

INNOVATION SCIENCE AND TECHNOLOGY

ISSUE 6, PART I / JUNE 2026

 Acceptance of papers



**Acceptance of
papers**

Published monthly



Topics

economics,
technology, social
sciences



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THE SCIENTIFIC-POPULAR ELECTRONIC
JOURNAL **"INNOVATION SCIENCE AND
TECHNOLOGY"** HAS BEEN REGISTERED
UNDER THE NUMBER **C-5669633** BY THE
AGENCY FOR INFORMATION AND MASS
COMMUNICATIONS (AOKA) OF THE
REPUBLIC OF UZBEKISTAN, EFFECTIVE
FROM OCTOBER 9, 2024.

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The scientific electronic journal "Innovation Science and Technology" has been included in the list of scientific publications recommended for the publication of main scientific results of dissertations for the award of PhD and DSc degrees in economics and technical sciences, in accordance with the Resolution No. 370 of the Presidium of the Higher Attestation Commission of the Republic of Uzbekistan, dated May 8, 2025.

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MODERN METHODS FOR ASSESSING ECONOMIC EFFICIENCY UNDER CONDITIONS OF DIGITAL TRANSFORMATION

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Abstract. The study examines the scientific, theoretical, and practical foundations of modern methods for assessing economic efficiency in the context of digital transformation. The impact of digital technologies on economic processes, as well as traditional and innovative approaches to efficiency measurement, is analyzed, and a comprehensive model for economic efficiency assessment is proposed. Particular attention is given to the application of modern tools, including Big Data, artificial intelligence, machine learning, digital analytics, the Balanced Scorecard, Activity-Based Costing (ABC), Economic Value Added (EVA), Return on Investment (ROI), and Key Performance Indicators (KPI). In addition, dynamic approaches to efficiency assessment based on simulation modeling, scenario analysis, and econometric models are developed. The findings have significant scientific and practical value for improving the management of digital transformation processes, enhancing the quality of strategic decision-making, and ensuring the long-term economic sustainability of enterprises and organizations.

Keywords: digital transformation, economic efficiency, assessment methods, digital analytics, Big Data, artificial intelligence, machine learning, KPI, Balanced Scorecard, EVA, ROI, ABC, simulation modeling, scenario analysis, econometric models, strategic management, innovative assessment, competitiveness.

Annotatsiya. Raqamli transformatsiya sharoitida iqtisodiy samaradorlikni baholashning zamonaviy usullarini ilmiy-nazariy va amaliy jihatdan asoslash masalalari tadqiq etilgan. Raqamli texnologiyalarning iqtisodiy jarayonlarga ta'siri, samaradorlikni o'lchashda qo'llaniladigan an'anaviy va innovatsion yondashuvlar tahlil qilinib, iqtisodiy samaradorlikni baholashning kompleks modeli taklif etilgan. Big Data, sun'iy intellekt, mashinaviy o'qitish, raqamli analitika, Balanced Scorecard, Activity-Based Costing (ABC), Economic Value Added (EVA), Return on Investment (ROI) va Key Performance Indicators (KPI) kabi zamonaviy usullarning imkoniyatlari yoritilgan. Shuningdek, imitasion modellashtirish, ssenariy tahlili va ekonometrik modellar asosida samaradorlikni baholashning dinamik yondashuvlari ishlab chiqilgan. Olingan natijalar korxona va tashkilotlarda raqamli transformatsiya jarayonlarini samarali boshqarish, strategik qarorlar qabul qilish sifatini oshirish hamda iqtisodiy barqarorlikni ta'minlashda muhim amaliy ahamiyat kasb etadi.

Kalit so'zlar: raqamli transformatsiya, iqtisodiy samaradorlik, baholash usullari, raqamli analitika, Big Data, sun'iy intellekt, mashinaviy o'qitish, KPI, Balanced Scorecard, EVA, ROI, ABC, imitasion modellashtirish, ssenariy tahlili, ekonometrik modellar, strategik boshqaruv, innovatsion baholash, raqobatbardoshlik.

Аннотация. Исследованы научно-теоретические и практические аспекты обоснования современных методов оценки экономической эффективности в условиях цифровой трансформации. Проанализировано влияние цифровых технологий на экономические процессы, а также традиционные и инновационные подходы к измерению эффективности. Предложена комплексная модель оценки экономической эффективности. Рассмотрены возможности применения таких современных методов, как Big Data, искусственный интеллект, машинное обучение, цифровая аналитика, Balanced Scorecard, Activity-Based Costing (ABC), Economic Value Added (EVA), Return on Investment (ROI) и Key Performance Indicators (KPI). Кроме того, разработаны динамические подходы к оценке эффективности на основе имитационного моделирования, сценарного анализа и эконометрических моделей. Полученные результаты имеют важное научное и практическое значение для эффективного управления процессами цифровой трансформации, повышения качества стратегических решений и обеспечения экономической устойчивости организаций и предприятий.

