mechanisms. This transition not only enhances production efficiency but also improves environmental performance. As a result, industrial enterprises gradually shift toward a sustainable management model that integrates both economic and environmental objectives.

The fourth stage is characterized by the development of a long-term and comprehensive green development strategy for industrial enterprises. At this stage, enterprises prioritize the adoption of low-carbon production technologies, the utilization of renewable energy sources, and the promotion of eco-innovations. Modernization initiatives based on public-private partnerships, the attraction of green investments, and the establishment of production systems that comply with international environmental standards become increasingly important. As a result, industrial enterprises move beyond merely complying with environmental regulations and establish a sustainable and competitive development model aligned with the fundamental principles of the green economy.

RESEARCH METHODOLOGY

This study uses a qualitative and analytical approach to examine the stages of industrial enterprises' transition to a green economy. It applies systematic and comparative analysis, along with scientific generalization and classification methods. The research also reviews international literature and reports on the green economy, energy efficiency, industrial decarbonization, and sustainable management. Based on these methods, the study develops a phased framework for green transformation in the context of management change.

The transition of industrial enterprises toward a green economy is shaped by a wide range of economic, environmental, technological, and institutional factors. In recent years, global challenges such as climate change, resource scarcity, and increasing environmental pollution have intensified the need to ensure environmental sustainability in industrial production [6]. Consequently, many countries have developed strategic programs aimed at modernizing the industrial sector and promoting the adoption of low-carbon technologies.

The principal factors driving this transformation include the following:

Climate change and increasing environmental pressure. The continuous growth of greenhouse gas emissions and environmental pollution has strengthened the need for industrial enterprises to adopt environmentally sustainable production systems [8].

Energy security and energy efficiency challenges. Rising demand for energy resources, coupled with the environmental impacts of conventional energy sources, has encouraged enterprises to implement energy-efficient technologies and optimize energy consumption [7].

International environmental policies and global climate agreements. Measures aimed at reducing carbon emissions, the introduction of carbon taxes, and increasingly stringent environmental standards require industrial enterprises to modernize their production processes in accordance with environmental regulations [8].

Technological advancement and digitalization. Digital monitoring systems, automated management mechanisms, and data-driven management technologies improve resource utilization efficiency and enhance the effectiveness of production management.

Green investments and financial support mechanisms. Investments and financial instruments that support environmental innovation play a crucial role in accelerating the ecological modernization of the industrial sector and facilitating the adoption of sustainable production practices [9].

Thus, the transition of industrial enterprises to a green economy is the result of the interaction of multiple economic, environmental, technological, and institutional factors. Collectively, these factors play a vital role in promoting environmental sustainability within industrial production while supporting the development of enterprises based on modern and sustainable management principles.

ANALYSIS AND RESULTS

The information presented in the table demonstrates that the transition of industrial enterprises toward a green economy is a gradual and sequential process. Initially, this transformation is driven by environmental and economic factors and subsequently progresses through technological modernization and the transformation of management systems. Therefore, the green transformation process requires not only

technological advancement but also the continuous improvement of management mechanisms to support sustainable development [10].

During the initial stage of transformation, enterprises focus on identifying challenges related to environmental risks and resource utilization. At this stage, key indicators such as energy consumption, waste generation, and the environmental impacts of production processes are assessed. This evaluation provides a solid foundation for establishing environmental risk management systems within industrial enterprises.

In the second stage, industrial enterprises begin implementing environmental management systems and undertake measures aimed at optimizing production processes in accordance with environmental standards. At this stage, improving energy efficiency, reducing waste generation, and promoting the efficient use of natural resources become the primary strategic priorities [11].

The third stage is characterized by the adoption of innovative technologies, digitalization, and the automation of production processes, all of which contribute to improving the environmental performance of industrial enterprises. In addition to enhancing resource utilization efficiency, these developments also help reduce production costs and increase overall operational effectiveness.

In the final stage, industrial enterprises establish a strategic model for sustainable green development. At this stage, priority is given to the adoption of renewable energy sources, the implementation of low-carbon technologies, and the promotion of green innovations [12]. Consequently, enterprises transition to an integrated management system that effectively combines economic efficiency with the principles of environmental sustainability.

CONCLUSION AND RECOMMENDATIONS

The findings of this study indicate that the transition of industrial enterprises toward a green economy is a complex and multi-stage transformation process. This process is closely associated with environmental challenges, energy security concerns, and technological advancement. Consequently, production technologies, management mechanisms, and institutional approaches within industrial enterprises are restructured to meet emerging environmental requirements.

The results demonstrate that the transition to a green economy follows a series of sequential transformation stages. In the initial stage, environmental and economic factors encourage enterprises to reassess their production processes. In the subsequent stages, production activities are modernized through the implementation of environmental management systems, improvements in energy efficiency, and the adoption of innovative technologies. In the final stage, enterprises establish a strategic green development model that successfully integrates economic performance with the principles of environmental sustainability.

To ensure the effective implementation of green transformation in industrial enterprises, several practical measures are recommended. First, energy efficiency should be improved by promoting the widespread adoption of energy-saving technologies and optimizing energy consumption in industrial operations. Second, environmental management systems should be implemented in accordance with international environmental standards to enhance the sustainability of production processes. Third, digitalization and automation within the industrial sector should be promoted to improve resource utilization efficiency, increase productivity, and strengthen operational performance. Fourth, ecological modernization should be accelerated by attracting green investments and supporting the adoption of innovative and environmentally friendly technologies.

Furthermore, strengthening cooperation between the public and private sectors is essential for achieving successful green transformation. The development of economic and institutional mechanisms that support ecological modernization through government policies can significantly accelerate the transition of industrial enterprises toward a green economy while enhancing their long-term sustainability and global competitiveness.

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