METHODOLOGY FOR ASSESSING INTEGRATED EFFICIENCY IN THE PRODUCTION PROCESS AND ITS PRACTICAL IMPLEMENTATION

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Annotatsiya. *Maqolada ishlab chiqarish jarayonida integral samaradorlikni baholash metodologiyasi va uning amaliy tatbiqi yoritilgan. Integral samaradorlik ishlab chiqarishning resurs, texnologik, ekologik va iqtisodiy jihatlarini kompleks baholash orqali aniqlanadi. Tadqiqotda integral ko'rsatkichni hisoblash bosqichlari hamda uning strategik qarorlar qabul qilish ва ishlab chiqarish samaradorligini oshirishdagi ahamiyati asoslab berilgan.*

Kalit so'zlar: *ishlab chiqarish jarayoni, integral samaradorlik, metodologiya, strategik qarorlar, ishlab chiqarish samaradorligini oshirish.*

Аннотация. *В статье освещена методология оценки интегральной эффективности в производственном процессе и её практическое применение. Интегральная эффективность определяется через комплексную оценку ресурсных, технологических, экологических и экономических аспектов производства. В исследовании обоснованы этапы расчёта интегрального показателя, а также его значение для принятия стратегических решений и повышения производственной эффективности.*

Ключевые слова: *производственный процесс, интегральная эффективность, методология, стратегические решения, повышение производственной эффективности.*

Abstract. *The article covers the methodology for assessing integral efficiency in the production process and its practical application. Integral efficiency is determined through a comprehensive evaluation of the resource, technological, environmental, and economic aspects of production. The study outlines the stages of calculating the integral indicator and highlights its significance for strategic decision-making and improving production efficiency.*

Keywords: *production process, integral efficiency, methodology, strategic decision-making, improving production efficiency.*

Introduction

The intensification of competition in the global economy, the limited availability of resources, and the growing scale of environmental problems require manufacturing enterprises to adopt new approaches to efficiency. Traditionally, production efficiency has been assessed mainly through economic outcomes such as profit, profitability, and cost levels. However, this approach fails to fully capture all aspects of the production process.

From this perspective, the methodology for assessing **integrated efficiency**, aimed at evaluating the production process through the harmonious combination of resource, technological, environmental, and economic aspects, is becoming increasingly relevant. This methodology serves as an important scientific and practical basis for determining the real state of enterprise performance, making strategic decisions, and ensuring sustainable development.

In the context of global competition and sustainable development, assessing the efficiency of manufacturing enterprises solely on the basis of economic indicators is no longer sufficient. Rational use of resources, implementation of modern technologies, and ensuring environmental sustainability have become key determinants of production efficiency. In this

regard, an integrated efficiency indicator that enables comprehensive assessment of the production process is of significant importance.

Integrated efficiency is an economic category that combines efficiency indicators of various dimensions of the production process into a single comprehensive indicator. It simultaneously takes into account resource utilization efficiency, the level of technological development, environmental sustainability, and economic efficiency of enterprise operations.

The advantage of the integrated approach lies in its ability to consider interconnections among indicators, enable comparability through normalization of different measurement units, and provide an objective and comprehensive assessment of production efficiency.

Integrated efficiency serves to comprehensively evaluate enterprise performance by combining resource, technological, environmental, and economic efficiency of the production process into a single indicator.

Integrated efficiency is determined through the following four key indicators:

- resource efficiency (RE);
- technological efficiency (TE);
- environmental efficiency (EE);
- economic efficiency (ECE).

Resource efficiency (RE) is an important economic indicator that reflects the extent to which available resources are used rationally, economically, and purposefully in the production process. It enables the assessment of the contribution of raw materials, materials, energy, labor resources, and fixed assets to product creation. High resource efficiency implies that more output or higher value is generated per unit of resource, leading to cost reduction, lower production costs, and increased competitiveness.

This indicator serves as a basis for identifying inefficiencies in resource use, reducing excessive expenditures, and implementing resource-saving

technologies. Resource efficiency is also closely linked to environmental sustainability, as efficient resource utilization reduces waste generation, lowers pressure on natural resources, and helps limit negative environmental impacts. From an economic perspective, increased resource efficiency strengthens the financial stability of enterprises, enhances investment attractiveness, and creates a solid foundation for long-term development.

Technological efficiency (TE) reflects the effectiveness of technologies applied in the production process, particularly their contribution to increasing labor productivity, reducing energy and resource consumption, and improving product quality. It enables evaluation of the level of adoption of modern equipment and technologies, automation and digitalization processes, and the impact of innovative solutions on production outcomes. High technological efficiency ensures stable, accurate, and continuous production processes, increased output volumes, and improved quality indicators. Moreover, modern technologies reduce labor costs, accelerate production cycles, and minimize human-related errors.

