INVESTMENTS IN INFRASTRUCTURE AS A STRATEGIC TOOL FOR ECONOMIC DEVELOPMENT AND SOCIAL WELL-BEING IN THE CONTEXT OF DIGITAL TRANSFORMATION

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Abstract

This article examines the multifaceted nature of infrastructure investments as a strategic tool for economic development and social well-being. It analyses the relationship between infrastructure investment and economic growth at macro and micro levels, paying particular attention to the multiplier effects of infrastructure projects. It also considers current issues of infrastructure financing, including public–private partnerships and attracting institutional investors. Furthermore, it analyses modern approaches to assessing the effectiveness of infrastructure investment, taking into account long-term socio-economic effects and environmental aspects. Particular attention is paid to the digital transformation of infrastructure and the integration of innovative technologies into traditional systems.

Keywords: infrastructure investment, infrastructure, investment, economic growth, public-private partnership, sustainable development, digital infrastructure

I. Introduction

Infrastructure is a complex of interconnected service structures, systems and objects that provide the basis for the functioning of the economy and the life of society. In a broad sense, infrastructure is a fundamental material, technical and institutional base that creates conditions for the implementation of production, social, managerial and other types of activities. From an economic point of view, it is characterized by a number of specific properties: high capital intensity, long life cycle, significant positive external effects, network nature, scale effect and indivisibility of objects [[1]]. Infrastructure often has the characteristics of a public or quasi-public good, which determines the specifics of its financing and management.

Infrastructure is a fundamental basis for the functioning of the modern economy and the life of society, acting as a necessary condition for the efficient production of goods and services, the free movement of people, goods and information. High-quality infrastructure creates a mechanism for a multiplier effect on economic growth by reducing transaction costs, increasing labor and capital productivity, expanding access to markets and resources, and creating conditions for technological innovation. Research by the World Bank and the IMF shows that an increase in infrastructure investment by 1% of GDP can lead to long-term GDP growth of 1.5%, which confirms the exceptional importance of infrastructure as a driver of economic development [[6]]. Moreover, infrastructure plays a key role in addressing today's global challenges, including urbanization,

climate change and digital transformation, determining not only current economic dynamics but also long-term prospects for sustainable development.

II. Methods

The social significance of infrastructure is no less important, since it directly affects the quality of life of the population, determining the availability of education, health care, cultural goods and other social services, as well as shaping the quality of the environment and living space. Access to basic infrastructure remains one of the key factors in reducing inequality and increasing social mobility, which is especially important for developing countries, where infrastructure limitations often become an insurmountable barrier to the socio-economic development of entire regions. According to the UN, investment in infrastructure is directly related to the achievement of at least 9 of the 17 Sustainable Development Goals [[7]], including poverty eradication, food security, health and well-being, quality education and gender equality. Infrastructure development is therefore not just a technical or economic issue, but a key condition for social progress and the formation of an inclusive society oriented towards meeting the needs of all its members.

The classification of infrastructure objects is presented in Fig. 1.

INFRASTRUCTURE FACILITIES		
Transport infrastructure	**Energy infrastructure**	**Public utilities infrastructure**
❑ Highways and bridges ❑ Railway infrastructure ❑ Ports and waterways ❑ Airports and air navigation systems ❑ Pipeline transport ❑ Multimodal logistics complexes	❑ Electricity generation facilities (thermal power plants, nuclear power plants, hydroelectric power plants, renewable energy facilities) ❑ Electrical networks and substations ❑ Gas transportation systems ❑ Heating systems ❑ Energy storage facilities ❑ Energy efficient technologies	❑ Water supply and sanitation systems ❑ Waste management facilities ❑ City Lighting ❑ Improvement of territories
Telecommunications infrastructure	**Social infrastructure**	**Institutional infrastructure**
❑ Multi-generation communication networks ❑ Data centers ❑ Broadband Internet Access ❑ Satellite communication systems ❑ Infrastructure for Internet of Things technology	❑ Educational institutions ❑ Healthcare facilities ❑ Sports facilities ❑ Cultural institutions ❑ Social security facilities	❑ Public administration systems ❑ Development financial institutions ❑ Legal and regulatory mechanisms