Ключевые слова: цифровая трансформация, экономическая эффективность, методы оценки, цифровая аналитика, Big Data, искусственный интеллект, машинное обучение, KPI, Balanced Scorecard, EVA, ROI, ABC, имитационное моделирование, сценарный анализ, эконометрические модели, стратегическое управление, инновационная оценка, конкурентоспособность.

INTRODUCTION

In the modern global economy, digital transformation processes are generating profound and systemic changes across all sectors. The rapid development of artificial intelligence, Big Data, cloud technologies, the Internet of Things (IoT), blockchain, automated management systems, and digital platforms is fundamentally transforming the content and nature of the activities of enterprises and organizations, thereby necessitating a reconsideration of traditional approaches to assessing economic efficiency. Under these conditions, the accurate, reliable, and comprehensive assessment of economic efficiency is becoming an important instrument of strategic management and remains one of the key factors in ensuring competitiveness in the digital economy.

Traditional methods for assessing economic efficiency have mainly been based on financial indicators and, therefore, cannot fully reflect the complex, multifactorial, and dynamic nature of digital transformation processes. Today, within the digital environment, there is a growing need for innovative methods of assessing economic efficiency, including digital analytics, artificial intelligence-based forecasting models, real-time monitoring systems, integrated sets of indicators, and approaches based on scenario analysis. These methods make it possible to conduct an in-depth analysis of enterprise activities, identify hidden patterns, and enhance the accuracy of strategic decision-making.

Under conditions of digital transformation, economic efficiency is increasingly interpreted as a comprehensive concept that encompasses not only financial results but also such indicators as innovation activity, the level of digital maturity, customer satisfaction, process efficiency, human capital potential, and environmental sustainability. Therefore, the integration of the Balanced Scorecard, KPI systems, Economic Value Added (EVA), Return on Investment (ROI), Activity-Based Costing (ABC), as well as simulation modeling and econometric approaches into the assessment of economic efficiency is of considerable scientific and practical importance.

Within the framework of the large-scale reforms being implemented in the Republic of Uzbekistan to digitalize the economy, accelerate innovative development, and modernize management systems, the introduction of modern methods for assessing economic efficiency is being defined as a priority task. In particular, the "Digital Uzbekistan – 2030" Strategy, programs aimed at the digitalization of industry, modernization of public administration, and development of digital infrastructure require the substantial improvement of the economic efficiency assessment system. This, in turn, increases the need to develop the theoretical foundations of modern assessment methods, adapt them to national conditions, and effectively introduce them into practice.

LITERATURE REVIEW

The issue of assessing economic efficiency under conditions of digital transformation is one of the priority areas of modern economic and management theory. In recent years, the rapid development of digital technologies, artificial intelligence, Big Data, digital platforms, and automated management systems has created the need to revise traditional methods for assessing economic efficiency and introduce innovative approaches. Consequently, a considerable number of fundamental and applied studies have been conducted in this field by both foreign and domestic scholars.

In foreign scientific literature, the relationship between digital transformation and the assessment of economic efficiency has been extensively analyzed. In particular, E. Brynjolfsson and A. McAfee empirically substantiated the influence of digital technologies on labor productivity, production efficiency, and economic growth. In their works, digital transformation is recognized as an important factor contributing to increased economic efficiency, while the need for a comprehensive approach to assessment is emphasized. K. Schwab also substantiated the necessity of considering innovative indicators, technological maturity, and digital competencies when assessing economic efficiency under the conditions of the Fourth Industrial Revolution [1–2–3–4].

The studies of T. Davenport, G. Westerman, and D. Bonnet highlight the role of analytical technologies and data-driven managerial decisions in enhancing economic efficiency during digital transformation processes. They developed models for assessing efficiency based on Big Data and digital analytics and emphasized the importance of expanding the capabilities of real-time monitoring and forecasting. M. Porter and J. Heppelmann, within the concept of smart and connected products, scientifically demonstrated that digital technologies are shaping new criteria for assessing economic efficiency [5–6–7–8].

