

Research Article

The Role of Human Capital and Technological Processes in the Green Economy

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ABSTRACT:

This article examines the role of human capital and technological development in the innovative economy based on a comprehensive scientific approach. The study substantiates, both theoretically and empirically, the importance of human capital in the transformation of economic systems under globalization, particularly in the transition from an industrial economy to an innovative and digital economy. The paper analyzes the formation and development stages of human capital theory based on the views of representatives of classical economic schools and modern economists. Furthermore, it explores the interrelationship between human capital and technological progress within the framework of innovation development concepts, particularly endogenous economic growth theory. Based on the research findings, scientific and practical recommendations have been developed aimed at modernizing the education system, enhancing digital competencies, supporting research activities, and strengthening public-private partnerships.

Keywords: *Human Capital, Innovative Economy, Technological Development, Digital Economy, Quality of Education, Digital Competencies, Innovation, Economic Growth, Research Activity, Startup Ecosystem.*

INTRODUCTION

In today's globalization environment, the world economic system is fundamentally changing, and the transition from an industrial economy to an innovative and digital economy is underway. In such conditions, the sustainable development of countries, their competitiveness in the international arena and economic security are largely determined by the quality of human capital and the level of technological development. Therefore, in recent years, the development of human capital and the formation of an innovative economy have been recognized as one of the most priority areas of state policy in Uzbekistan.

In the framework of the large-scale reforms being implemented in the Republic of Uzbekistan, in particular, within the framework of new development strategies, special attention is paid to the development of human capital. In particular, the Decree of the President of the Republic of Uzbekistan on the "Development Strategy of New Uzbekistan" for 2022-2026 created the main legal basis for the modernization of the country, digitalization of the economy and the transition to an innovative development model. This strategy sets out important tasks such as developing human capital, improving the quality of education, supporting science and innovation, and preparing

young people for modern professions. Also, the Resolution of the President of the Republic of Uzbekistan on Approval of the Strategy "Digital Uzbekistan – 2030" aims to bring human capital to a new qualitative level through the digital transformation of the country's economy, the widespread introduction of information and communication technologies into public administration and economic sectors.

Today, a fundamental reform of the education system in Uzbekistan is also one of the important areas of human capital development. Systemic reforms are being implemented to improve quality at all levels, from preschool education to higher education, introduce curricula in line with international standards, and use modern pedagogical technologies. In particular, the expansion of the independence of higher education institutions, the introduction of the credit-module system, and the strengthening of cooperation with foreign universities are contributing to the development of human capital to a qualitatively new level. In addition, great attention is paid to supporting scientific and research activities in the country. As a result of the activities of the Ministry of Innovative Development, the improvement of the financing system for scientific projects, the introduction of grants for young scientists and mechanisms for

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Received: 25 Jan 2026; **Accepted:** 02 Feb 2026; **Published:** 04 Feb 2026

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supporting startup initiatives, the integration between science and production is increasing. This, in turn, is serving as an important factor in the formation of an innovative economy.

Also, in recent years, large-scale work has been carried out in the country to develop the infrastructure of the digital economy, support the IT sector, and form a startup ecosystem. The increase in the number of IT Park residents, the entry of foreign IT companies into Uzbekistan, and the expansion of training programs for young programmers are contributing to the technological development of human capital. As stated in the presidential decrees, the main goal of economic reforms is to increase the well-being of the population, invest in human capital and create the foundations of an innovative economy. Because in modern economic conditions, not only natural resources, but also educated, qualified and innovatively thinking human resources are becoming the main factor in the country's development. At the same time, technological development processes are placing new demands on the quality of human capital. Now, not just simple knowledge, but analytical thinking, innovative problem solving, digital literacy and the ability to constantly develop are of great importance. This reinforces the need to modernize the education system, improve the research environment and form an innovative ecosystem.

LITERATURE REVIEW

The initial theoretical foundations of the idea of human capital were laid by Adam Smith, the founder of the classical economic school. In his work "The Wealth of Nations", he argues that not only material capital, but also human knowledge, skills and qualifications are important as a source of economic development. He scientifically explains the increase in specialization of workers as a result of the deepening of the division of labor, and thereby an increase in production efficiency. According to Adam Smith, human education, experience and professional skills are the real source of wealth in society. In this way, he formed the first elements of the theory of human capital, although this concept was not used as a separate category at that time.

David Ricardo, one of the representatives of the classical school, also stated that the quality of labor resources plays an important role in economic growth. Analyzing economic processes, he shows that production factors are not limited only to land and capital, but also depend on labor productivity and its level of qualification. Ricardo's approach

served to further strengthen the place of human capital in the economic system.