Figure 1: *Classification of infrastructure objects*

III. Results

The modern understanding of infrastructure also includes the concept of "critical infrastructure" – systems and facilities whose disruption could lead to a significant negative impact on national security, the economy and public welfare [[5]]. In the context of the digital transformation of the economy, the concept of "smart infrastructure" is of particular importance. It is characterized by the integration of physical objects with digital technologies, including the Internet of Things, big data and artificial intelligence, which allows optimizing the operation of infrastructure facilities, increasing their efficiency and adaptability to changing conditions.

Thus, infrastructure is a multidimensional economic phenomenon, covering a wide range of tangible and intangible assets, ensuring the functioning and development of the economic system and social sphere of the state. In the context of global economic challenges and increasing international competition, investments in infrastructure are acquiring strategic importance for ensuring the sustainable development of national economies.

Infrastructure investments are long-term capital investments in infrastructure facilities with the aim of creating, modernizing or expanding material and technical and organizational and economic systems that provide fundamental conditions for the functioning of the economy and the life of society. This type of investment has a number of specific characteristics that determine their special place in the economic system:

- long-term nature – infrastructure investments imply a long payback period, often measured in decades, which requires a strategic approach to planning and implementing such investments;
- high capital intensity – the implementation of infrastructure projects requires significant initial capital investments, which creates significant barriers for private investors and determines the need for state participation;
- multiplier effect – infrastructure investments generate significant economic effects, stimulating the development of related industries and creating conditions for long-term economic growth;
- social significance – the results of infrastructure investments have wide public use and affect the quality of life of the population, often going beyond purely economic criteria of efficiency;
- network nature – many infrastructure facilities function as parts of a single system, which requires coordination of investment decisions and an integrated approach to infrastructure development;
- significant positive externalities – infrastructure investments create positive externalities that cannot always be monetized by the investor, which determines their underfunding under the conditions of a market mechanism [[2]].

The essence of infrastructure investment is not only the creation of physical assets, but also the formation of fundamental conditions for economic growth, increased productivity and competitiveness of the economy as a whole. In modern conditions, they are also considered as a tool of countercyclical regulation: during economic downturns, states often increase the volume of infrastructure investment to stimulate aggregate demand and create jobs. Infrastructure investment is characterized by significant diversity and can be classified according to various criteria (Fig. 2).

Infrastructure investments play a key role in the economic development of states and regions, forming the basis for sustainable growth and improving the quality of life of the population. Depending on the goals, scale and nature of the objects, four main types of infrastructure investments can be distinguished, each of which has its own characteristics, advantages and areas of application.

Thus, greenfield investments are aimed at creating completely new infrastructure facilities "from scratch" [[4]]. These projects are implemented in previously undeveloped territories or in areas where the corresponding infrastructure was absent. Key features of investments in infrastructure greenfield projects include: high initial costs, significant freedom in design and

planning, no restrictions associated with existing facilities, a long payback period (usually 15-30 years), and increased risks due to the lack of operational history. Examples of such investments are the construction of new airports, the laying of new railway lines, the construction of new power plants, the creation of new reservoirs.

