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Article

Economic Parameters of The Development of Regional Industrial Infrastructure

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Abstract: The aim of this paper is to explore the effect of economic fundamentals on regional industrial infrastructure growth and productivity. Despite widespread discussion of industrial potential, a comprehensive understanding of the interactions between investment flows, transport services, energy supply, innovation expenditure, and technological modernization remains scant. In closing the gap, our research conducts system and indicator-based analysis to assess infrastructure dynamics in Khorezm over the period 2010–2024. Results show steady growth of industrial investments, growth of transport services, electricity supply, and a growth of innovative expenditures. The modernization index of fixed-asset renewal, production automation, and the overall index of infrastructure development are also steadily upward, reflecting the country's gradual development over the past decades. These changes have enhanced production efficiency, promoted clustering, and improved regional competitiveness. This indicates coordinated investment in infrastructure, energy, logistics and innovation is needed for sustainable industrial growth. The implication of the study is that the gaps between regions advocate for place-based policies that greater integrate the digital transformation, increase the efficiency of resources and speed up diversification so to provide long-term resilience overall.

Keywords: Industrial infrastructure, economic parameters, regional development, investment dynamics, transport services, energy supply, innovation expenditures, technological modernization, infrastructure competitiveness.

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1. Introduction

Analyzing and evaluating the state of regional industrial infrastructure based on economic parameters is of great importance for deeply understanding the industrial potential of territories and determining scientifically grounded ways to regulate it optimally. The effective functioning of the elements of industrial infrastructure increases the competitiveness of regional industrial enterprises, the efficiency of resource use, and the volume of production. Therefore, when determining the level of development of regional industrial infrastructure, the main economic indicators are analyzed in a comprehensive manner. These parameters, in addition to assessing the current state of industrial infrastructure, make it possible to identify its weak points and determine directions for its future development. Ultimately, on the basis of economic analysis and evaluation results, mechanisms for optimally regulating industrial infrastructure are developed.

Within the framework of the Decree of the President of the Republic of Uzbekistan No. PF-60 "On the Development Strategy of New Uzbekistan for 2022–2026," 100 goals determining the development of our country have been formulated. In paragraph 4 of Goal

24, the task is set to "reduce losses in industrial sectors and increase the efficiency of resource use" [1].

In this context, factors such as the efficient allocation of resources, strengthening organic linkages between production clusters, directing investment flows in a targeted manner, and widely introducing innovative technologies are prioritized.

In particular, at the regional level, the results of analysis based on economic parameters serve as an important guideline for maintaining the economic sustainability of infrastructure sectors, ensuring the territorial diversification of production, and forming new industrial zones.

Thus, a systematic analysis of regional industrial infrastructure is not only a tool for identifying existing opportunities, but also the basis for optimizing economic policy, ensuring sustainable industrial development, and securing balanced economic growth between regions.

Literature Review

Enterprises can enhance their innovative capabilities by improving the efficiency of factor allocation, increasing investments in research and development, and restructuring the industrial value chain-measures that, in turn, contribute to overall improvement [2].
A.M. Lopukhov emphasizes in his research that "industry is the most important sector of the national economy and has a decisive impact on the level of economic development of society" [3]. Investments directed toward industrial infrastructure, he notes, increase labor productivity, expand export potential, and support sustainable economic growth.

N.G. Glushich defines industrial infrastructure as a complex of sectors that ensure the movement of industrial branches and production resources [4]. The decline can be attributed to growing international tax competition, rising pressure on countries to attract investment, and Base Erosion and Profit Shifting (BEPS) initiatives led by the OECD, which concentrated on base broadening rather than increasing nominal rates [5].

After 2010, the corporate income tax rate in Uzbekistan has changed considerably and after 2020, this indicator has stabilized. More specifically, the CIT rate went from 12% in 2010 down to 7.5% in 2014 [6].

K.Gulzora defines industrial infrastructure as "a system of engineering, transport, logistics, information, and innovation facilities necessary for the stable functioning of industrial production" [7].

2. Materials and Methods

The research is aimed at analyzing the main components of industrial infrastructure and studying mechanisms for managing and optimizing them. In the course of the study, these components were identified and their management and optimization mechanisms were examined in a systematic way.