Modern methods of assessing economic efficiency, including the Balanced Scorecard, KPI, EVA, ROI, and ABC, have been comprehensively examined in the research of R. Kaplan and D. Norton, P. Drucker, H. Horngren, R. Cooper, and R. Kaplan. These scholars substantiated the necessity of assessing economic efficiency not only through financial results but also through the integration of internal processes, innovation potential, customer satisfaction, and human capital development [10–11–12–13].

Methods for assessing economic efficiency based on artificial intelligence and machine learning have developed rapidly in recent years. In particular, researchers such as J. Manyika, E. Brynjolfsson, A. Ng, and T. Mitchell have scientifically demonstrated that algorithmic models, forecasting systems, and automated analytical platforms significantly enhance the accuracy of economic efficiency assessment. These approaches contribute to improving the quality of strategic decision-making under conditions of uncertainty [2–7].

Studies conducted by scholars from CIS countries also extensively address the assessment of economic efficiency under conditions of digital transformation. In particular, the works of S. Glazyev, A. Aganbegyan, V. Makarov, L. Abalkin, and V. Tambovtsev [16–17–18–19] analyze the institutional and methodological foundations for assessing efficiency in the digital economy. Their research particularly emphasizes the importance of incorporating innovative and digital factors into the assessment of economic efficiency.

In the studies conducted by Uzbek scholars, issues related to the digital economy, innovative development, and the assessment of economic efficiency are increasingly being explored in a broader context. In particular, the scientific works of B. Khodiev, A. Tursunov, Sh. G'ulomov, B. Yo'ldoshev, N. Qosimov, M. Saidov, and other researchers provide an in-depth analysis of enterprise digitalization, business process optimization, the introduction of modern assessment methods, and the improvement of strategic management. In these studies, the assessment of economic efficiency is interpreted as an important instrument for enhancing the competitiveness of the national economy [20–21–22–23].

At the same time, an analysis of the existing scientific literature indicates that the development of a comprehensive integrated model for assessing economic efficiency under conditions of digital transformation, the practical implementation of assessment mechanisms based on artificial intelligence and Big Data, as well as the empirical and econometric analysis of their impact on economic efficiency, require further systematization and methodological refinement. In particular, within the context of Uzbekistan, the development of a national model and methodological framework for assessing economic efficiency while taking digital transformation processes into account remains a relevant scientific issue.

This study is aimed at addressing this scientific need through the systematization of modern methods for assessing economic efficiency under conditions of digital transformation, the development of their integrated model, and the formulation of practical recommendations.

RESEARCH METHODOLOGY

The methodological basis of this study consists of a set of scientific approaches aimed at comprehensively examining modern methods for assessing economic efficiency under conditions of digital transformation, systematizing their scientific foundations, and developing mechanisms for their practical implementation. In the research process, general scientific, special economic, statistical-analytical, and digital analytics methods were systematically applied.

The theoretical and methodological foundation of the study is formed by the systems approach, comprehensive analysis, the institutional approach, strategic management theory, and the concept of digital transformation. Based on these approaches, the process of assessing economic efficiency was examined as a multifactorial, dynamic, and integrated system, while the impact of digital technologies on this process was comprehensively analyzed.

Using the methods of economic analysis and synthesis, the system of traditional and modern efficiency indicators was examined. In particular, financial indicators (revenue, profit, profitability, and liquidity), operational indicators (cost efficiency, production cycle, and labor productivity), innovation indicators (R&D expenditures, the number of patents, and the share of new products), and digital maturity indicators (the level of IT infrastructure, digital competencies, and the degree of automation) were analyzed.

Statistical and econometric analysis methods constitute an important component of the study, and correlation, regression, panel data analysis, and forecasting models were widely applied. With the help of these methods, the relationship between the level of digital transformation and indicators of economic efficiency was identified and quantitatively assessed. In addition, factor analysis was used to determine the factors exerting the greatest influence on efficiency.

Based on digital analytics and Big Data technologies, large volumes of structured and unstructured data were analyzed, and hidden patterns of economic efficiency were identified using machine learning algorithms, including regression trees, neural networks, clustering, and classification models. This contributed to improving forecast accuracy and enhancing the quality of strategic decision-making.

Using simulation modeling and scenario analysis methods, the development trajectories of economic efficiency under the influence of various external and internal factors were modeled. These approaches made it possible to identify optimal strategies under conditions of uncertainty, assess risks, and forecast the potential consequences of managerial decisions in advance.

