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THE ECONOMIC ESSENCE OF RESOURCE USE EFFICIENCY AND ITS ROLE IN INDUSTRIAL ECONOMICS

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Abstract: This article analyzes the theoretical foundations of the concept of resource use efficiency, its role in industrial economics, and the specific features of its application in the grain products industry. The study examines scientific approaches ranging from the representatives of the classical economic school to modern theories of efficiency. In addition, various methods for assessing resource efficiency are analyzed. The results show that the rational use of resources is an important factor in increasing enterprise competitiveness, reducing production costs, and ensuring sustainable industrial development.

Key words: resource efficiency, technical efficiency, economic efficiency, DEA, SFA, Malmquist index, grain products industry, competitiveness.

Аннотация: В данной статье анализируются теоретические основы понятия эффективности использования ресурсов, его роль в промышленной экономике, а также особенности применения в отрасли зерновой продукции. В исследовании рассматриваются научные подходы, начиная от представителей классической экономической школы и заканчивая современными теориями эффективности. Кроме того, анализируются различные методы оценки эффективности использования ресурсов. Полученные результаты показывают, что рациональное использование ресурсов является важным фактором повышения конкурентоспособности предприятий, снижения производственных затрат и обеспечения устойчивого промышленного развития.

Ключевые слова: эффективность использования ресурсов, техническая эффективность, экономическая эффективность, DEA, SFA, индекс Малмквиста, отрасль зерновой продукции, конкурентоспособность.

INTRODUCTION

In the modern economy, resource use efficiency has become one of the most important criteria for evaluating the performance of industrial enterprises. Under conditions of limited production factors — raw materials, energy, labor, and capital — achieving maximum output from each unit of resource has acquired strategic importance. Particularly in resource-intensive sectors such as grain products manufacturing, the high consumption of energy, water, and material resources further increases the need to improve efficiency. In the Republic of Uzbekistan, the grain products industry is considered one of the priority sectors ensuring food security. Therefore, improving resource use efficiency in this sector is becoming an important direction of national economic policy.

The purpose of this study is to reveal the theoretical essence of the concept of resource use efficiency, analyze its role in industrial economics, and highlight the practical significance of efficiency assessment methods.

LITERATURE REVIEW

The theory of resource efficiency has undergone continuous development from classical economics to modern quantitative methods. The concept of “efficiency” has been discussed in economic thought since the eighteenth century. Adam Smith theoretically substantiated the possibility of increasing productivity through labor division and specialization in his work The Wealth of Nations. David Ricardo demonstrated in the theory of comparative advantage that countries specializing in sectors corresponding to their relative advantages could allocate resources more efficiently.

Later, representatives of neoclassical economics such as Léon Walras, Alfred Marshall, and Vilfredo Pareto developed the mathematical and theoretical foundations of economic efficiency. Walras attempted to describe the general equilibrium of resource allocation through a system of mathematical equations. Marshall developed marginal analysis as a practical tool and demonstrated the regulation of resource flows through prices. Pareto identified the equilibrium state in which no one's condition can be improved without worsening another's condition as the main criterion of economic efficiency. The concept of "Pareto optimality" later became the foundation of all efficiency theories and remains a methodological basis for performance analysis today.

Since the second half of the twentieth century, quantitative methods for measuring efficiency have developed rapidly. Farrell developed a methodology for evaluating technical efficiency relative to the production possibility frontier in his article "The Measurement of Productive Efficiency." He divided economic efficiency into technical efficiency and allocative efficiency and empirically measured them for the first time. Later, Koopmans linked the mathematics of activity efficiency with the concept of Pareto optimality within the framework of activity analysis. This transition from classical theory to quantitative frontier analysis laid the foundation for the emergence of DEA and SFA methods.

In the economic literature of CIS countries, the category of "resource use efficiency" is traditionally considered within the framework of analyzing economic activity. Galina Savitskaya described methodologies for separately analyzing the efficiency of fixed assets, labor resources, and material resources. Aleksey Sheremet examined the system of resource efficiency indicators, including capital productivity, capital profitability, and material intensity indicators. These economic categories largely correspond to international concepts such as technical efficiency, allocative efficiency, and scale efficiency, although their calculation methodologies have specific features.

