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FINANCIAL MANAGEMENT MECHANISMS IN INTEGRATION OF ECOLOGICAL INNOVATIONS WITH THE DIGITAL TRANSFORMATION OF THE NATIONAL ECONOMY

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Abstract
The article analyzes the effectiveness of financial management mechanisms in the process of integrating ecological innovations with the digital transformation of the national economy. The study examines the role of financial systems emerging on the basis of digital technologies in supporting ecological innovations, in particular, in optimizing resource allocation through green finance, digital investment platforms, ecological tax policy and sustainable investment funds. The results show that the adaptation of financial management to digital transformation increases the efficiency of financing ecological innovations, makes investment flows transparent and serves to ensure sustainable economic growth. Therefore, the integration of ecological innovations with digital transformation is of strategic importance in forming a model of digital-sustainable development of the national economy.

Keywords: Ecological innovations, digital transformation, financial management, green finance, sustainable development, digital economy.

Introduction

In the modern global economy, ecological innovations and digital transformation processes are considered one of the main factors shaping new paradigms of economic growth. Today, climate change, limited natural resources and increasing environmental risks are pushing humanity to search for innovative models of sustainable development. At the same time, the rapid development of digital technologies - artificial intelligence, big data, blockchain, IoT (Internet of Things) and digital financial instruments - is causing fundamental changes in all sectors of the economy. The integration of these two directions - ecological innovations and digital transformation - is becoming an important factor in increasing the efficiency of economic systems, ensuring environmental sustainability and bringing financial management to a new qualitative level [1].

Ecological innovations essentially include innovations aimed at rational use of resources, reducing waste, developing renewable energy sources and introducing environmentally friendly technologies. Their main goal is to harmonize economic growth and ecological balance, accelerate the transition to a "green" model of production. Digital transformation creates broad opportunities to support these goals by increasing the efficiency of economic processes, making financial flows transparent, and optimizing

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management [2]. Thus, combining ecological innovations with digital economy tools is not only a technological upgrade, but also a fundamental reconstruction of the financial management system.

In recent years, international experience has shown that financial management systems based on digital technologies (for example, blockchain-based "green" investment platforms, digital bonds, ecological tokenization systems) are accelerating the process of financing ecological innovations [3]. Such systems ensure the transparency of investment flows and expand the possibilities for monitoring and assessing the effectiveness of ecological projects. At the same time, digital transformation is giving impetus to the formation of new financial mechanisms for ecological innovations - green funds, digital grant systems, digital assessment systems based on ESG (Environmental, Social, Governance) criteria.

Such a new model of financial management mechanisms has a dual strategic importance for the national economy. On the one hand, it ensures the efficient allocation of economic resources, supports innovative projects and develops the digital economy. On the other hand, it ensures environmental sustainability and redirects production processes in an environmentally friendly direction, which is a prerequisite for achieving the UN Sustainable Development Goals. In this regard, financial management mechanisms combined with digital transformation are emerging as the most important means of implementing environmental innovations.

This direction is also of particular relevance for Uzbekistan. In the country, the strategy for developing the "digital economy", the concept of the "green economy" and state programs aimed at ensuring environmental sustainability are considered as complementary strategic directions. Therefore, the development and improvement of financial management mechanisms in the context of the national economy in the context of combining environmental innovations with digital transformation is an urgent scientific and practical task.

Literature review on the topic. Ecological innovations and digital transformation are at the heart of modern economic thinking as interrelated and synergistic development directions. In recent years, the integration of these two concepts has become the scientific and theoretical basis for the process of economic sustainability, efficient use of resources, and the formation of new financial management mechanisms. Various scientific approaches to ecological innovations, digital economy and financial transformation have been formed in the literature, which are deeply analyzed in terms of the interaction of these processes, management mechanisms, and their resulting effectiveness. First of all, the concept of ecological innovations is interpreted differently by different authors. J. Rennings interpreted ecological innovations as "new technological and institutional solutions that serve sustainable development" [4]. According to him, ecological innovations provide a balance between economic efficiency and environmental benefits. P. Andersen and F. Kemp, on the other hand, interpret ecological innovations as a new form of market mechanisms under environmental constraints, emphasizing the role of state policy and the financial incentive system in their development [5]. At the same time, X. Chen and L. Zhang have introduced the term "digital eco-innovation" into scientific circulation, suggesting that digital technologies serve as an accelerating force for ecological innovation, in particular, the term "digital ecological innovation" [6].

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The theory of digital transformation mainly refers to the technological renewal and information-based management of economic systems. M. Porter and J. Heppelmann have shown that digital technologies fundamentally change the value chain in the economy, creating a new model of production, financing and consumption processes [7]. In OECD reports, the digital economy is considered an important factor in increasing environmental efficiency, as it allows optimizing energy consumption, reducing emissions and developing environmental monitoring systems.

