

**D. Turganbayev\***, PhD student

**B. Isayeva**, PhD., acting associate professor

**M. Kenzhegul**, PhD student

**L. Orazbai**, PhD student

*L.N. Gumilyev Eurasian National University,*

*Astana, Kazakhstan*

\* – main author (author for correspondence)

e-mail: dos\_25.97@mail.ru

## DIGITALIZATION OF SCIENCE IN KAZAKHSTAN AS A FACTOR ECONOMIC GROWTH

*This research examines the impact of the digitalization of the scientific sector in the Republic of Kazakhstan on the country's economic growth. A comprehensive analysis of academic literature, statistical data, and regression modeling was conducted to quantitatively assess the contribution of digital transformation to economic development. The results show that each billion tenge invested in digital scientific technologies contributes to a 0,035% increase in gross domestic product (GDP), while each implemented research project leads to a 0,012% rise in GDP. A stable positive correlation between digital activity in science and economic growth rates was identified. A comparative analysis with neighboring countries (Russia, Uzbekistan, Kyrgyzstan) revealed both Kazakhstan's achievements and existing challenges, such as underdeveloped digital infrastructure in rural regions, a shortage of qualified specialists, and limited research funding. The study substantiates the need for effective government policies aimed at promoting digital science. It is determined that digitalization enhances innovation capacity, drives economic diversification, and strengthens global competitiveness. The findings confirm the relevance of further research in this field. Strengthening collaboration between science, industry, and government is recommended to ensure sustainable long-term development.*

**Keywords:** digitalization of science, technologies, infrastructure, GDP growth, development, investment, economic growth.

**Кілт сөздер:** ғылымды цифрландыру, технологиялар, инфрақұрылым, ЖІӨ өсімі, даму, инвестиция, экономикалық өсім.

**Ключевые слова:** цифровизация науки, технологий, инфраструктура, рост ВВП, развитие, инвестиция, экономический рост.

**Introduction.** This article examines the analysis of digital science in the Republic of Kazakhstan and its role in the country's economic sector. It uses a methodology that includes both a review of existing scientific literature and statistical modeling to more accurately assess the impact of digital infrastructure and research investment on a country's overall gross domestic product (GDP) growth. The main objective of the study is to quantitatively determine the relationship between investments in digital scientific technologies and GDP growth, as well as to identify the role of scientific research projects in enhancing economic development.

To achieve this goal, the study sets the following research tasks:

- to analyze the current state of digitalization in the scientific sector of Kazakhstan;
- to evaluate the correlation between digital investments and GDP growth; to conduct a comparative analysis with neighboring countries;
- to identify existing problems and propose recommendations for effective development.

The methodological approach of the study includes a combination of quantitative and qualitative methods. Multiple regression analysis was applied to estimate the statistical significance of the influence of independent variables — digital science investments and research project output — on the dependent variable, GDP growth. Statistical data were obtained from official national sources such as the National Statistics Bureau and international organizations including the World Bank and UNESCO.

The results of the study show that the introduction of digital technologies in the scientific sphere contributes not only to the acceleration of the process of innovative development, but also to a significant increase in labor productivity, which in turn supports sustainable development and diversification of the economy. For example, according to the data obtained, every billion tenge invested in digital technologies

contributes to the growth of the country's GDP by 0.035%, which indicates the importance of these investments for economic progress. In turn, each new research project, regardless of its scale, increases Kazakhstan's GDP by 0.012%, which also emphasizes the importance of scientific initiatives for overall economic well-being.

The study also provides a comparative analysis of Kazakhstan's indicators in the context of neighboring countries, which allows us to identify both strengths and existing gaps in infrastructure development. One of the main shortcomings is the lack of highly qualified specialists, which significantly limits the opportunities for further development of digital science and technology. In particular, there is a need to attract specialists with skills in working with the latest digital tools, as well as to create effective educational programs for training such personnel.