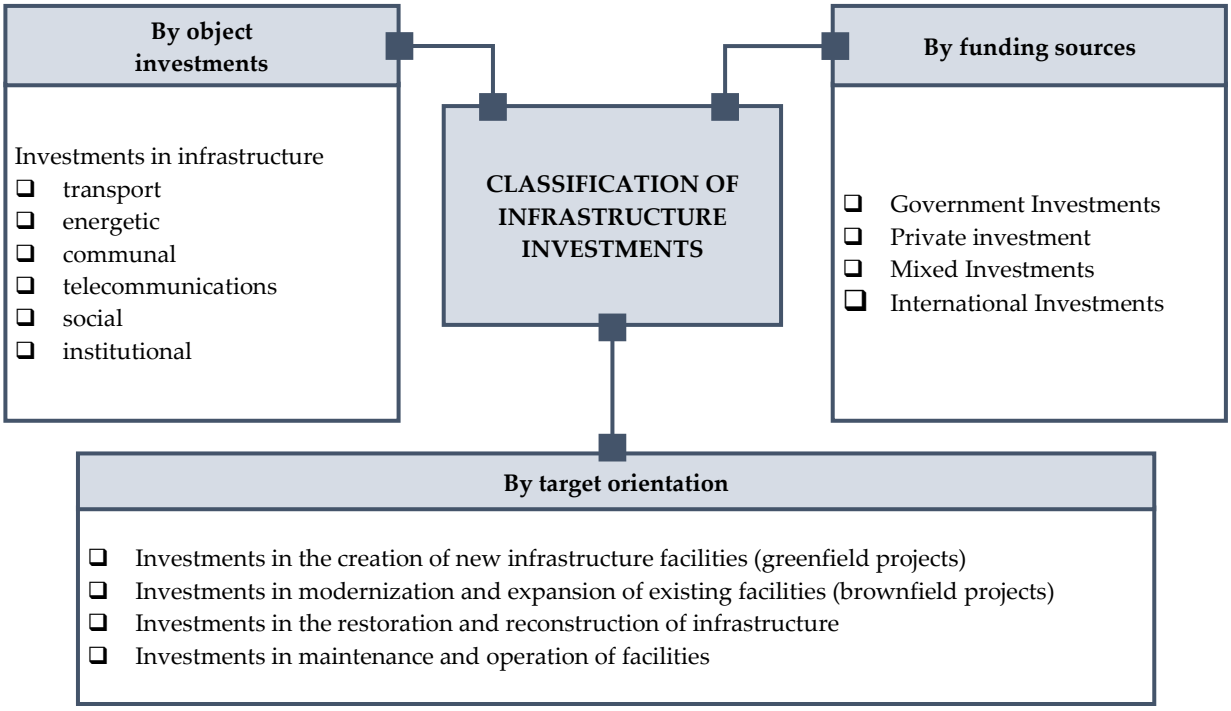

Figure 2: *Classification of infrastructure investments*

IV. Discussion

Brownfield investments are aimed at expanding, modernizing, or refurbishing existing infrastructure facilities to improve their efficiency or increase their capacity. The features of such infrastructure investments are lower initial costs, shorter implementation periods, more predictable risks due to the presence of an operational history, a relatively quicker achievement of the break-even point, and some limitations associated with the existing infrastructure. Examples of such investments include investments in the expansion of port terminals, modernization of electrical networks, expansion of highway capacity, and updating of telecommunications equipment.

Significant infrastructure investments also include investments in restoring the functionality and upgrading obsolete or damaged infrastructure facilities to extend their service life or adapt them to new requirements. The main characteristics of such investments are their focus on extending the life cycle of infrastructure systems, upgrading the technological base, and reducing operating costs in the long term. This type of investment often includes elements of modernization and may involve improving the environmental performance of the relevant facilities. Examples of such projects include: reconstruction of bridges, restoration of historic buildings while maintaining their functionality, upgrading urban sewer systems, and reconstruction of obsolete industrial facilities.

Investments in maintenance and operation are aimed at maintaining the current functioning of infrastructure facilities, preventing their premature wear and tear, and ensuring uninterrupted

operation. The features of this category of infrastructure investments are the regularity and repeatability of investments, relatively small amounts compared to other types of investments, critical importance for preventing more expensive repairs, direct impact on operational efficiency, and ensuring user safety. Such investments include scheduled road surface repairs, regular maintenance of water supply systems, maintenance of equipment at power plants, and seasonal preventive maintenance on utility networks.

Ensuring adequate financing for infrastructure projects is one of the key problems of economic development for both developed and developing countries. The diversity of sources of infrastructure financing reflects the complexity and comprehensive nature of infrastructure projects, as well as the diversity of mechanisms for attracting capital to this sector of the economy.

