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Prospects for Implementing Digital Technologies in the Development of Industrial Infrastructure in the Kashkadarya Region

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Abstract: This article analyzes, based on the SWOT analysis methodology, the implementation of digital technologies in the development of industrial infrastructure in the Kashkadarya region, their significance in the economy and production enterprises, as well as their advantages, disadvantages, and challenges. With the implementation of the Industry 4.0 concept, the application of artificial intelligence, IoT, SCADA, ERP, and other digital technologies in industry can achieve great efficiency in the development of enterprises. During the analysis, it was determined that these digital technologies play an important role in developing industrial infrastructure, and the advantages, disadvantages and challenges of their application were substantiated.

Keywords: Logistics, Transport, Industry 4.0, Artificial Intelligence, Internet of Things, Big Data, Cloud Technologies, ERP, MES, SCADA and PLC Automation Systems, Robotics and Automated Lines, Digital Twin, Blockchain, GIS (Geographic Information Systems), CAD/CAM/CAE Systems, Automated Control Systems, Real-Time Monitoring, Simulation

Citation: Guzorovich, E. A. Prospects for Implementing Digital Technologies in the Development of Industrial Infrastructure in the Kashkadarya Region. American Journal of Economics and Business Management 2026, 9(4), 979-983.

Received: 10th Feb 2026

Revised: 25th Mar 2026

Accepted: 12th Apr 2026

Published: 30th Apr 2026



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1. Introduction

Today, amid the processes of globalization affecting the development of our country on a global scale, a number of priority directions improving the population's living standards, addressing unemployment, developing education and healthcare, industrial production, developing industrial and service infrastructure, establishing new enterprises, developing electricity, gas, water and road infrastructure, developing logistics and transport infrastructure, increasing the volume of investment, improving entrepreneurial infrastructure, and expanding industrial zones were defined in Resolution PQ-96 of the President of the Republic of Uzbekistan dated 13 March 2026, "On Further Accelerating Measures Aimed at the Socio-Economic Development of Kashkadarya Region," and priority tasks for the development of Kashkadarya region were discussed [1].

Kashkadarya possesses enormous potential owing to its vast territory, rich natural resources, developed industry, and hardworking, entrepreneurial population. Accordingly, last year gross regional product grew by 6.8 percent, industry by 7.2 percent, the services sector by 13.6 percent, and agriculture by 4.3 percent. Between 2017 and 2025, gross regional product per capita increased 3.2-fold, reaching 26.9 million soums. Unemployment and poverty levels fell to 4.9 percent and 6.5 percent, respectively.

It was noted that in 2026, through the implementation of new projects across sectors of the economy, industry is planned to grow by 8.6 percent, and, on the basis of 3.5 billion

dollars in investment, 727 million dollars' worth of products are planned to be exported. As a result, the regional economy is expected to grow by 8.2 percent, services by 15.9 percent, construction by 13.2 percent, and agriculture by 5.8 percent [2].

The relevance of this study lies in the fact that, based on the indicators above, it can be argued that the growth of industry in Kashkadarya region can be further developed and increased through the introduction of digital technologies into the development of industrial infrastructure. In recent years, Uzbekistan has been gradually introducing various digital technologies into the development of industrial infrastructure through the Industry 4.0 concept, which was first articulated as a strategic initiative for the digitalization of manufacturing [3] and has since been defined as the integration of cyber-physical systems, the Internet of Things and cloud computing into industrial value creation [4]. In line with the Industry 4.0 concept, this article analyzes the prospects for developing industrial infrastructure through the application of digital technologies such as artificial intelligence (AI), the Internet of Things (IoT), Big Data Analytics, Cloud Computing, Enterprise Resource Planning (ERP) systems, Manufacturing Execution Systems (MES), SCADA and PLC automation systems, robotics and automated lines, Digital Twin technology, blockchain, Geographic Information Systems (GIS), and CAD/CAM/CAE systems.

The issue of analyzing the introduction of digital technologies into the development of industrial infrastructure in Uzbekistan has attracted considerable interest from economist-researchers, doctoral candidates, and scholars in recent years. In particular, the official statistical data published by the Ministry of Economy and Finance of the Republic of Uzbekistan and the State Statistics Committee serve as the main information base for the empirical assessment of regional economic development.

In the international literature, Industry 4.0 has become one of the most intensively studied topics in industrial economics and engineering management. Xu, Xu and Li surveyed the state of the art and future trends of Industry 4.0, emphasizing the convergence of information and operational technologies [5], while Liao et al. and Oztemel and Gursev provided systematic literature reviews mapping the field's core technologies and research directions [6], [7]. Zhong et al. reviewed intelligent manufacturing in the Industry 4.0 context, highlighting the role of automated control, real-time data acquisition and simulation in modern production systems [8]. The process of introducing digital technologies in industrial enterprises is carried out in several main directions; first, automated control systems are installed on production lines, and process efficiency is increased through real-time monitoring and simulation [9].

Among local scholarly studies on the Industry 4.0 concept, S. Qilichov presents economic analyses on improving production processes, increasing productivity, reducing production costs, and improving product quality and customer service through Industry 4.0 (Internet of Things) technology, artificial intelligence, Big Data, and cloud technologies [10]. Likewise, N. Rakhmonov's study examines the essence and advantages of the Industry 4.0 programme for manufacturing enterprises and the application of information technologies within it, analyzing prior scholarly work; the article studies the introduction of the Industry 4.0 programme in Uzbekistan's leather-footwear enterprise network, identifies existing problems, and develops proposals for addressing them [11]. Researcher E. Axrorov likewise examines, from a scholarly perspective, the automation of production processes and the improvement of production efficiency through artificial intelligence, IoT, and other digital technologies within the Industry 4.0 concept, noting that the application of these digital technologies in industry in Uzbekistan also reduces production costs, strengthens export potential, and contributes to sustainable development [12]. These local findings are consistent with international evidence that the adoption of Industry 4.0 technologies follows distinct implementation patterns [13] and is expected to raise industrial performance across operational and economic dimensions [14].