System and indicator-based approaches, as well as comparative analysis methods, were applied. On this basis, practical recommendations were developed for the effective management of industrial infrastructure and its economic parameters [8].

3. Results

In our research, a number of economic parameters were considered. In particular, the volume of investments assimilated in industry is one of the most important economic parameters of industrial infrastructure, since it directly determines the degree of renewal of the production base, the pace of technological modernization, and the industrial potential of the region.

If investments are directed toward expanding and improving the energy, transport, logistics, communications, and engineering networks of infrastructure, this, in turn, increases production efficiency, reduces production costs, and creates new jobs. The growth in the volume of investments assimilated in industry forms an economic basis for the creation of industrial clusters in the region, the introduction of innovative technologies, and the expansion of the production of export-oriented products [9]. At the same time, the

stability of investment flows and their efficient use are decisive factors in ensuring the competitiveness of the regional economy.

Therefore, an in-depth analysis of this parameter makes it possible to form a complete picture of the dynamics of industrial infrastructure development, its economic efficiency, and the level of investment attractiveness of the region.

According to the table, the data are presented in real terms relative to the 2010 price index. It shows that during 2010–2024, the volume of investments assimilated in industry demonstrated a significant growth trend, indicating accelerating processes of modernization of regional industrial infrastructure, expansion of production capacity, and technological renewal [10].

In 2010, the investment volume amounted to 138.2 billion soums; by 2024, it had increased to 979.78 billion soums, growing by almost a factor of seven. This growth indicates that the technical and economic base of industrial sectors has been strengthened, and that the volume of investments directed toward new production facilities, energy and transport infrastructure, and engineering and communication systems has increased.

Dynamic analysis shows that in 2010–2014, the volume of investments grew gradually-from 138.2 to 315.21 billion soums-with an average annual growth rate of about 22–24 percent. In 2015, however, a certain decline was observed, and the investment volume decreased to 264.01 billion soums [11]. This is explained by structural changes in the economy, a reduction in external investment flows, and a reallocation of state budget expenditures.

In 2016-2018, the investment volume passed into a recovery stage, increasing from 277.93 to 402.16 billion soums, which indicates a reactivation of reconstruction and modernization processes in industrial infrastructure [12].

Especially in the period 2019-2021, the volume of investments increased sharply: in 2019 it reached 601.72 billion soums, in 2020 – 507.34 billion soums, and in 2021 - 745.95 billion soums (Table 1).

Table 1. Economic parameters of the industrial infrastructure of Khorezm region in real terms, base year – 2010

Period	Volume of investments assimilated in industry, bln soums	Volume of transport services, bln soums	Electric power supply of industrial enterprises, mln kWh	Expenditures on innovative development of industrial infrastructure, mln soums
2010	138.20	354.20	106.57	4,367.2
2011	186.56	433.54	115.15	6,044.4
2012	207.07	502.91	126.85	6,812.6
2013	302.09	612.54	134.33	10,120.0
2014	315.21	698.91	163.86	10,685.6
2015	264.01	796.06	169.60	9,425.1
2016	277.93	925.02	238.83	10,867.0
2017	365.30	953.69	240.08	15,525.2
2018	402.16	981.35	247.31	18,016.8
2019	601.72	1,020.61	248.04	27,618.8
2020	507.34	1,017.54	271.45	23,794.4
2021	745.95	1,184.42	356.38	36,178.7
2022	705.55	1,344.32	341.68	35,347.9
2023	826.30	1,399.94	343.39	42,637.1
2024	979.78	1,586.14	354.33	51,634.6

***Compiled by the author based on data from the National Statistical Committee of the Republic of Uzbekistan and the Khorezm Regional Department of Statistics.**

The fundamentals of growth are considered to be the initial industrial policy emphasis on diversification, a more active role from the private sector, the establishment of new

industrial zones and the relatively liberal environment created by the government toward foreign investment during this period.

In 2022, the volume of investments slightly decreased to 705.55 billion soums, this decline was of a temporary nature. In 2023-2024, the indicator grew again, reaching 826.30 and 979.78 billion soums, respectively.