RESEARCH METHODOLOGY

The study employed both theoretical and empirical scientific methods. In particular, the historical and logical analysis method was used to study the stages of development of resource efficiency theory; the comparative analysis method was applied to analyze the differences and interrelations among types of efficiency; parametric and non-parametric methods were used to examine approaches to efficiency assessment; and economic-statistical methods were employed to analyze the essence of efficiency indicators.

The methodological basis of the research was formed by the theoretical approaches developed by Michael James Farrell (1957), Tjalling Koopmans (1951), Abraham Charnes, William Wager Cooper, and Edward Rhodes (1978), Dennis Aigner, C. A. Knox Lovell, and Peter Schmidt (1977), as well as Douglas Caves, Laurits Christensen, W. Erwin Diewert (1982), and Chojiro Nakajima (1988).

ANALYSIS AND RESULTS

Table 1.1. Main Types of Resource Use Efficiency[1]

Type of Efficiency	Definition (Essence)	Measurement Indicator	Main Source
Technical Efficiency	Achieving maximum output with minimum resources within a given technological boundary	TE = Actual Output / Potential Output	Farrell (1957)
Allocative Efficiency	Allocation of resources according to their marginal productivity ratios	Price ratio analysis; cost minimization	Koopmans (1951); Debreu (1951)
Economic Efficiency	Combination of technical and allocative efficiency	EE = TE × AE	Farrell (1957); Coelli et al. (2005)
Scale Efficiency	Reduction of unit costs as production volume increases	Returns to scale coefficient	Banker, Charnes & Cooper (1984)
Dynamic Efficiency	Increasing productivity over time through innovation and technological renewal	Malmquist TFP Index	Caves, Christensen & Diewert (1982)

1 Source: Compiled by the authors based on Farrell (1957), Koopmans (1951), and Caves, Christensen & Diewert (1982).

As can be seen from the table above, all types of efficiency collectively represent the overall productivity of enterprise resources. Technical efficiency reflects the degree of utilization of existing technological capabilities, while allocative efficiency ensures the optimal distribution of resources according to price ratios. The combination of these two forms of efficiency constitutes economic efficiency, that is, the ability to achieve a given result at minimum cost. Scale efficiency reflects the dynamics of costs in response to changes in production volume and is especially important in the grain products industry, since the unit cost of production in large-scale milling enterprises may be significantly lower than in small enterprises. Dynamic efficiency, in turn, represents the ability to improve all other forms of efficiency over time through innovation and technological modernization.

In economic science, several methodological approaches have been developed for the quantitative assessment of resource efficiency. Among the first group — parametric methods — the most widespread is Stochastic Frontier Analysis (SFA), developed by Dennis Aigner, C. A. Knox Lovell, and Peter Schmidt. This method evaluates the production function using the following stochastic model:

$$\ln(Y_i) = f(X_i; \beta) + v_i - u_i,$$

where v_i represents random errors (weather conditions, measurement errors), and $u_i \geq 0$ - technical inefficiency component.

This model simultaneously considers both technical inefficiency and the influence of random external factors and is widely applied in the agricultural and food sectors because weather, climate, and other random factors significantly affect production outcomes in these fields.

Among the second methodological group — non-parametric methods — Data Envelopment Analysis (DEA), developed by Abraham Charnes, William Wager Cooper, and Edward Rhodes, occupies a special place. DEA constructs an "efficient production frontier" based on linear programming and determines the distance of each decision-making unit (DMU) from this frontier as an efficiency indicator. This method allows for a quantitative assessment of where resources are wasted in grain product enterprises and how much efficiency improvement is possible.

To measure dynamic efficiency, Douglas Caves, Laurits Christensen, and David Malmquist developed the Total Factor Productivity (TFP) index. This index makes it possible to decompose productivity changes between two periods into technological change and efficiency change components. This approach serves as an important practical tool for evaluating whether digital technologies and modernization projects in grain product enterprises generate real economic benefits.