2. Materials and Method

In this study, comparative analysis and SWOT analysis methodological approaches were selected for examining the application of digital technologies in developing industrial infrastructure in Kashkadarya region. The empirical base of the study assessed the impact of digital technologies on the development of industrial infrastructure based on industrial and digitalization indicators for 2015–2025 published by the State Statistics Committee and regional statistics departments. This methodology allows for the scholarly analysis of hypotheses regarding the advantages and disadvantages of applying digital technologies in industrial infrastructure, using industrial enterprises as examples, on the basis of SWOT analysis. As a result, the study's findings acquire important practical significance for shaping regional economic policy.

3. Results and Discussion

The role of digital technologies in developing industrial infrastructure in Kashkadarya region is very significant. Many enterprises face a number of challenges in transitioning to the Industry 4.0 concept. In particular, one of the most pressing problems is the shortage of qualified specialists capable of implementing digital technologies within this concept — such as artificial intelligence, the Internet of Things, Big Data Analytics, Cloud Computing, ERP systems, MES, SCADA and PLC automation systems, and similar systems — in manufacturing enterprises for industrial modernization. To apply these technologies, a number of laws, decrees, and projects aimed at developing personnel policy have been gradually introduced into practice in recent years.

For example, at the Shurtan Gas-Chemical Complex, the introduction of automated technological control (DCS/SCADA), real-time monitoring, and digital control systems has increased production stability, reduced the risk of accidents, and improved the monitoring of technological processes. At the Mubarek Gas Processing Plant, SCADA systems, automatic control, and online monitoring of technological parameters are being used to increase the reliability and management efficiency of the gas-processing process. Similar systems have also been introduced at large-scale production facilities such as Uzbekistan GTL, the Dehqonobod Potassium Plant, and the Talimarjan Thermal Power Station, whereby a high level of automated control of major technological complexes has been established, and production processes are being continuously monitored. Based on the above indicators, and applying the SWOT analysis methodology, the strengths and weaknesses of applying the Industry 4.0 concept in the region are presented in Table 1.

Table 1. SWOT analysis of applying the Industry 4.0 concept in Kashkadarya region (strengths and weaknesses)

Strengths	Weaknesses
Natural resources create a solid foundation for the digitalization of industry in production	The level of application of Industry 4.0 technologies in enterprises is low
Large industrial enterprises (oil and gas, chemical, energy, construction materials, and textiles) provide opportunities for introducing digital technologies	There is a shortage of qualified specialists in IoT, artificial intelligence, and data analytics
Transport and logistics infrastructure is developing step by step	In some industrial zones, high-speed internet and digital infrastructure are insufficient
The state supports the policy of digital-economy development and industrial modernization	Many enterprises still retain outdated production equipment
The presence of free economic zones and industrial zones in the region increases opportunities for attracting innovative projects	Management systems such as ERP, MES, and SCADA have not been introduced in all enterprises

Interest in ICT and engineering fields is growing among young people

Strategic management experience in digital transformation is limited

The SWOT analysis shows that Kashkadarya region possesses significant natural, industrial, and institutional potential for introducing Industry 4.0 technologies. In particular, the oil and gas, chemical, energy, and construction-materials industries create a favorable foundation for carrying out digital transformation, in line with international evidence that resource- and capital-intensive sectors are among the earliest adopters of advanced manufacturing technologies [13].

However, existing weaknesses — the shortage of qualified personnel, the uneven development of digital infrastructure, outdated equipment, and the limited presence of modern management systems in enterprises — may slow the broad introduction of Industry 4.0 technologies. These barriers mirror those reported in the wider literature, where skills gaps and legacy infrastructure are consistently identified as the principal obstacles to realizing the expected performance gains of Industry 4.0 [7][14].

Among the opportunities, production efficiency, product quality, and export potential can be increased through the introduction of artificial intelligence, IoT, Big Data, Digital Twin, and smart logistics solutions. Beyond productivity, the adoption of these technologies is increasingly linked to sustainability outcomes such as resource-use efficiency and reduced emissions [15], [16]. At the same time, it is necessary to strengthen cooperation among the state, scientific institutions, and the private sector in order to reduce threats such as cybersecurity risks, high investment costs, and technological dependency.

5. Conclusion

The study's findings show that introducing digital technologies into the development of industrial infrastructure in Kashkadarya region is an important factor in increasing economic efficiency, reducing production costs, and strengthening the competitiveness of enterprises. Although certain elements of automated control systems, ERP, SCADA, and other digital solutions have been introduced in the region's oil and gas, chemical, energy, construction-materials, and textile sectors, the more advanced technologies of the Industry 4.0 concept — such as artificial intelligence, Industrial IoT, Big Data Analytics, Digital Twin, and predictive maintenance — have not yet been widely implemented.

It is also observed that labor productivity, resource-use efficiency, and management quality are improving in enterprises applying digital technologies. At the same time, the shortage of qualified personnel, outdated technological equipment, limited investment resources, and the uneven development of digital infrastructure remain the main problems hindering the acceleration of digital transformation. Overall, the introduction of Industry 4.0 technologies into the region's industrial infrastructure emerges as a decisive condition for sustaining the region's projected industrial and economic growth.

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