ECONOMIC FACTORS INFLUENCING THE EFFICIENCY OF PRODUCTION INFRASTRUCTURE MANAGEMENT IN INDUSTRIAL ZONES

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In the global economy, the increasing technological complexity of industrial production, the restructuring of global value chains, and the digital transformation of manufacturing have significantly enhanced the strategic importance of industrial zones as key regional platforms for accelerating economic growth. The competitiveness of modern industrial zones is no longer determined solely by their production capacity or investment volume, but also by the efficiency of their production infrastructure management systems. Only when energy supply, transport and logistics networks, engineering and utility infrastructure, industrial service centers, warehousing facilities, digital monitoring platforms, and production support services are managed in an integrated manner can industrial zones achieve higher resource efficiency, lower production costs, and stronger investment and export potential. Therefore, identifying the economic factors that determine the efficiency of production infrastructure management and improving their practical mechanisms of influence have become major priorities in research on industrial economics and management.

In recent years, geo-economic transformations in the international economy have fundamentally changed approaches to production infrastructure. Enterprises now evaluate not merely the availability of production sites but also the reliability of electricity supply, the availability of multimodal logistics, the effectiveness of digital management systems, the dependability of engineering infrastructure, the responsiveness of industrial support services, and the level of environmental infrastructure as the primary determinants of production efficiency. In particular, the implementation of Industry 4.0 and smart manufacturing technologies has transformed infrastructure management from a routine operational function into a strategic management activity. Consequently, the efficiency of production infrastructure has become widely recognized as a critical managerial factor that directly influences enterprises' operating costs, the continuity of production processes, the speed of resource circulation, and overall economic performance.

Furthermore, the Law of the Republic of Uzbekistan "On Special Economic Zones," the Law "On Investments and Investment Activities," and a number of government resolutions concerning the development of industrial zones establish mechanisms aimed at enhancing the economic efficiency of enterprises through the comprehensive development of production infrastructure, the construction of modern engineering and utility networks, the improvement of logistics services, and the digitalization of production processes. These legal and regulatory frameworks have positioned the improvement of infrastructure management in industrial zones as an integral component of Uzbekistan's industrial policy.

According to official statistical data, Uzbekistan's industrial gross value added increased by 9.1% in 2025, remaining one of the principal drivers of the country's economic growth. During the same period, the manufacturing sector accounted for approximately 84% of total industrial output, while production volumes in high-technology manufacturing industries expanded significantly. Furthermore, by the end of 2025, the country's electricity generation exceeded 81 billion kWh, with additional generating capacities commissioned based on renewable energy sources, thereby strengthening the reliability of uninterrupted energy supply to industrial enterprises. In the field of transport infrastructure, growth in freight transportation volumes and logistics services also contributed positively to the performance of industrial zones. These indicators confirm that the development of

production infrastructure is one of the key economic factors underpinning the efficiency and sustainable growth of industrial production.