Public investment has traditionally played a dominant role in financing infrastructure projects, which is due to a number of objective factors. First of all, many infrastructure projects are public or quasi-public goods, characterized by non-excludability and/or non-rivalry in consumption [[3]]. These characteristics make private financing of such objects economically inexpedient and determine the need for state participation. State financing of infrastructure is carried out through various channels and mechanisms: direct budget investments, state infrastructure funds, investment programs of state companies and natural monopolies, targeted state programs for infrastructure development.

Direct budget investments are the most traditional and widespread mechanism, whereby infrastructure projects are financed directly from federal, regional or municipal budgets. This mechanism is especially relevant for socially significant infrastructure facilities, such as educational institutions, healthcare facilities, and public road networks. The advantages of direct budget financing are the relative simplicity of administration and the possibility of implementing projects with low commercial but high social returns; the disadvantages include budget constraints and the risks of inefficient use of funds in the absence of market incentives.

State infrastructure funds are specialized financial institutions created by the state for the targeted financing of infrastructure projects. These funds can be formed from various sources, including tax revenues, income from the export of natural resources, income from privatization, and others. Examples of such funds are the National Welfare Fund in Russia, infrastructure funds at the level of individual states in the United States, and the National Infrastructure Fund in the United Kingdom. The advantage of creating specialized funds is the possibility of long-term planning and financing of infrastructure projects, regardless of short-term fluctuations in budget revenues [[2]].

Investment programs of state-owned companies and natural monopolies are an important channel for financing infrastructure, especially in strategic sectors of the economy. State-owned companies in the energy, transport and telecommunications sectors implement large-scale investment programs aimed at developing the relevant infrastructure. The mechanisms for financing such programs may include both the companies' own funds and debt financing under state guarantees, as well as various forms of state support, including interest rate subsidies and tax incentives.

Targeted state infrastructure development programs involve a comprehensive approach to financing interrelated infrastructure projects within a single development strategy. Such programs are often implemented at the national level and cover both the modernization of existing and the creation of new infrastructure. Examples of such programs are National Projects in Russia, the Infrastructure Investment and Jobs Act in the United States, and the TEN-T transport infrastructure development program in the European Union.

Attracting private capital to infrastructure projects allows not only to overcome the limitations of public financing, but also to increase the efficiency of project implementation by introducing market incentives, advanced technologies and management practices. Corporate investments are investments of private companies in the creation and modernization of infrastructure facilities necessary for their production activities. This mechanism is most common in sectors with a high

degree of commercialization, including telecommunications, energy, and port infrastructure. Corporate investments can be made both at the expense of the companies' own funds and by attracting debt financing on market terms.

Infrastructure funds allow attracting funds from institutional investors to infrastructure projects, including pension funds, insurance companies, sovereign wealth funds, which are characterized by a long-term investment horizon corresponding to the life cycle of infrastructure facilities. Infrastructure bonds are a specialized financial instrument that allows attracting funds from a wide range of investors to finance infrastructure projects. Bonds can be issued both by private companies implementing infrastructure projects and by specialized project companies within the framework of public-private partnerships. Infrastructure bonds often imply the presence of certain state guarantees or tax benefits that increase their attractiveness to investors.

Project financing is a mechanism for attracting long-term debt financing for large infrastructure projects, where the main collateral is future cash flows from the project. This mechanism involves the creation of a special project company (SPV), which is responsible for the implementation of the project and servicing the attracted financing. Project financing allows structuring complex financial schemes involving various types of investors and creditors, as well as optimally distributing project risks between its participants.

Venture capital investments have become a significant source of financing for innovative infrastructure projects in recent years, especially in the field of digital infrastructure and smart cities. Venture capital funds and business angels invest in startups developing technological solutions for infrastructure problems, which contributes not only to financing, but also to the technological modernization of the infrastructure sector. Despite the growth of private investment in infrastructure, their share in the total volume of infrastructure investment remains relatively low, which is due to a number of limitations, including high risks of infrastructure projects, regulatory uncertainty, difficulty in assessing long-term projects, and other factors.

