



DIGITAL TRANSFORMATION FINANCING MECHANISMS FOR INDUSTRIAL ENTERPRISES: OPPORTUNITIES AND CHALLENGES IN UZBEKISTAN

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ARTICLE INFO

Received: 04th September 2026

Accepted: 06th September 2026

Online: 08th September 2026

KEYWORDS

digital transformation, industrial enterprises, financing mechanisms, digital economy, investment, bank lending, leasing, foreign investment, venture capital, Industry 4.0, Uzbekistan

ABSTRACT

This article examines the mechanisms for financing digital transformation in industrial enterprises in Uzbekistan, with particular emphasis on available financial instruments, opportunities, and institutional challenges. The study analyzes the role of internal funds, bank lending, leasing, government subsidies and guarantees, foreign direct investment, venture capital, public-private partnerships, and international financial institutions in supporting the digital transformation of industrial enterprises. The research applies systematic, comparative, statistical, economic-logical, and modeling methods. The findings indicate that conventional financing mechanisms are often insufficient for digital transformation projects because such investments increasingly involve intangible assets, software, data infrastructure, artificial intelligence, cybersecurity, and digital competencies. The study proposes an integrated financing model combining enterprise resources, bank loans, leasing, government guarantees, private capital, and international financial resources. The proposed approach is intended to reduce financial barriers, improve access to long-term financing, and increase the economic efficiency and technological competitiveness of industrial enterprises in Uzbekistan.

1.Introduction

The rapid development of digital technologies is fundamentally transforming the organization of production, management, and financial activities in industrial enterprises. Automation, artificial intelligence, big data, cloud computing, the Internet of Things (IoT), robotics, digital twins, and enterprise resource planning (ERP) systems provide industrial enterprises with new opportunities to reduce production costs, increase labor productivity, improve resource allocation, and strengthen competitiveness.

However, one of the most significant barriers to digital transformation is the availability of sufficient financial resources. Unlike conventional investment projects, digital transformation projects frequently require substantial initial expenditures, while their economic benefits may only become visible over the medium and long term. Therefore, industrial enterprises need a comprehensive financing system that combines traditional bank

lending with leasing, private investment, venture capital, government support mechanisms, guarantees, and international financial resources.

In Uzbekistan, the development of the digital economy and technological modernization of industry have become important components of national economic policy. According to the National Statistics Committee of the Republic of Uzbekistan, in January–September 2025, the gross value added generated by information and communication technologies reached UZS 32.4 trillion, while the share of ICT services in GDP increased to 2.6%, compared with 2.1% in 2023 [1].

At the same time, the Uzbek industrial sector has significant potential for technological modernization. In January–February 2026, high-technology manufacturing accounted for 1.1% of manufacturing output, while medium-high-technology manufacturing accounted for 18.5% [2]. These indicators demonstrate the need to expand investment in technologies capable of generating higher value added.

The volume of communication and information services in Uzbekistan also continues to increase. In 2025, the volume of communication and information services reached UZS 79.5 trillion, representing a 22.7% increase compared with 2024 [3]. This trend indicates the formation of an expanding technological and service ecosystem that can support digital transformation in industrial enterprises.

The objective of this study is to analyze the existing mechanisms for financing digital transformation in industrial enterprises in Uzbekistan, identify their major opportunities and constraints, and develop an integrated financing framework suitable for the national industrial sector.

The scientific novelty of the research lies in the development of an integrated financing approach based on the combination of **bank lending, leasing, government guarantees, private capital, and international financial resources**.

2. METHODS

The research applies a combination of systematic, comparative, statistical, economic-logistical, and modeling methods.

The information base of the study consists of official statistical data from the National Statistics Committee of the Republic of Uzbekistan, reports and strategic documents of international financial institutions, regulatory documents concerning digital economic development and industrial modernization, and relevant academic literature.

$$ROI = (P^d - I) / I \times 100$$

ROI — return on digital transformation investment;

P^d — additional profit generated as a result of digital transformation;

I — total investment in digital transformation.

The payback period can be determined as:

$$PP = I / CF$$

where:

PP — payback period;

I — amount of investment;

CF — annual cash flow generated by digital transformation.

These indicators make it possible to evaluate the economic effectiveness of investments in ERP systems, automated production lines, robotics, IoT technologies, artificial intelligence, and other digital solutions.