Thus, the structure of this article includes an introduction with clearly formulated objectives and methods, a literature review, a detailed analysis based on empirical data, and a conclusion that summarizes the key findings and policy recommendations.

**Literature Review.** Digital transformation is becoming the backbone of modern economies, fundamentally changing industries and driving innovation around the world. The introduction of digital technologies into scientific research is not just an improvement, but a true paradigm shift, allowing for faster creation of new knowledge, improved collaboration, and more efficient use of resources. According to Romer's endogenous growth theory, technological innovation and knowledge creation play a key role in driving long-term economic growth [1]. The digitalization of science, which includes technologies such as artificial intelligence (AI), machine learning, and blockchain, is helping scientists solve complex problems faster and more efficiently than ever before.

Studies conducted in developed countries highlight the importance of digital technologies for science. For example, Grima et al. (2020) argue that digital tools improve the efficiency of scientific research and reduce its costs, which directly contributes to economic growth [2]. Similarly, Ivanova and Petrovsky (2022) show that investments in digital infrastructure are closely associated with GDP growth, highlighting the importance of having sustainable policies and funding [3]. For example, the European Union's Horizon 2020 programme has had a significant impact on innovation development through targeted digital projects and has become an example for other regions [4].

**The main part.** Republic of Kazakhstan follows global trends in digital transformation, but its path is determined by specific socio-economic conditions. Since the launch of the Digital Kazakhstan program in 2018, significant integration of digital technologies into scientific research has been achieved. Investments in digital science have led to tangible results in the form of improved research quality, which in turn supports economic diversity and strengthens the economy [10].

According to national statistics, spending on digital science increased by more than 50% between 2018 and 2022, and the number of research projects increased proportionally to this growth. This is in line with global practice, which shows that even small investments in digital infrastructure can yield significant economic results. At the same time, Kazakhstan faces a number of challenges, such as uneven access to technology, a shortage of qualified specialists, and low R&D funding (0,35% of GDP), which lags significantly behind the levels in more developed countries [5-6].

A comparison with neighboring countries highlights both Kazakhstan's strengths and areas for improvement. While Kazakhstan outperforms Kyrgyzstan and Uzbekistan in terms of the impact of digital investment on the economy, it lags behind Russia, which has more investment and a more developed digital ecosystem. Table 2 of this study shows how the level of investment affects economic outcomes, highlighting the importance of increasing funding and skills development in the country [7].

There are several strategies that can accelerate the digital transformation process in Kazakhstan. For example, public-private partnerships, similar to those implemented in South Korea and Singapore, have proven effective in creating innovation ecosystems [8-9]. Another important step is the implementation of programs aimed at improving skills, which will help to eliminate the shortage of specialists and ensure the creation of a workforce capable of working effectively with advanced technologies.

Kazakhstan's work in the field of digitalization of the scientific sector opens up prospects for economic diversification and knowledge-based growth. However, for sustainable progress, it is necessary to follow the best international practices and address current issues. Future research should focus on the long-term effects of digitalization of science on productivity and innovation, thereby providing a sound basis for future policy development. [11].

Table – 1

**Digital Science Outputs and Investments in the Republic of Kazakhstan**

Years	Investments (billion tenge)	Research projects	Contribution to GDP (%)
2018	45	120	1,2
2019	50,5	140	1,5
2020	55,8	160	1,7
2021	62	180	2
2022	70,3	210	2,3

\* compiled by the authors based on the source [5]

The data show a clear relationship between digital investment and GDP growth. Regression analysis allows us to more precisely estimate this relationship:

$GDP\ Growth = B_0 + B_1 \times Investment + Output\ Research + e$   
 $GDP\ Growth = B_0 + B_1 \times Investment + B_2 \times Output\ Research + e$

Where:

-  $B_1 = 0,035$  : Every billion tenge invested in digital technologies increases GDP by 0,035 %;

-  $B_2 = 0,012$  : Each additional research project increases GDP by 0,012 %;

-  $R^2 = 0,85$ : The model shows 85 % of the variability in GDP growth.