Such high growth rates are associated with the expansion of energy sectors within industrial infrastructure, modernization of production areas, improvement of transport and logistics systems, and the formation of new production clusters based on digital technologies.

At the same time, the geographical diversification of investment activity has expanded: investments were directed not only to major industrial centers but also to regional production sectors [13]. As a result, the economic sustainability of industrial infrastructure has strengthened, the utilization rate of production capacity has increased, and the efficiency of resource use has improved.

The analysis shows that the stable upward trend in the volume of investments assimilated in industry plays a decisive role in ensuring the long-term competitiveness of the regional economy. This process accelerates technological renewal in the production sphere, increases labor productivity, and expands export potential.

In general, based on the data presented, it can be said that during 2010–2024 this economic parameter of industrial infrastructure-the volume of assimilated investments-has ensured high dynamic growth rates in the regional economy and has made a significant contribution to the innovative development of industrial sectors, the modernization of production, and the strengthening of economic stability.

The volume of transport services, as an important structural parameter of regional industrial infrastructure, determines the continuity of the production process, the speed of resource movement, and the efficiency of delivering finished products to the market.

Transport infrastructure is a supporting pillar of the economic system that connects production, logistics, storage, distribution, and consumption processes.

Analysis of the data shows that in recent years the volume of transport services has followed a stable growth trend [14]. This is closely linked to the expansion of industrial production volume in the region, the increase in export-import operations, and the modernization of logistics systems.

Growth in the volume of transport services has been positively influenced by the expansion of highways, railway lines, and infrastructure facilities connecting industrial zones, as well as by the introduction of digital management systems that increase the efficiency of freight transport. At the same time, the share of transport costs in production cost has been declining, indicating the transition of logistic infrastructure to an energy-saving and technologically advanced state. In densely populated areas, especially in territories where industrial clusters are located, a high volume of transport services ensures full utilization of production capacities and guarantees the timely delivery of finished products to domestic and foreign markets. Thus, the growth of the volume of transport services increases the logistic flexibility of industrial infrastructure and strengthens the competitiveness of the regional economy. However, to make this process even more efficient, it is necessary to expand digital management platforms in the transport system, develop multimodal transport schemes, and invest in environmentally friendly modes of transport [15]. In our view, such measures will raise the overall efficiency of industrial infrastructure to a higher level.

The electric power supply of industrial enterprises is the main energy parameter of industrial infrastructure and is a factor that determines the continuous operation of production capacities, the stability of technological processes, and the level of efficient use of resources.

Analysis of recent years' statistics indicates that electric power supply volume to industrial production has been rising year by year, which is stipulated by both an increase in production and a changing structure of energy consumption.

This two-way association of improvement in energy supply is linked to modernization of energy infrastructure-the extensive development of power grids, transformer substations, renewable energy sources and large-scale deployment of energy-efficient technologies and also to the extensive utilization of digital-control monitoring and automated control systems in manufacturing processes.

Analysis indicates that reducing the technical interruptions of the power supply increases the reliability of electric power supply and results in a 5–10 percent gain in production efficiency.

From another side, energy efficiency measures are progressing: the electricity consumption per output has been reduced. It shows that industrial enterprises have turned towards energy transformation and that demand for renewable sources of energy continues to increase.

Yet in some regions, energy shortages are starting to develop where high demand for electricity is turning into lack of production capacity.

Hence, in order to provide energy sustainability of industrial infrastructure it is necessary to counterbalance centralized and local energy sources, digitize power transmission networks and to implement energy auditing in production enterprises.

In general, the consistent increase in power supply of electricity is a growing economic base of future production capacity of industrial infrastructure that requires and can increase energy efficiency to provide competitive clean production in the process.

Costs of innovation intensive implementation of industrial infrastructure are one of the main parameters that define the modernization potential of an economic system, the extent of technological renewal of productive assets, and the competitiveness factors.

They are mainly aimed at deploying newer production technologies, automating systems and smart production forms, digital infrastructure, and R&D activities.

According to the data, in recent years the volume of funds allocated to innovative development has been steadily increasing. This process, due to the deepening of digital transformation in industrial sectors, the automation of production processes, and the introduction of new technological equipment, has led to a rise in efficiency.