Based on comparative and benchmarking methods, the experience of foreign countries and leading enterprises was examined, and advanced models for assessing economic efficiency were identified. The obtained results were adapted to national conditions, and practical recommendations were developed.

Within the framework of the empirical research, sociological surveys, expert assessments, interviews, and focus-group methods were applied. Through these methods, enterprise managers, financial managers, IT specialists, and economists evaluated the practical effectiveness, implementation challenges, and development prospects of modern assessment methods.

The information base of the study consisted of official statistical data from the State Statistics Committee of the Republic of Uzbekistan, the Ministry of Economy and Finance, the Ministry of Digital Technologies, the World Bank, the International Monetary Fund, OECD, UNDP, and other international organizations, as well as studies published in scientific journals and monographs.

Overall, the methodology of this study serves as a comprehensive scientific and methodological foundation for developing modern methods of assessing economic efficiency under conditions of digital transformation, evaluating their practical effectiveness, and ensuring their effective application in managerial decision-making.

ANALYSIS AND RESULTS

The results of the conducted study scientifically confirmed that modern methods for assessing economic efficiency under conditions of digital transformation possess greater accuracy, flexibility, and strategic significance compared with traditional approaches. The analyses carried out using digital analytics, Big Data, artificial intelligence, machine learning, simulation modeling, and integrated systems of indicators demonstrated the importance of a comprehensive and dynamic approach to assessing economic efficiency.

According to the results of the empirical analysis, enterprises that introduced digital assessment methods demonstrated steady growth in economic efficiency indicators. In particular, significant positive developments were observed in key indicators such as labor productivity, operational cost efficiency, return on assets, and net profit. This confirms the effectiveness of modern assessment methods in optimizing managerial decisions and ensuring the rational use of resources.

The results of the econometric analysis demonstrated the existence of a strong statistical relationship between the level of digital transformation and economic efficiency. According to correlation and regression models, the active introduction of digital technologies, the level of automation, and the widespread use of data-driven managerial decisions exert a significant positive influence on economic efficiency indicators. In particular, forecasting systems based on artificial intelligence and Big Data reduce uncertainty in decision-making and create additional opportunities for effective risk management.

Overall, the research results indicate that modern methods for assessing economic efficiency under conditions of digital transformation constitute an important instrument for effectively managing the activities of enterprises and organizations, improving the quality of strategic decisions, reducing risks, and ensuring sustainable economic development. The obtained scientific conclusions have substantial theoretical and practical significance for modernizing the system of economic efficiency assessment, deepening digital transformation processes, and strengthening competitiveness.

CONCLUSION AND RECOMMENDATIONS

This study is devoted to a comprehensive scientific, theoretical, and practical analysis of modern methods for assessing economic efficiency under conditions of digital transformation. The obtained results demonstrated that these methods possess greater accuracy, flexibility, and strategic significance compared with traditional assessment approaches. During the study, it was scientifically substantiated that new assessment systems formed on the basis of digital technologies more comprehensively reflect the complex, dynamic, and uncertain characteristics of economic processes.

The results of empirical and econometric analyses confirmed the existence of a strong positive relationship between the level of digital transformation and economic efficiency. In enterprises that introduced modern assessment methods, stable growth was observed in such indicators as labor productivity, return on assets, operational cost efficiency, and net profit. This demonstrates the practical effectiveness of digital assessment systems in optimizing managerial decisions, ensuring the rational use of resources, and supporting strategic development.

The factors identified during the study, including the development of digital infrastructure, enhancement of qualified personnel capacity, improvement of data quality and security systems, and the strengthening of innovation-oriented management culture, were assessed as important directions for expanding the implementation of modern assessment methods. To further strengthen these opportunities, the study substantiated the

importance of implementing comprehensive measures aimed at developing digital competencies, modernizing IT infrastructure, improving data management systems, and enhancing the regulatory and legal framework.

Overall, this study makes an important scientific contribution to economic theory and management practice through the systematization of modern methods for assessing economic efficiency under conditions of digital transformation, the development of their integrated model, and the substantiation of practical implementation mechanisms. The obtained conclusions can be effectively applied to modernize the system for assessing the activities of enterprises and organizations, accelerate digital transformation processes, and ensure sustainable economic development.

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Proofreader: Zokir ALIBEKOV

Layout and Designer: Oloviddin Sobir ugli

2026. № 6

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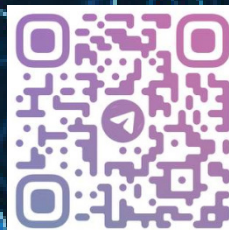
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