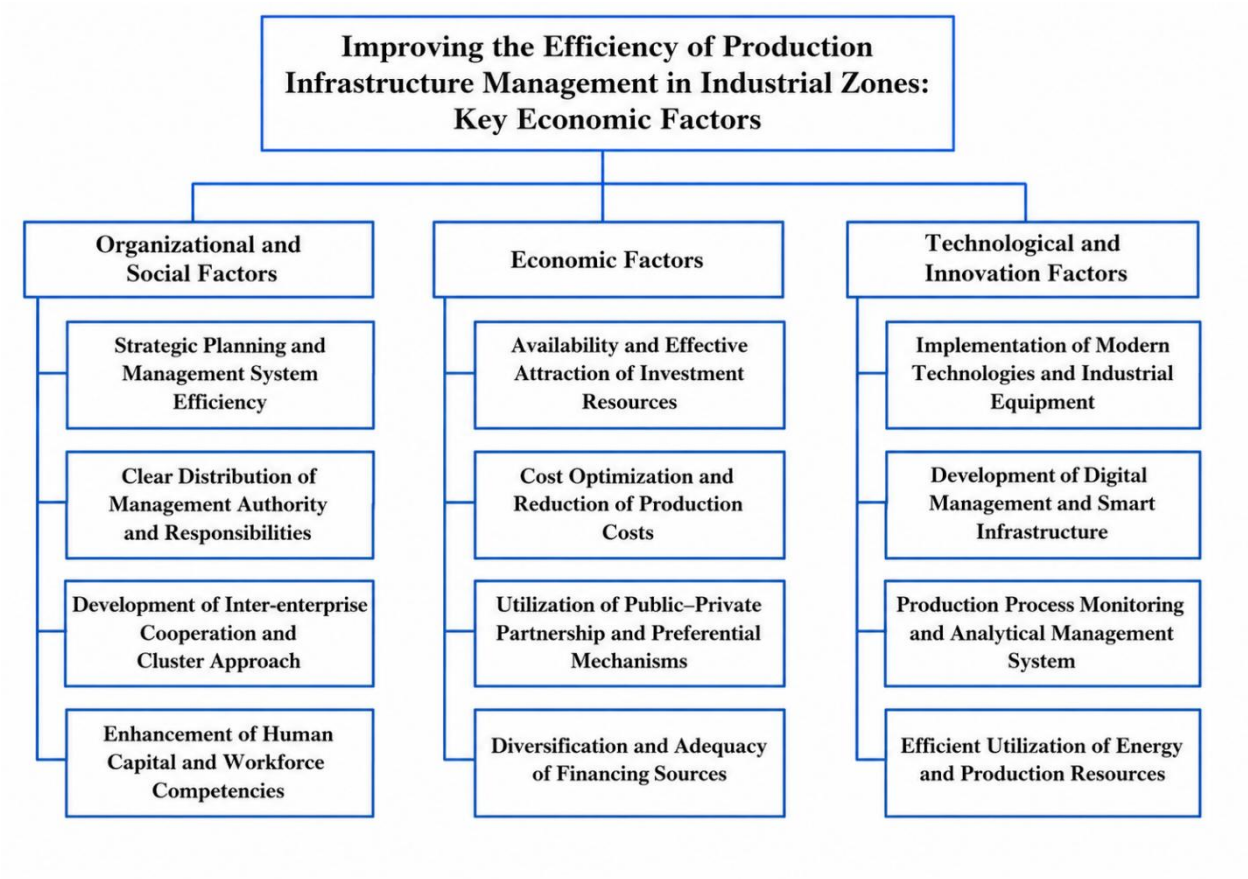


Figure 1. **Conceptual Framework of the Economic Factors Affecting the Efficiency of Production Infrastructure Management in Industrial Zones**[1]

This conceptual framework systematically illustrates the interrelationships among the organizational, economic, and technological factors influencing the efficiency of production infrastructure management in industrial zones. The framework presents a conceptual approach to improving production infrastructure management through strategic governance, the efficient utilization of investment resources, cost optimization, the development of public–private partnership mechanisms, and the implementation of digital technologies.

The efficiency of production infrastructure management in industrial zones is increasingly explained in contemporary academic literature through the perspectives of energy efficiency, regional integration, resource utilization, and the coordinating role of governance institutions. Recent studies no longer regard infrastructure merely as a collection of technical facilities but rather as an economic management system that directly influences production costs, technological continuity, and regional competitiveness.

Among foreign scholars, L. Mortensen and co-authors, using the GreenLab Industrial Park in Denmark as a case study, highlight the intermediary role of the regional operator in ensuring effective infrastructure management. According to their findings, coordinating energy systems, manufacturing activities, research and development, and industrial symbiosis infrastructure through a unified

[1] Developed by the author.

platform enhances capacity utilization, accelerates resource exchange, and reduces operational costs. This approach redefines the industrial park management authority not as a conventional administrative body but as a professional operator responsible for facilitating technological and economic cooperation among resident enterprises.

M. Li and co-authors, in their analysis of the low-carbon transformation of industrial parks in China, identify the efficiency of energy infrastructure as a key determinant of effective management. Their study examined energy facilities across 1,604 industrial parks and found that 92.3% of carbon emissions were associated with coal-based electricity generation. The authors argue that the implementation of centralized energy supply systems, cogeneration technologies, renewable energy sources, and digital monitoring systems can significantly reduce production costs while improving resource efficiency.