To assess the economic efficiency of digital transformation investments, several indicators are considered, including return on investment (ROI), payback period, labor productivity growth, production cost reduction, and changes in product cost.

3. RESULTS

3.1. Current State of Digital Transformation in Uzbekistan's Industrial Sector

The development of the digital economy in Uzbekistan has accelerated significantly in recent years. According to the National Statistics Committee, the volume of communication and information services reached UZS 79.5 trillion in 2025, increasing by 22.7% compared with the previous year [3].

During January–November 2025, computer programming services reached UZS 29.8 trillion, while telecommunications services amounted to UZS 22.6 trillion [4].

These developments demonstrate that Uzbekistan is gradually developing a domestic market for digital technologies and services, creating favorable conditions for the digital transformation of industrial enterprises.

As of December 1, 2025, approximately 59.3 thousand enterprises were operating in Uzbekistan's industrial sector [5]. Therefore, the potential number of enterprises requiring digital transformation is considerable.

Nevertheless, the level of digital maturity varies significantly between enterprises. Large industrial companies are generally more capable of implementing ERP systems, electronic document management, automated accounting, GPS monitoring, IoT technologies, and advanced analytics. Small and medium-sized enterprises, in contrast, face greater financial constraints and limited access to technological resources.

3.2. Main Financing Mechanisms for Digital Transformation

The analysis identifies several major sources of financing for digital transformation in industrial enterprises.

Financing mechanism	Main opportunity	Main challenge
Internal funds	Independence in decision-making	Limited financial capacity
Bank loans	Financing relatively large projects	Interest rates and collateral requirements
Leasing	Gradual financing of equipment	Overall cost of leasing
Government subsidies	Reduces financial burden	Limited coverage
Foreign investment	Combines capital and technology	Currency and institutional risks
Venture capital	Suitable for innovative projects	Limited application in traditional industry

Financing mechanism	Main opportunity	Main challenge
International financial institutions	Access to long-term resources	Complex project requirements
Public-private partnerships	Suitable for large infrastructure projects	Complex project management

Among these instruments, bank lending remains one of the most widely used sources of external financing. However, conventional short-term loans are not always suitable for digital transformation because many digital projects require several years before their economic benefits become fully visible.

Therefore, **long-term and relatively affordable financing** is particularly important for industrial digitalization.

3.3. The Role of Leasing in Digital Transformation Financing

A significant proportion of industrial digitalization expenditures is associated with technological equipment rather than software alone. Such equipment may include automated production systems, industrial robots, sensors, CNC machines, scanners, control systems, and other Industry 4.0 technologies.

Consequently, leasing represents an important financing instrument for digital transformation.

The major advantage of leasing is that an enterprise does not necessarily have to finance the entire cost of equipment immediately. Instead, the investment can be repaid gradually from the cash flows generated by the use of the equipment.

This mechanism is particularly important for small and medium-sized industrial enterprises with limited internal financial resources.

3.4. International Financial Institutions as a Source of Financing

International financial institutions play an increasingly important role in supporting digital transformation and private-sector development in Uzbekistan.

The European Bank for Reconstruction and Development (EBRD) identifies private-sector development, digitalization, development of IT skills, e-commerce, and capital-market development among the important areas of its strategy for Uzbekistan [6].

The EBRD's Digital Transformation Support Programme also combines financing with advisory and technical assistance, demonstrating that digital transformation should not be considered solely as a financial investment, but rather as a combination of finance, technology, consulting, and human capital development [7].

The World Bank has also initiated programs aimed at improving access to finance for private enterprises and small and medium-sized businesses in Uzbekistan. The FINGROW project is designed to strengthen financing opportunities and support private-sector development [8].

4. Discussion

The results indicate that the principal problem in financing digital transformation in Uzbekistan is not simply a shortage of financial resources. Rather, the major challenge is the

limited adaptation of existing financing instruments to the specific characteristics of digital investments.

Traditional bank lending generally emphasizes collateral, credit history, and current cash flows. Digital transformation, however, increasingly involves investment in intangible assets such as software, algorithms, databases, cloud infrastructure, digital platforms, cybersecurity systems, and organizational knowledge.