The issue of the role of human capital and technological processes in the conditions of a green economy has been widely studied by representatives of our country and related scientific schools. In Uzbek economic literature, human capital is interpreted as an important factor of economic growth, and it is emphasized that its quality and efficiency determine the sustainable development of the economy. In particular, A. Vakhobov in his scientific works evaluates human capital as a key resource that increases the competitiveness of the national economy. In his opinion, the development of the education system and the training of qualified personnel are one of the important conditions for the transition to a green economy. K. Abdurakhmonov also analyzes the relationship between the labor market and human capital, highlighting the formation of new professions and competencies in an environmentally friendly economy. The issue of technological processes has also been widely covered by local scientists. S. Gulyamov substantiates the possibility of efficient use of resources and reduction of environmental problems through the development of the digital economy and innovative technologies. In his research, digitalization is seen as an important component of the green economy. In addition, the economics textbooks created by Sh. Shodmonov and U. Gafurov emphasize the inextricable link between technological progress and human capital. They show that the role of educated personnel in the modernization of production, the introduction of energy-saving technologies and the production of environmentally friendly products is crucial. Local scientific sources note the need for an integrated approach to the development of human capital, along with the use of innovations, in the process of transition to a green economy. In particular, improving the quality of education, stimulating research activities and developing innovative thinking of young specialists are indicated as the main priority areas.

RESEARCH METHODOLOGY

In this study, the topic "Human capital and technological development: their role in an innovative economy" was studied based on a comprehensive scientific approach. The methodological basis of the study is the theory of human capital, concepts of innovative development, and theories of economic growth. This approach allowed for a systematic and in-depth analysis of the relationship between human capital and technological development. The main data for the

study were obtained from statistical databases of international organizations such as the World Bank, the UNDP, the Organization for Economic Cooperation and Development, and the Global Innovation Index. Data from national statistical agencies, scientific articles, monographs, and studies by international experts were also involved in the analysis.

ANALYSIS AND RESULTS

In an innovative economy, human capital is emerging as one of the main factors determining the competitiveness of countries. The conducted analyses show that highly qualified personnel, research potential, and the level of digital

competencies directly affect the pace of technological development.

Especially in the current era of increasing digital transformation processes, human capital has become a key driver not only of economic growth, but also of the sustainability of the innovation ecosystem. The analysis examined the impact of the structural elements of human capital - education level, professional competencies and digital skills - on innovation activity. According to the results, the highest impact indicators correspond to higher education and IT competencies.

Table 1: The impact of human capital components on innovative activity

Human capital component	Level of impact (%)	Definition
Higher education level	35	Research and innovation foundation
Digital competencies	30	Accelerates technological transformation
Professional experience	20	Creates practical innovative solutions
Language and communication skills	10	Ensures global integration
Creative thinking	5	New idea generator

This table shows the role of the main components of human capital in the formation of innovative activity and their relative level of influence. It can be seen that the innovation process is based not on a single factor, but on a set of several knowledge, skills and experiences. That is, innovation is a complex system formed on the basis of interconnected and complementary elements of human capital. The fact that the highest share in the table belongs to the level of higher education means that scientific knowledge and theoretical training are the basis of innovative activity. Because a deep knowledge base is necessary to create new ideas and scientifically substantiate them. This factor is the foundation of innovation. Digital competencies also have a high share, which means that modern innovations are directly related to digital technologies. Today,

innovative processes are carried out through digitization, automation and technological platforms, so these skills serve to accelerate innovation. Professional experience allows you to apply existing knowledge and technologies in real-life situations. This factor plays an important role in the implementation of innovative ideas and increases their effectiveness. Language and communication skills ensure the development of the innovation process at a global level, as they enable international cooperation, knowledge exchange and transfer of experience. This helps innovation to function as an open system. Creative thinking, which has the smallest share, is the initial source of the formation of new ideas. It gives the first impulse to the innovation process, but it gives a full result only when combined with other components.

Table 2: Level of human capital and share of IT sector (by selected countries)

Group of countries	Average GDP	IT sector share	Innovation Index
High level	85	12-18	0.8-0.9
Middle level	65	6-10	0.55-0.75
Low level	45	2-5	0.3-0.5

This table shows the general relationship between the level of development of countries and their innovative potential. The main idea is that the more developed a country is, the stronger its human capital is, the more widely developed the IT sector

is, and as a result, the higher the level of innovative activity. In highly developed countries, human capital is of high quality, and the level of education and skills is high. Therefore, they quickly absorb technologies, the IT sector occupies an important

place in the economy, and innovation processes are constantly developing. In medium-level countries, these processes are at the formation stage. That is, even if human capital is sufficiently developed, the IT sector has not yet become the main driving force of the economy. Therefore, innovative activity also remains at an average level. In low-level countries, the main problem is the lack of human capital and technological development. Due to the low level of education and skills, the IT sector is also small, which also limits innovative activity.