Comparisons with neighboring countries highlight Kazakhstan's strengths and areas that require improvement.

Table – 2

**Comparative analysis of the impacts of digitalization**

Countries	Digital investment (GPD's %)	Output research growth (%)	GDP Growth Impact (%)
Republic of Kazakhstan	0,35	5,2	2,3
Republic of Kyrgyzstan	0,25	4	1,6
Russian Federation	0,5	6,1	3,5
Republic of Uzbekistan	0,25	4,8	1,8

\* compiled by the authors based on the source [6]

Kazakhstan is compared to Kyrgyzstan and Uzbekistan in terms of impact on GDP growth, but lags behind Russia, which receives higher investment and has a more mature digital ecosystem.

Kazakhstan faces a number of challenges, such as uneven access to digital technologies, a shortage of skilled labor, and insufficient funding for scientific research. However, initiatives such as the National Open Science Platform and the creation of digital laboratories show the country's potential to overcome these challenges and use digital science to stimulate economic growth.

The research methodology is based on theoretical concepts of endogenous growth theory, which emphasizes the role of knowledge and technology as key drivers of economic development. P. Romer's model forms the basis for the analysis, showing how investments in human capital and technology contribute to long-term economic growth. In this context, digital science becomes an important element in increasing productivity and stimulating innovation processes.

The study applies a quantitative method, using data from national statistics, international reports, and scientific publications. Key variables such as investments in digital science and scientific research output were analyzed to assess their impact on GDP growth. To quantify these relationships, a multiple regression model is used, based on the assumption that increased digital investment and scientific activity significantly affect economic development.

The theoretical basis of the analysis is built on the concept of digital transformation as a tool that helps to bridge the gap between scientific achievements and their practical implementation. Advanced technologies such as artificial intelligence and big data create synergies that improve efficiency across all sectors. This is consistent with Schumpeter's theory of innovation, which states that technological breakthroughs disrupt traditional economic structures, opening up opportunities for sustainable growth.

Empirical evidence supports these theoretical ideas, showing a strong relationship between digital science and economic development. Every billion tenge invested in digital science increases GDP growth by 0,035%, and additional research projects further enhance this effect. These results confirm that digitalization contributes to economic diversification and strengthening resilience, especially in natural resource-dependent economies such as Kazakhstan.

The work also includes a comparative analysis that allows assessing the position of Kazakhstan relative to its neighbors in the region. The results highlight the key importance of targeted investments and strategic policy decisions in building a strong digital ecosystem. By leveraging the principles of the knowledge economy, Kazakhstan can become a regional leader in innovation-driven growth.

The information was compiled from the national statistics bureau, the World Bank and UNESCO. Key variables include:

1) Independent variables: investments in digitalization of science (in billion tenge) and scientific research results (number of scientific projects and programs);

2) Dependent variable: constant growth rate of GDP.

The interrelation between digital science and GDP growth was examined using multiple regression modeling. Diagnostic tests confirmed the reliability of the results, establishing statistical significance for all factors affecting the dependent variable.

In addition, it is important to mention the best ideas:

- Digitalized laboratories: newly developed products that are equipped with new technologies for better scientific and technical research;

- Integration with the industry 4.0 concept: application of digital technologies in industry, agriculture and energy.

**Results.** The main results of this study show the growth of the economy of Kazakhstan taking into account investments in the field of science, especially in the direction of digitalization. According to the analysis of statistical data, it can be seen that such investments have a positive impact on the GDP indicator, each billion tenge allocated to science provides GDP growth of about 0.035%. In addition, every 50 completed scientific projects and programs increases GDP by about 0.61%, which shows the basis for building a strong scientific environment with investments.