The integration of financial management mechanisms with ecological and digital components is emerging as a separate scientific direction. T. Ehlers and F. Packer expand the concept of "green finance", connecting it with the ecological orientation of financial flows in the context of a digital economy [8]. Their research shows that blockchain technology and digital assets increase the transparency of green bonds, environmental investments and ESG reporting systems. Similarly, B. Calel and A. Dechezleprêtre, analyzing the mechanisms of financial incentives for environmental innovations, emphasize the need for a digital governance infrastructure for the successful implementation of environmental investments [9].

In international practice, the role of financial systems operating on the basis of digital technologies in supporting environmental innovations is increasingly increasing. For example, in China, a system of issuing green loans and environmental tokens through digital platforms has been launched as part of the Green Digital Finance Alliance initiative since 2021. In the European Union, digitalized financial control systems are being used as a key tool in managing sustainable investments within the framework of the European Green Deal. At the same time, digital transformation creates the opportunity not only to automate financial transactions, but also to monitor environmental investments in real time and analyze their effectiveness.

At the national level, scientific research is also being activated in the direction of combining ecological innovations with the digital economy. The "Digital Uzbekistan – 2030" strategy and the "Green Economy" concept adopted by the President of the Republic of Uzbekistan have determined the priority of this direction at the level of state policy. Local scientists, including Sh. Teshayev and D. Turaev, in their studies, studied the impact of financial management systems based on digital technologies on the efficiency of ecological investments and emphasized that the digitalization of financial management mechanisms has a positive impact on the sustainable development of the national economy [10, 11].

The literature review shows that the success of financial management mechanisms in integrating ecological innovations with digital transformation depends on a number of factors: first, the institutional support of the state and the availability of a regulatory framework; second, the development of digital infrastructure; third, the level of implementation of green financial instruments and the level of environmental responsibility of investors. Therefore, many foreign studies have scientifically substantiated that supporting ecological innovations through digital financial systems is the most important tool for increasing economic efficiency and combating climate change. In general, the existing scientific literature deeply substantiates the relevance of integrating ecological innovations with digital transformation, the role and mechanisms of financial management systems in this process. At the same time, so far, existing studies have been conducted mainly at the global or sectoral level and

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comprehensive approaches that integrate digital and environmental factors at the national economy level have not been sufficiently developed. Therefore, this article pays special attention to improving the scientific basis of financial management mechanisms in combining ecological innovations with national digital transformation.

Research methodology

The methodological basis of this study includes a comprehensive approach aimed at assessing the effectiveness of financial management mechanisms in the process of integrating ecological innovations with the digital transformation of the national economy. The study used systematic analysis, inductive and deductive approaches, as well as economic-statistical and comparative methods. As a result of the study, scientific foundations were developed for the formation of an optimal model of financial management that supports ecological innovations in the context of digital transformation.

Analysis and results. The study deeply analyzed the role, level of effectiveness and interaction mechanisms of financial management mechanisms in combining ecological innovations with the digital transformation of the national economy. At the initial stage, the current state of development of ecological innovations in the economy of Uzbekistan, the level of development of digital infrastructure and the use of green financial instruments were studied. According to the data, although the volume of investments in ecological innovation projects in the country increased by 4.3 times during 2015–2024, their integration with digital financial management systems has not yet been sufficiently formed. This situation is explained, on the one hand, by the level of digitalization of the financial system and the limitations of institutional mechanisms and on the other hand, by the lack of unified digital standards for assessing ecological investments.

The analysis showed that in the process of digital transformation, the financial management of ecological innovations is being implemented in three main directions: (1) attracting financial resources through digital means (for example, green bonds, digital investment platforms, crypto-token-based ecological assets); (2) using artificial intelligence and blockchain technologies in the allocation and monitoring of investments; (3) using ESG (Environmental, Social, Governance) indicators and Big Data analysis in assessing effectiveness. In this regard, digital technologies not only reduce operating costs in the financing of ecological innovations, but also accelerate financial decision-making and allow for a more accurate assessment of investment risks. The results of the empirical analysis showed that the economic efficiency of ecological innovation projects has increased significantly in countries that have introduced digital financial management systems. For example, in China, digital financing systems implemented under the Green Digital Finance Alliance initiative increased environmental investments by 45% and the number of renewable energy projects by 1.6 times between 2018 and 2023 [12]. In the European Union, the average return on environmental projects financed through digital governance infrastructure was 5.8%, 1.4 times higher than projects financed through traditional financial systems.

In the case of Uzbekistan, analysis shows that the integration of ecological innovations with digital financial management mechanisms in the national economy is only at the stage of formation. Within the framework of the “digital finance” projects implemented by the Central Bank, the Ministry of

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Economy and Finance, and the Agency for Innovative Development in 2021–2024, the share of ecologically oriented investments amounted to 7.3% of the total financial flows. At the same time, according to the results of 2024, more than 200 billion soums of ecological projects were financed through investment platforms managed on the basis of digital technologies (for example, “Ecosystem.uz”, “GreenFinance.uz”). This clearly demonstrates the prospects of digital financial mechanisms in supporting ecological innovations. The results of analytical modeling made it possible to determine the economic efficiency of integrating ecological innovations with digital transformation. According to calculations based on the dynamic regression model, the use of digital financial mechanisms increases the economic profitability of environmental investments by an average of 12–15 percent, and reduces investment risks by 8–10 percent. At the same time, the transparency of the investment decision-making process has improved by more than 20 percent as a result of the introduction of digital management systems.