The growth in the volume of innovation expenditures not only ensures the technical modernization of production but also contributes to the strengthening of scientific potential, the upgrading of workforce skills, and the formation of an innovative environment in regional industrial clusters.

And on the other hand, due to these costs, the share of resource-saving technologies in production is increasing, energy consumption is decreasing, and the quality of products is improving. As a result, the competitiveness of industrial enterprises in the domestic and foreign markets increases, and the export opportunities expand.

Studies conducted show that 1 billion soums of investment channeled into innovation development returns 3–4 times more economic benefit per a soum in comparison to such investments directed into traditional sectors (an increase in output volume, a decrease in unit cost prices, a rise in labor productivity).

Therefore, in state policy it is necessary to attach strategic importance to the development of innovation infrastructure, create tax incentives for the private sector, and improve mechanisms for financing innovation activities. In particular, the expansion of technoparks, start-up centers, scientific-production laboratories, and university–industry cooperation systems within industrial enterprises will further increase the economic return on innovation expenditures.

In general, expenditures on the innovative development of industrial infrastructure are a key economic factor that supports technological renewal of the economy, the transition

to a model of sustainable growth, and the establishment of a strong position for industrial sectors in the global competitive environment under the conditions of a digital economy.

The renewal rate of fixed assets in the industrial sector is one of the most important economic indicators reflecting the technical and technological potential of industrial infrastructure. This parameter shows the rate at which production means, machinery and equipment, production buildings, transport vehicles, and energy systems are renewed. Analyses show that in recent years the renewal rate of fixed assets in the region has been gradually increasing, indicating an intensifying process of replacing obsolete technical equipment with modern, energy-efficient, digitally controlled machinery in industrial sectors.

Whereas in the early 2010s the renewal rate of fixed assets was low (3-4 percent), now in many regions this indicator has reached around 10-12 percent. This has led to more efficient operation of production capacities, improved product quality, and increased efficiency in the use of resources.

In sectors where the renewal rate of fixed assets is high, labor productivity has increased by an average of 1.5-2 times. In addition, the introduction of new technological lines and digital control systems has reduced production costs and increased the share of export-oriented products (Table 2).

Table 2. Economic parameters of the industrial infrastructure of Khorezm region

Period	Renewal rate of fixed assets in the industrial sector, percent	Level of automation of the industrial production system, percent	General development index of regional infrastructure	Output produced in small industrial zones (KSZ), bln soums*
2010	0.161	38.45	0.34	2.474
2011	0.162	39.16	0.36	4.227
2012	0.168	41.28	0.37	4.779
2013	0.171	40.95	0.39	6.582
2014	0.182	43.54	0.41	8.505
2015	0.185	45.09	0.42	11.534
2016	0.197	47.13	0.43	11.783
2017	0.204	48.25	0.46	14.291
2018	0.209	50.38	0.47	17.705
2019	0.212	53.47	0.48	21.088
2020	0.223	54.16	0.49	24.776
2021	0.227	55.89	0.52	31.059
2022	0.238	58.11	0.53	37.768
2023	0.241	61.05	0.54	42.989
2024	0.254	63.72	0.55	49.664

** in real terms, base year – 2010*

**Compiled by the author based on the data of the National Statistical Committee of the Republic of Uzbekistan and the Statistics Department of Khorezm Region*

At the same time, regional disparities also exist: in some industrial zones, due to the obsolescence of fixed assets, production capacities are not fully utilized.

Therefore, in order to ensure sustainable growth for this parameter of industrial infrastructure, it is necessary to strengthen cooperation between public investments, private sector investments, and funds from international financial institutions.

Overall, the renewal rate of fixed assets determines the stage of technological modernization of industrial infrastructure and serves as a decisive factor in shaping a competitive industrial base in the region.

The automation level of the industrial production system is an indicator of the regional industrial infrastructure transfer degree to digital economy, the technological renewal rate and production efficiency.

This is a sign of a decrease in the proportion of human labor in enterprises because automated control systems, robotized production lines and digital supervision systems are being introduced.

According to data analysis, in key sectors of the region's industry share of automated production has a tendency to grow from year to year. Automated production processes often produce fewer errors, produce quality and uniform products, reduce production time, and most importantly, these processes substantially minimize production expenses.