Public-private partnership (PPP) has become one of the key mechanisms for attracting private capital to infrastructure projects while maintaining strategic control by the state. PPP is an institutional and organizational alliance of the state and business, created for a certain period to implement a specific project and ceasing to exist after its completion. The development of PPP mechanisms requires the formation of an adequate institutional environment, including legislative regulation, dispute resolution mechanisms, a system of guarantees for investors, as well as the development of the competencies of government agencies in the field of structuring and managing PPP projects.

International investment plays an important role in financing infrastructure projects, especially in developing countries that face limited domestic sources of capital. Thus, international development finance institutions, including the World Bank, regional development banks (Asian Development Bank, African Development Bank, Inter-American Development Bank, etc.), provide concessional financing and technical assistance for the implementation of infrastructure projects in developing countries. Financing can be carried out both in the form of direct loans and through co-financing mechanisms with private investors, provision of guarantees and other instruments. International financial institutions also play an important role in developing standards and best practices in the field of sustainable infrastructure development.

New international financial institutions, in particular the Asian Infrastructure Investment Bank (AIIB) and the New Development Bank of the BRICS, initiated by China, are actively increasing financing of infrastructure projects in Asia, Africa and Latin America. These institutions focus on financing projects in the fields of transport, energy, digital infrastructure and social development. National external infrastructure financing programs, such as China’s Belt and Road Initiative, Japan’s Partnership for Quality Infrastructure, and the US’s Build Back Better World initiative, provide financing and technical support for infrastructure development in partner countries. Such programs often combine economic goals with the geopolitical interests of donor countries.

International infrastructure funds, including sovereign wealth funds, pension funds, and insurance companies from developed countries, are increasingly investing in infrastructure projects on a global scale, viewing them as a source of stable long-term income and a way to diversify their investment portfolio. Cross-border infrastructure projects are a special category of international infrastructure investments implemented jointly by several countries. Such projects are especially common in the areas of transport (international transport corridors), energy (cross-border power grids, international gas pipelines), and telecommunications (underwater communication cables). Financing of such projects is often carried out through complex international consortia involving public and private partners from different countries.

At the present stage, the infrastructure financing sector faces a number of significant challenges that determine the evolution of capital raising mechanisms:

1) Global infrastructure gap – various international organizations estimate that infrastructure investments of USD 3.5 – 4.5 trillion annually are required to meet the growing needs of the global economy and achieve the UN Sustainable Development Goals, while actual investments amount to approximately USD 2.5 – 3 trillion, creating a significant funding gap [[7]];

2) Fiscal constraints – high levels of public debt in many countries limit the ability of public sector infrastructure financing and necessitate more active involvement of private capital;

3) Regulatory barriers – the complexity and instability of the regulatory environment, especially in developing countries, creates significant risks for private investors and increases the cost of capital for infrastructure projects;

4) Technological transformations – digitalization and decarbonization of the economy require large-scale investments in new types of infrastructure (digital, “green” infrastructure), as well as the modernization of existing infrastructure systems.

In response to these challenges, new trends in infrastructure financing are emerging:

1) Development of innovative financial instruments, including “green” and “social” bonds, sustainability-linked bonds, blended finance, which allows combining commercial financing with grant support for projects with high social or environmental impacts;

2) Creation of specialized platforms for connecting investors and infrastructure projects, including digital platforms that facilitate the process of structuring and financing projects, as well as reducing transaction costs;

3) Standardization of infrastructure projects and development of infrastructure as an asset class, which allows for increased transparency and comparability of projects for investors, as well as reduced investment risks;

4) Integration of ESG (Environmental, Social, Governance) criteria into the process of making investment decisions and assessing infrastructure projects, which reflects the growing attention to issues of sustainable development and social responsibility;

5) Development of new PPP models that take into account the lessons of previous experience and allow for a more effective distribution of risks and responsibilities between the public and private sectors.

Thus, infrastructure financing is a complex and dynamically developing area at the intersection of public policy, financial markets and the real sector of the economy. An effective combination of various sources of financing, including public, private, mixed and international investments, is a key condition for bridging the global infrastructure gap and ensuring sustainable development in the long term.

CONFLICT OF INTEREST.

Authors declare that they do not have any conflict of interest.

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