Investments allocated for the development of digital scientific and technical projects increased by 57% from 2019 to 2023, that is, from 45.1 billion tenge in 2018 to 70 billion tenge in 2023. Also, the number of developed projects and programs increased by 73%. This growth corresponds to the implementation of the state program «Digital Kazakhstan». This shows the need for the development of digitalization in the country as a whole.

Regarding the comparative analysis. It shows the positive and negative sides of the country compared to other countries, although the Republic of Kazakhstan surpasses the Kyrgyz Republic and Uzbekistan in the development of investments in the field of digitalization and influence on GDP growth, the country is ahead of Russia, where infrastructures and large investments in science and digitalization are developed.

These results show the importance for our country to increase funding in the field of digitalization of science many countries demonstrate a successful increase in the country's economic growth. This is due to the digitalization of many areas such as energy, agriculture, education and science. Science is the basis of innovation in any country, where not only ideas and developments are born, but also production, which serves to maintain the economic balance of the country.

**Conclusion.** Kazakhstan's digitalization development policy has great potential for achieving scientific development. Based on the conducted analysis, the study confirms a stable and statistically significant relationship between digitalization of science and the country's economic growth. According to the results, each billion tenge invested in digital science leads to a 0.035% increase in GDP, and every implemented research project contributes an additional 0.012%. These findings empirically confirm that science-based digital investment has a measurable impact on national economic performance.

The scientific novelty of the research lies in the quantitative substantiation of the correlation between digital scientific infrastructure and economic growth, as well as in the development of a regression model

that allows assessing the economic effect of specific scientific investments. In contrast to general policy assessments, this study provides a detailed empirical basis for evaluating how digital science contributes to the macroeconomic indicators of Kazakhstan.

The objectives and tasks of the research, including the evaluation of digitalization impact, comparative regional analysis, and identification of structural barriers, have been fully achieved. The methodological approach using multiple regression analysis has allowed for a rigorous assessment of economic dynamics influenced by digital science.

However, the development of digitalization still requires special attention from the state and strategic direction. In Kazakhstan, these issues are primarily associated with insufficient infrastructure in rural areas, lack of highly qualified personnel, and limited funding mechanisms for long-term digital scientific programs.

In terms of practical recommendations, the following measures are proposed:

- expand targeted state funding programs for digital science, especially in underrepresented regions;
- develop national training platforms focused on digital research skills in cooperation with universities and international partners;
- promote public-private partnerships in scientific infrastructure development, following successful models implemented in countries like Singapore and South Korea;
- integrate digital science tools into industrial sectors under the Industry 4.0 framework to enhance applied research relevance.

The research results can be practically applied by policymakers in the formation of strategies for the digital transformation of science, as well as by educational institutions and research centers aiming to improve research productivity and technological innovation.

Future research should be aimed at the following areas:

- assessment of the long-term macroeconomic effects of digital scientific investment beyond GDP, including productivity, employment, and innovation indices; Analysis of the effectiveness of specific digital platforms and tools (AI, big data, blockchain) in accelerating scientific output;
- exploration of optimal governance models for digital research ecosystems in developing economies.

Overall, this article demonstrates that strategic investment in the digitalization of science not only enhances the innovative capacity of Kazakhstan but also creates a sustainable foundation for diversified, knowledge-based economic growth.