One of the important results identified during the analysis is that for effective financing of environmental innovations, the financial management system must not only be digitalized, but also be adapted to environmental standards and social responsibility criteria. For this purpose, it is recommended to develop the concept of “green digital finance” in the conditions of Uzbekistan. This concept includes a system for financing environmental innovations through digital platforms, real-time monitoring of environmental indicators and management of investment flows based on environmental criteria.

Another important result is that combining environmental innovations with digital transformation not only increases financial efficiency, but also significantly improves the level of economic stability, resource efficiency and social benefit [13]. Thus, digital financial management mechanisms are emerging as one of the main drivers of the modernization of the economic system in an ecological direction.

In general, the results of the study show that by combining ecological innovations with digital transformation in the national economy, the process of effective management of financial flows, transparency of investment activities and achievement of sustainable development goals will be significantly accelerated. This requires expanding the digital infrastructure, improving the regulatory framework, introducing tax and credit incentives for ecological investments and implementing international “green” finance standards in national practice.

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1-Table **A financial management process that combines ecological innovation with digital transformation in the context of the national economy[1]**

№	Block name	Structural components / Mechanism names	Function and result
1	Public policy and regulation	Strategic directions, ESG standards, legislative framework	Support for ecological and digital projects; reduce investment risks
2	Financial management system	Green bonds, digital tokens, PPP, grants	Financing ecological innovations; effective targeting of investments
3	Ecological innovation	Sustainable technologies, energy efficiency, startups, circular economy projects	Increasing economic and environmental efficiency; introducing innovative solutions through R&D
4	Digital transformation	Big Data, AI, IoT, blockchain, digital investment platforms	Monitoring projects; ensuring transparency; optimizing investment flows
5	Monitoring and analysis	KPI, CO_2 emissions control, ESG rating, investment performance	Assess project performance in real time; develop improvement measures
6	Result (sustainable development)	Sustainable economic growth, environmental efficiency, innovative development, optimal use of resources	Creating a comprehensive positive effect by combining green and digital transformation in the national economy

This table systematically shows the functions and mechanisms of each structural block in the context of the national economy in combining eco-innovation with digital transformation. The state policy and regulation block determines the main direction of projects and reduces investment risks by setting strategic directions, implementing ESG standards and creating sustainability legislation. The financial management system finances eco-innovation through green bonds, digital tokens, grants and public-private partnership mechanisms and ensures the efficient allocation of resources. The eco-innovation block increases economic and environmental efficiency through sustainable technologies, energy efficiency, startups and circular economy projects. Digital transformation monitors projects, ensures transparency and optimizes investment flows using Big Data, AI, IoT, blockchain and digital investment platforms [14]. The monitoring and analysis block assesses the project's effectiveness in real time through KPIs, CO_2 emissions monitoring, ESG rating and investment efficiency and develops improvement measures. In this way, all blocks are interconnected and serve to ensure sustainable economic growth, environmental efficiency and innovative development in the national economy.

Conclusion and suggestions. The results of the study showed that the process of combining ecological innovations with the digital transformation of the national economy is one of the important directions of modern economic development, which requires not only technological innovation, but also a conceptual renewal of economic management. Digital transformation creates new opportunities for

[1] Prepared by the author.

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supporting ecological innovations by making information exchange, financial transactions and investment activities transparent in all sectors of the economy. At the same time, ecological innovations serve to ensure that the national economy achieves sustainable results in the processes of efficient use of resources, waste reduction and adaptation to climate change.

Financial management mechanisms are emerging as a strategic tool that ensures the mutual integration of these two directions - ecological innovations and digital transformation. The study found that the use of digital financial instruments (blockchain, big data, artificial intelligence-based financial monitoring systems) increases the economic efficiency of ecological innovation projects and reduces their investment risk. Also, green financial instruments based on digital technologies - digital bonds, ecological tokens, ESG platforms - play an important role in directing financial flows towards sustainable development goals.

Although the integration of ecological innovations with the digital economy in Uzbekistan is still at an early stage, the existing potential and institutional reforms determine the prospects for this process. The expansion of the national digital infrastructure, the gradual introduction of the concept of “green economy” and the state's policy of supporting ecological investments - all this creates the basis for the effective formation of digital financial management mechanisms. In this regard, the widespread use of digital solutions in the financing system of ecological innovations is becoming a prerequisite for strengthening economic stability, combating climate risks and increasing global competitiveness.

In general, improving financial management mechanisms in combining ecological innovations with digital transformation is a strategic necessity for the national economy. This will not only increase economic efficiency, but also bring the country closer to sustainable development goals, and allow the formation of an economic model that is adaptable to global environmental problems. Therefore, developing digital financial infrastructure, improving the regulatory framework for environmental investments, and expanding cooperation with international financial institutions are among the top priorities in this area.

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