In practical management, the Overall Equipment Effectiveness (OEE) indicator is widely used to monitor resource efficiency at the operational level. Developed by Seiichi Nakajima, this indicator is expressed as the product of three components:

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$$

Here, availability refers to the ratio of actual operating time considering downtime; performance refers to the ratio of actual speed to nominal speed; and quality refers to the proportion of acceptable products. In global practice, the "world-class" OEE indicator for grain product enterprises is considered to be 85%, while many enterprises in developing countries remain within the range of 50–65%.

The relationship between resource efficiency and enterprise competitiveness is one of the central issues in modern strategic management theory. Michael Porter, in his work Competitive Advantage, substantiated that improving resource efficiency at every stage of the value chain is the primary source of reducing production costs and achieving differentiation advantages. In The Competitive Advantage of Nations, Porter incorporated resource efficiency into the "diamond model" of national competitiveness, demonstrating that it plays an important role in creating systemic competitive advantages together with factor conditions, domestic demand conditions, related and supporting industries, and firm strategy.

From the perspective of industrial economics, resource efficiency is closely connected with industry structure. The "Structure–Conduct–Performance" (SCP) paradigm, created by Joe S. Bain and developed by Edward S. Mason, serves as a key analytical tool for examining the impact of industry concentration, entry barriers, and market competition on enterprise efficiency. In the grain products industry, the SCP approach makes it possible to analyze industry concentration, for example, the market share of the five largest enterprises, pricing behavior, and average technical efficiency in an integrated manner.

Studying the experience of transition economies, Stephen Osborne and Michael Trueblood demonstrated in their research on the agricultural sectors of Russia and Ukraine that the implementation of institutional reforms can significantly improve agricultural efficiency. This conclusion also has important methodological significance for Uzbekistan.

The issue of resource efficiency in Uzbekistan's grain products industry has its own specific characteristics. Although grain harvesting volumes in the country are high, losses along the grain products value chain remain significant. According to the Food and Agriculture Organization (FAO), post-harvest and distribution losses in the grain products chain in South and Central Asia are significantly higher than the global average. The FAO report estimates that global losses from the post-harvest stage to the retail level amount to approximately 14% of total food production worldwide. Inadequate storage infrastructure, lack of cooling systems, and outdated processing technologies are among the main causes of resource losses in grain product enterprises in developing countries.

CONCLUSION AND SUGGESTIONS

The results of the study indicate that resource efficiency in grain product enterprises has a multidimensional and systemic nature. It is difficult to significantly improve efficiency solely through technological modernization or only through management improvement; instead, it requires the integrated influence of all factors. In particular, the institutional environment, including state regulation, ownership forms, and competition policy, plays an important role in improving resource efficiency in Uzbekistan.

As part of the ongoing reforms in Uzbekistan's agricultural sector, the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030, approved by Presidential Decree No. PF-5853 dated October 23, 2019, identifies the modernization of the agricultural sector, improvement of resource use, and development of processing capacities as important priorities [1]. This strategic document creates an institutional basis for scientific research aimed at improving mechanisms for enhancing resource efficiency in grain product enterprises.

The Sustainable Development Goals (SDGs), adopted at the September 2015 Summit of the United Nations General Assembly, represent a plan for achieving a more sustainable future and better outcomes for all. Of the 17 goals, 12 are directly or indirectly related to agriculture and food systems, while Goal 2 specifically focuses on strengthening food security, improving nutrition, and promoting sustainable agriculture. Achieving these objectives is directly linked to improving resource efficiency in the sector. The SDGs aim to halve food losses at the retail and consumer levels and reduce food losses throughout production and supply chains by 2030. In achieving this global goal, improving resource efficiency in the grain products industry is of immense importance.

Thus, the conducted theoretical analysis demonstrated that the category of resource use efficiency possesses a complex, multidimensional, and dynamic nature. The theoretical foundations established by classical economists — Smith, Ricardo, Walras, Marshall, and Pareto — were further enriched by the quantitative methods of Farrell, Koopmans, Aigner, and others, as well as the strategic concepts of Porter and Barney. This synthesis creates a strong methodological basis for analyzing mechanisms aimed at improving resource efficiency in the grain products industry.

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