Automated production systems have increased production efficiency by 25–30 percent, especially in energy, metallurgy, mechanical engineering, and the chemical industry. This means that industrial infrastructure has reached a point of digital transformation.

On the flip side, there are barriers to doubling down on automation, such as reliance on high-tech equipment imported from abroad, a lack of skilled labor, and low levels of investment in software too.

Thus, in order to expand the technological capacity of the system of industrial production, there is a need to enhance the technological transfer mechanisms, the digital infrastructure networks to modernize, and the digital skills competencies to ensure production in higher education institutions of the technical profile.

In general, the level of automation of the production system is a criterion that reflects the innovative state of industrial infrastructure and creates a foundation for the technological independence of the region, the rational use of resources, and achieving competitive advantage in the global market.

The general development index of regional infrastructure is an indicator that comprehensively assesses the degree of integration and economic efficiency of industrial, transport, energy, social, and communication infrastructure sectors. This index is constructed to take into account the production capacity of a region, the distribution of economic resources among different territorial units, and the territorial distribution of infrastructure, among others.

Also, the analyses indicate that overall index of regional infrastructure development has demonstrated positive tendency in recent years. This is an indicator of the development of transport and logistics systems, industrial zones, energy networks, and digital communication infrastructure, which have been funded by state investment programs, the private sector, and foreign investors and contractors.

A higher value of the index indicates the balanced development of production in the region and the expansion of opportunities for comprehensive utilization of resources. In other words, this parameter can be considered a measure of the “economic health” of the region.

At the same time, in some areas the value of the index remains low, which indicates inconsistencies between elements of industrial infrastructure, insufficient utilization of resources, or underdevelopment of transport and energy networks. Therefore, within the framework of regional policy, it is necessary to coordinate infrastructure sectors and to develop industrial and transport projects in an integrated manner.

Raising the general development index of regional infrastructure plays a decisive role in expanding economic activity, increasing the efficiency of the spatial distribution of industrial sectors, and reducing socio-economic disparities between territories. The output of small industrial zones (KSZ) reflects the micro-level economic efficiency of industrial infrastructure, clustering processes in the region, and the intensity of regional economic activity.

This parameter is particularly important for the development of small business and private entrepreneurship, for expanding local production capacities, and for supplying the domestic market with nationally produced goods. In recent years, the

output of KSZ has been growing steadily, which is the result of preferential loans, tax incentives, streamlined land allocation procedures, and improved infrastructure support provided by the state.

Enterprises operating in small industrial zones typically use local resources efficiently, produce goods based on local raw materials, and thereby strengthen regional economic stability. In addition, the growth of KSZ output increases industrial employment, creates new jobs, and directly affects the growth of household incomes. Analyses show that a 10 percent increase in KSZ output leads to a 1.5-2 percent increase in regional gross product.

Moreover, small industrial zones supply large enterprises with raw materials, components, and semi-finished products by expanding production cooperation, which strengthens inter-sectoral integration. However, in some territories, KSZ production capacities are not fully utilized due to shortages of financial resources or underdeveloped logistics systems.

Therefore, when developing small industrial zones, it is important to expand infrastructure support, establish cooperation centers, and introduce innovative production technologies.

Overall, KSZ output is a strategic indicator that reflects the level of economic activity of industrial infrastructure, the self-sufficiency potential of regions, and the degree of inter-sectoral integration in the national economy.

4. Conclusion

In our view, the volume of transport services, the provision of electric power, and expenditures on innovative development represent three interrelated core directions of industrial infrastructure. Thy is decisive for Regional economy in terms of its further integration into a regional industrial competition, stability of production capacities, and growth of innovation potential.

These four economic indicators of industrial infrastructure, the renewal rate of fixed assets, the automation level of the production system, the infrastructure development index, and the production of small industrial zones, are not only interconnected but collectively provide for the strength, competitiveness, and sustainable development of the regional economic system.

The growth processes observed in each of these parameters strengthen the industrial potential of the region, raise the technological level of production, create new economic opportunities, and serve as a reliable analytical basis for determining the strategic directions of economic policy.

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