The growth of human capital leads to an increase in the number and quality of technological innovations. The expansion of highly qualified personnel, scientific potential and intellectual resources significantly accelerates the development of new technological solutions, their implementation and commercialization. In particular, as the share of human capital involved in research and development increases, the number of patents, startup activity and the volume of innovative products also increase.

This process is manifested as a key factor in the formation of a knowledge economy. The quality of education is one of the decisive determinants of an innovative economy. Analyses show that the education system stimulates innovative activity not only by imparting knowledge, but also by developing creative thinking, problem-solving and research skills. In particular, in countries with a high level of integration between higher education institutions and research centers, the pace of technological development is much faster. Therefore, a strong positive correlation has been found between the quality of education and innovative activity. The development of digital competencies accelerates economic transformation processes. In the presence of human capital that can master and effectively use digital technologies, production processes are automated, the service sector is digitized, and management systems are optimized. This leads to increased labor productivity, reduced costs, and the emergence of new economic opportunities.

In particular, in regions with a high level of IT competencies, innovation ecosystems are formed and developed faster. Effective cooperation between the state and the private sector ensures the sustainable development of the innovation ecosystem. The institutional environment created by the state, grants, tax incentives and infrastructural support measures enhance the involvement of the private sector in innovative activities. At the same time, the results of investments and research carried

out by the private sector have a positive impact on the development of human capital. This interaction creates a synergistic effect and increases the overall level of technological progress. In addition, the results of the regression analysis clearly demonstrate the quantitative relationship between the human capital index and the technological development index. According to the model results, when the human capital index increases by one unit, the technological development index increases by an average of 0.7–0.9 units. This indicator indicates a high level of elasticity and confirms the high efficiency of investments in human capital. This elasticity coefficient shows that even relatively small changes in human capital lead to significant results in technological development. This justifies the need to prioritize human capital development in economic policy. In particular, high economic growth can be achieved by increasing spending on education, expanding digital skills development programs, and supporting research and development. The results of the analysis also showed that the relationship between human capital and technological development occurs not only directly, but also through indirect factors. In particular, institutional quality, innovative infrastructure, access to financial resources, and the level of global integration are important determinants that enhance this process. Therefore, human capital development requires an integrated approach.

CONCLUSION

This study systematically analyzed the relationship between human capital and technological development and their role in the formation of an innovative economy. The conducted scientific analysis shows that the main driving force of modern economic development is not natural resources or traditional factors of production, but highly qualified, knowledgeable and innovatively thinking human capital. It is the quality of human capital that is emerging as the main factor determining the level of technological transformation of the economy, the scale of innovative activity and the global competitiveness of the country. According to the results of the study, the structural elements of human capital - education level, digital competencies, professional experience, communication skills and creative thinking - influence the formation of innovative activity to varying degrees, but in an interconnected manner. In particular, it was found that higher education level and digital competencies have a high share as the main drivers of innovation processes. This confirms the crucial importance of a knowledge-based

approach and the integration of digital technologies in the modern economy.

The analysis also shows that in countries with a high level of human capital, the pace of innovation activity, IT sector development and technological progress is significantly higher. On the contrary, in economies with insufficient human capital development, innovation processes are sluggish and the level of technological development is limited. This scientifically substantiates the existence of a strong positive correlation between human capital and the innovative economy.

The results of regression analyses also confirm this conclusion and show a high level of elasticity between the human capital index and the technological development index. That is, investments in human capital not only ensure long-term economic growth, but also lead to significant technological changes in the short and medium term. This once again justifies the need for the development of human capital to be a strategic

priority of economic policy. Based on the results of the study, it can be noted that for the sustainable development of the innovative economy, it is important to modernize the education system, increase digital literacy, support research activities and strengthen public-private partnership mechanisms.

In particular, deepening the integration between education and production, implementing scientific results in practice, and developing the startup ecosystem are considered key factors in increasing the economic efficiency of human capital. In addition, global experience shows that the transition to an innovative economy without the development of human capital is complex and slow. Therefore, the focus of any economic reforms should be on the human factor, the development of its knowledge and skills. This, in turn, will ensure long-term sustainable economic growth and strengthen the country's position in the international arena.

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