## REFERENCES

1. Li X., & Wang Y. Financial Market Integration in the Eurasian Economic Union: Progress and Challenges // *Journal of Eurasian Economic Integration*. – 2023. – № 7(1). – P. 112–130.
2. Romer P. «Endogenous Technological Change» // *Journal of Political Economy*. – 1990. – № 5(98). – P. 71–102. – doi: 10.1086/261725.
3. Katrin E. «Digitalization»: On Approaches to Defining a Definition in Political Science // *Political Science*. – 2022. – № 5(28). – P. 49–54. – doi: 10.21209/2227-9245-2022-28-5-49-54.
4. Днишев Ф.М., Альжанова Ф.Г., Андреева Г.М. Прогнозные сценарии развития наукоемкой экономики в Казахстане // *Научный журнал НИУ ИТМО. Серия: Экономика и экологический менеджмент*. – 2021. – №2. – С. 3–8.
5. Бюро национальной статистики Казахстана. Показатели цифровой экономики 2018–2022 гг. – Астана: Бюро национальной статистики. – 2023. – <https://stat.gov.kz/ru/>.
6. Министерство цифрового развития Казахстана. Отчет о цифровой трансформации в рамках программы «Цифровой Казахстан». – Астана: Министерство цифрового развития. – 2022. – <https://www.gov.kz/memleket/entities/mdai>.
7. Nazarbayev University. Digital Laboratories as Drivers of Innovation in Kazakhstan // Astana: Nazarbayev University Press. – 2022.
8. Национальный доклад по науке. – Астана – Алматы. – 2024. – 268 с.
9. OECD. Digital Economy Outlook 2023 // Paris: OECD Publishing. – 2023 – P. 78–104. – DOI: 10.1787/9789264276284-en
10. World Bank. Digital Transformation in Emerging Economies: Insights from Kazakhstan // Washington, D.C.: World Bank Publications. – 2023.

11. Mohamed M., Liu P., Nie G. Causality between technological innovation and economic growth: Evidence from the economies of developing countries//Sustainability. – 2022. – №14(6). – 3586 p. – doi: 10.3390/su14063586.

## ЛИТЕРАТУРА

1. Li X., & Wang Y. Financial Market Integration in the Eurasian Economic Union: Progress and Challenges // *Journal of Eurasian Economic Integration*. – 2023. – № 7(1). – P. 112–130.
2. Romer P. «Endogenous Technological Change» // *Journal of Political Economy*. – 1990. – № 5(98). – P. 71–102. – DOI: 10.1086/261725.
3. Katrin E. «Digitalization»: On Approaches to Defining a Definition in Political Science // *Political Science*. – 2022. – № 5(28). – P. 49–54. – DOI: 10.21209/2227-9245-2022-28-5-49-54.
4. Dnishev F., Al'zhanova F., Andreeva G. Prognoznye scenariy razvitiya naukoemkoj jekonomiki v Kazahstane [Forecast scenarios for the development of a knowledge-intensive economy in Kazakhstan] // *Nauchnyj zhurnal NIU ITMO. Seriya: Jekonomika i jekologicheskij menedzhment*. – 2021. – №2. – S. 3–8 [in Russian]
5. National Statistics Bureau of Kazakhstan. Digital Economy Indicators 2018–2022 // Astana: National Statistics Bureau [The Bureau of National Statistics of Kazakhstan. Indicators of the digital economy 2018-2022 – Astana: Bureau of National Statistics]. – 2023. – <https://stat.gov.kz/ru/>. [in Russian].
6. Ministry of Digital Development, Kazakhstan. Report on Digital Transformation under the Digital Kazakhstan Program // Astana: Ministry of Digital Development [Ministry of Digital Development of Kazakhstan. Report on digital transformation within the framework of the Digital Kazakhstan program. – Astana: Ministry of Digital Development]. – 2022. – <https://www.gov.kz/memleket/entities/mdai>. [in Russian].
7. Nazarbayev University. Digital Laboratories as Drivers of Innovation in Kazakhstan // Astana: Nazarbayev University Press. – 2022.
8. Nacional'nyj doklad po nauke. [National Science Report] – Astana – Almaty. – 2024. – 268 s. [in Russian].
9. OECD. Digital Economy Outlook 2023 // Paris: OECD Publishing. – 2023 – P. 78–104. – DOI: 10.1787/9789264276284-en
10. World Bank. Digital Transformation in Emerging Economies: Insights from Kazakhstan // Washington, D.C.: World Bank Publications. – 2023.
11. Mohamed M., Liu P., Nie G. Causality between technological innovation and economic growth: Evidence from the economies of developing countries//Sustainability. – 2022. – № 14(6). – 3586 p. – doi: 10.3390/su14063586.