R. Zhang and W. Yan, in their study of 89 industrial parks in the Tokyo metropolitan area, argue that evaluating infrastructure efficiency solely on the basis of internal park indicators is insufficient. They emphasize that when the energy and transportation systems of an industrial zone are managed in coordination with nearby enterprises, public utility networks, and service facilities, regional synergies are created. Such integration increases infrastructure utilization while reducing the unit cost of production.

Among researchers from the Commonwealth of Independent States, T. Likhacheva, S. Globa, and A. Rusina propose the use of relative performance indicators, in addition to conventional aggregate measures, for evaluating industrial parks. They argue that calculating production output, investment volumes, and fiscal revenues on a per-resident or per-hectare basis provides a more accurate assessment of actual performance. This approach enables meaningful comparative evaluations of industrial zones of different sizes and supports the differentiated allocation of government assistance and development incentives.

T. Burtseva and A. Akhmadov assess the multiplier effects of new industrial infrastructure on regional economic development. According to their findings, the economic value of a new electricity network, logistics center, or engineering facility should be evaluated not only by its direct financial return but also by its contribution to industrial output, employment generation, tax revenues, and the attraction of private investment. This approach demonstrates that both direct and indirect economic benefits should be taken into account when selecting and prioritizing infrastructure development projects.

The reviewed scholarly literature indicates that the efficiency of production infrastructure management is determined by five key factors: the level of capacity utilization, energy and logistics costs, regional integration, the managerial capability of the infrastructure operator, and the economic returns generated by infrastructure investments.

International experience further confirms that the professional management of production infrastructure can significantly improve economic performance. In Germany, the experience of industrial clusters demonstrates that the digitalization of production infrastructure, the integration of logistics networks, and the automation of manufacturing processes are among the principal drivers of industrial productivity. German industrial policy supports technological modernization by increasing public investment in infrastructure while simultaneously attracting private capital. According to the Organisation for Economic Co-operation and Development, Germany plans to gradually increase public infrastructure investment and expand its share in gross domestic product in the coming years, with the objective of strengthening the long-term competitiveness of industrial enterprises.

In Japan, the management of production infrastructure in industrial zones is closely linked to energy efficiency and digital management systems. Studies conducted in industrial areas within the Tokyo metropolitan region indicate that managing energy consumption at the regional level reduces production costs, improves the utilization of infrastructure capacity, and accelerates resource sharing

among enterprises. At the same time, the manufacturing sector accounts for approximately 27% of Japan's national economy, and continuous investment is directed toward infrastructure that supports high-technology industries, thereby reinforcing the country's industrial competitiveness and sustainable economic development.

Another noteworthy example can be found in China's industrial parks. Between 2023 and 2025, the modernization of energy infrastructure, the implementation of centralized energy management systems, and the deployment of digital monitoring platforms significantly improved resource utilization efficiency within industrial parks. Studies covering more than 1,600 industrial parks demonstrated that centralized management of energy flows and the optimization of production loads reduced enterprises' operating costs while simultaneously improving their environmental performance. Although infrastructure modernization requires substantial initial investment, it generates significant long-term economic benefits through lower production costs and higher capacity utilization rates.

The comparative analysis conducted in this study makes it possible to classify the economic factors affecting the efficiency of production infrastructure management into five major categories. The first category is resource utilization efficiency, including the utilization rates of electricity, water, natural gas, and industrial facilities. The second category comprises logistics costs, where the quality of transport infrastructure supporting the movement of raw materials and finished products plays a decisive role. The third category is digital management technologies, which enable real-time monitoring of infrastructure assets and facilitate the prevention of equipment failures. The fourth category relates to the quality of infrastructure services, referring to the efficiency and responsiveness of technical and support services provided to resident enterprises. The fifth category concerns institutional governance, specifically the capacity of industrial zone management authorities to coordinate resources, plan infrastructure investments, and integrate the activities of resident enterprises.

In conclusion, the findings indicate that the principal economic factors for improving the efficiency of production infrastructure management in industrial zones include increasing resource utilization rates, optimizing logistics costs, digitalizing energy management systems, enhancing the quality of infrastructure services, and strengthening the integration of governance institutions. The effective coordination of these factors within a unified management framework provides a solid economic foundation for improving production efficiency, reducing operating costs, increasing investment attractiveness, and ensuring the long-term industrial development of regions.

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