Technological efficiency represents the innovative potential of an enterprise and is a crucial factor in enhancing competitiveness in both domestic and international markets. Furthermore, technological modernization is closely linked to environmental efficiency, as the implementation of energy-saving and low-waste technologies reduces negative environmental impacts. Economically, increased technological efficiency contributes to optimization of production costs, reduction of unit costs, and long-term sustainable development of enterprises.

Environmental efficiency (EE) is a key integrated indicator that reflects the extent to which negative environmental impacts of the production process are reduced. It encompasses factors such as waste reduction, recycling levels, limitation of harmful emissions, and efficient use of energy and water resources.

High environmental efficiency ensures that production processes cause minimal environmental damage, comply with environmental norms and standards, and promote harmonious development with nature. This indicator demonstrates the social responsibility of enterprises and allows assessment of their compliance with environmental obligations toward society and the state. Moreover, improvements in environmental efficiency are closely interconnected with resource and technological efficiency, as the adoption of energy-efficient and low-waste technologies reduces production costs.

From an economic perspective, environmental efficiency supports sustainable development, reduces environmental penalties and risks, and enhances the enterprise's image and competitiveness in both domestic and international markets.

Economic efficiency (ECE) is a core financial and economic indicator that expresses the ratio between revenues obtained from the production process and the costs incurred. It enables evaluation of financial performance, profitability, and cost management effectiveness. High economic efficiency indicates greater value creation from available resources, reduced production costs, and increased profitability. This indicator plays a crucial role in optimizing production costs, expanding revenue sources, and ensuring financial stability. Additionally, economic efficiency enhances the investment attractiveness of enterprises and demonstrates a reliable financial position to internal and external investors. Economic efficiency is closely linked to resource, technological, and environmental efficiency, and improvements in these areas ensure sustainable income generation and competitiveness in the long term.

Integrated efficiency is calculated using the following formula:

$$I = \alpha \cdot RE_{norm} + \beta \cdot TE_{norm} + \gamma \cdot EE_{norm} + \delta \cdot ECE_{norm}$$

Here, **α, β, γ, and δ** are weighting coefficients that represent the relative importance of the indicators, and their sum is equal to 1.

Since different indicators are expressed in different measurement units, it is necessary to convert them to a unified scale. As a result of normalization, all indicators take values within the range from 0 to 1, which ensures their fair comparability in the integrated assessment.

If the integrated efficiency, that is **I = 1**, it indicates maximum efficiency, meaning that each indicator has achieved its highest possible level.

I = 0, it represents minimum efficiency, indicating that none of the indicators meets the required standards.

I = (0.75, 1), the production process is considered highly efficient.

I = (0.5, 0.75), the production process is moderately efficient, and in this case additional reforms are required within the enterprise.

I < 0.5, the production process is considered to be at a low efficiency level, and significant reforms are required for the enterprise to improve its performance or maintain its competitive position.

Based on the normalized indicators and weighting coefficients, the integrated efficiency indicator is calculated. This indicator serves as a final measure that reflects the overall state of the production process.

The economic significance of assessing integrated efficiency is primarily manifested in strategic decision-making, as the results of such assessment enable enterprise management to determine which areas should receive investment priority, which production processes or technologies require modernization, and to clearly identify the strengths and weaknesses of enterprise operations.

The integrated efficiency methodology not only contributes to ensuring economic growth but also promotes the balanced development of resource efficiency and environmental sustainability, thereby creating a solid foundation for the long-term and sustainable development of enterprises. Through comprehensive integrated analysis, existing shortcomings, excessive costs, and inefficient directions in the production process are identified, and targeted

measures aimed at their elimination are developed, resulting in a significant increase in production efficiency. In addition, the integrated assessment of multiple efficiency indicators enhances enterprise competitiveness in both domestic and international markets, improves product quality, and increases value creation. Analyzing integrated efficiency over time allows identification of growth or decline trends in enterprise development, forecasting future efficiency levels, and scientifically substantiating strategic plans.

The main advantages of the integrated efficiency assessment methodology include:

- comprehensive evaluation of the production process;
- integration of diverse indicators;
- simplification of decision-making processes;
- support for strategic planning.

Conclusion. The methodology for assessing integrated efficiency in the production process is an important scientific and practical tool for the comprehensive analysis of enterprise performance. It plays a significant role in improving production efficiency, ensuring rational use of resources, and maintaining environmental sustainability.

In conclusion, the widespread implementation of the integrated efficiency assessment methodology in practice contributes to the sustainable development of enterprises and enhances the competitiveness of the national economy.

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