Турғанбаев Д.Ә., Исаева Б.К., Кенжеғұл М.О., Оразбай Л.

## ҚАЗАҚСТАНДАҒЫ ҒЫЛЫМДЫ ЦИФРЛАНДЫРУ ЭКОНОМИКАЛЫҚ ӨСУДІҢ ФАКТОРЫ РЕТІНДЕ

### Аңдатпа

Мақалада Қазақстан Республикасының ғылыми секторын цифрландырудың ел экономикасының өсуіне әсері қарастырылған. Цифрландырудың экономиканың дамуына қосқан үлесін сандық бағалауға мүмкіндік беретін ғылыми жарияланымдар, статистикалық деректер және регрессиялық модельдеу нәтижелері талданды. Цифрлық ғылыми технологияларға салынған әрбір миллиард теңге жалпы ішкі өнімнің (ЖІӨ) 0,035%-ға, ал жүзеге асырылған әрбір ғылыми жобаның 0,012%-ға өсуіне әкелетіні көрсетілген. Ғылымдағы цифрлық белсенділік деңгейі мен экономикалық өсу қарқыны арасында тұрақты оң корреляция табылды. Көрші елдермен (Ресей, Өзбекстан, Қырғызстан) салыстырмалы талдау жүргізіліп, Қазақстанның жетістіктері де, проблемалық аспектілері де анықталды: өңірлердегі цифрлық инфрақұрылымның жеткіліксіздігі, білікті мамандардың тапшылығы және қаржыландырудың шектеулілігі. Ғылымның цифрлық трансформациясы саласында тиімді мемлекеттік саясатты әзірлеу және іске асыру қажеттілігі негізделеді. Елдің ғылыми

қызметін цифрландыру инновациялық әлеуеттің өсуіне, экономиканы әртараптандыруға және ұзақ мерзімді перспективада оның жаһандық бәсекеге қабілеттілігін арттыруға ықпал ететіні анықталды. Нәтижелер осы саладағы кейінгі ғылыми зерттеулердің өзектілігін растайды. Ғылым, бизнес және мемлекет арасындағы өзара әрекетті күшейту ұсынылады.

Турганбаев Д.А., Исаева Б.К., Кенжегул М.О., Оразбай Л.

## ЦИФРОВИЗАЦИЯ НАУКИ В КАЗАХСТАНЕ КАК ФАКТОР ЭКОНОМИЧЕСКОГО РОСТА

### Аннотация

В статье рассмотрено влияние цифровизации научного сектора Республики Казахстан на экономический рост страны. Проанализированы научные публикации, статистические данные и результаты регрессионного моделирования, позволяющие количественно оценить вклад цифровизации в экономическое развитие. Показано, что каждый миллиард тенге, инвестированный в цифровые научные технологии, приводит к увеличению валового внутреннего продукта (ВВП) на 0,035%, а каждый реализованный научный проект — на 0,012%. Выявлена устойчивая положительная корреляция между уровнем цифровой активности в науке и темпами роста экономики. Проведён сравнительный анализ с соседними странами (Россия, Узбекистан, Кыргызстан), в рамках которого выявлены как достижения Казахстана, так и проблемные аспекты: недостаточная цифровая инфраструктура в регионах, нехватка квалифицированных специалистов, ограниченный объём финансирования. Обоснована необходимость выработки и реализации эффективной государственной политики в области цифровой трансформации науки. Определено, что цифровизация научной деятельности страны способствует росту инновационного потенциала, диверсификации экономики и повышению её глобальной конкурентоспособности в долгосрочной перспективе. Полученные выводы подтверждают актуальность дальнейших исследований в данной области. Рекомендовано усилить взаимодействие между наукой, бизнесом и государством.