This creates difficulties for conventional collateral-based lending.

For example, an industrial enterprise may invest UZS 5 billion in an ERP system. The economic benefits of such an investment may arise through reduced inventory costs, increased labor productivity, faster managerial decision-making, and lower accounting errors. However, the ERP system itself cannot normally serve as collateral in the same manner as real estate or physical equipment.

Therefore, the financing system should gradually move from a collateral-based lending model toward project and cash-flow-based financing.

4.1. Proposed Integrated Financing Model

Based on the research findings, an integrated financing model for digital transformation in industrial enterprises is proposed.

Stage 1 — Digital Audit

The enterprise should first evaluate its existing IT infrastructure, production processes, human-resource capacity, cybersecurity, and level of digital maturity.

Stage 2 — Digital Transformation Project

A detailed project should then be developed covering ERP, MES, IoT, automation, artificial intelligence, robotics, or other relevant technologies.

Stage 3 — Mixed Financing

The proposed financing structure can be expressed as:

$$[DF=E+B+L+G+F+V]$$

where:

DF — total financing for digital transformation;

E — enterprise's own funds;

B — bank financing;

L — leasing;

G — government guarantees or subsidies;

F — financing from international financial institutions;

V — venture or private capital.

The key advantage of this model is the diversification of financing sources and the reduction of dependence on a single financial instrument.

4.2. Opportunities for Uzbekistan

The first major opportunity is the rapid expansion of the digital services market. The volume of communication and information services reached UZS 79.5 trillion in 2025, demonstrating increasing demand for digital products and services [3].

The second opportunity is the development of Uzbekistan's IT sector. During January–September 2025, market services provided by IT Park participants reached UZS 21.9 trillion [9].

The third opportunity is the growing interest of international financial institutions in supporting digitalization and private-sector development in Uzbekistan. The EBRD's country strategy specifically emphasizes digital transformation and investment support [6].

The fourth opportunity is the development of long-term financing mechanisms in local currency. Such instruments can reduce currency risks for industrial enterprises whose revenues are primarily generated in Uzbek soums.

4.3. Major Challenges

The study identifies the following major challenges:

1. limited availability of long-term financing for digital projects;
2. high costs of advanced technological equipment;
3. difficulties in using intangible assets as collateral;
4. shortages of highly qualified digital specialists;
5. rapid technological obsolescence;
6. increasing cybersecurity expenditures;
7. insufficient experience in evaluating the economic effectiveness of digital investments;
8. limited internal financial resources among small and medium-sized enterprises.

According to World Bank assessments, access to finance remains an important constraint for Uzbek small and medium-sized enterprises. The estimated MSME financing gap demonstrates the need for additional mechanisms capable of expanding access to financial resources [10].

5. Conclusion

The findings demonstrate that digital transformation is becoming an increasingly important factor in improving the technological competitiveness and financial performance of industrial enterprises in Uzbekistan.

Digitalization enables enterprises to reduce production costs, increase labor productivity, improve resource efficiency, strengthen product quality, optimize managerial processes, and expand export potential.

However, achieving these benefits requires modernization of existing financing mechanisms.

The study proposes an integrated financing model combining enterprise internal resources, bank loans, leasing, government guarantees and subsidies, international financial resources, and private capital.

To strengthen the financing ecosystem for digital transformation in Uzbekistan, the following measures are recommended:

- expanding preferential long-term credit lines for digital transformation projects;
- supporting leasing of digital and automated industrial equipment;
- introducing specialized guarantee mechanisms for digital investment projects;
- improving legal and financial mechanisms for evaluating intangible assets;
- strengthening cooperation between industrial enterprises and IT companies;
- establishing specialized digital transformation funds in cooperation with international financial institutions;
- introducing cash-flow-based assessment mechanisms for digital investment projects;

- developing KPI systems for measuring the economic efficiency of digital transformation;

- strengthening digital and financial literacy among managers of industrial enterprises.

Thus, digital transformation financing should not be viewed merely as a technological expenditure. It should be regarded as a strategic investment in the long-term competitiveness, productivity, innovation capacity, and financial sustainability of industrial enterprises.

The proposed integrated financing model can contribute to reducing financial barriers to digital transformation and creating more favorable conditions for the technological modernization of Uzbekistan's industrial sector.

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