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INNOVATION AND INVESTMENT SUPPORT FOR UKRAINE'S CONSTRUCTION SECTOR IN THE CONTEXT OF DIGITAL TRANSFORMATION AND POST-WAR RECONSTRUCTION

The article examines modern concepts of innovation and investment support of the construction complex in the context of digital transformation and post-war recovery of the Ukrainian economy. It is emphasized that the construction sector plays a strategic role as a key driver of the post-war recovery of the national economy, an indicator of the investment climate and a tool for ensuring social stability. The international experience of implementing BIM technologies and innovative approaches to construction management in the leading countries of the world is analyzed. The classification of innovations of the construction complex by types, directions of application, sources of financing and orientation is substantiated. The role of the Unified State Electronic System in the field of construction (UNESSB) as a key tool for the digitalization of the industry is revealed: indicators of the scale of its functioning are given, the impact on reducing corruption risks, speeding up permit procedures, integration with other state registers and services for the restoration of damaged property is demonstrated. Particular emphasis is placed on the relationship between BIM technologies and the development of the Smart Cities concept, where information modeling acts as the basis for the creation of «smart» buildings and infrastructures integrated into urban digital platforms, which allows to increase energy and resource efficiency, quality of services and living comfort in the conditions of growing urbanization. The evolution of views on the role of the state in the development of the construction complex is analyzed, in particular in terms of deregulation, decentralization of management, integration of the principles of sustainable development and environmentally safe modernization. It has been proven that the innovation and investment support of the construction complex is a critical factor in increasing its competitiveness, investment attractiveness and efficiency of the post-war recovery of the national economy.

Keywords: construction sector; innovation and investment support; BIM technologies; digital transformation; post-war recovery

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ІННОВАЦІЙНО-ІНВЕСТИЦІЙНЕ ЗАБЕЗПЕЧЕННЯ БУДІВЕЛЬНОГО КОМПЛЕКСУ УКРАЇНИ В УМОВАХ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ ТА ПІСЛЯВОЄННОГО ВІДНОВЛЕННЯ

У статті досліджено сучасні концепції інноваційно-інвестиційного забезпечення будівельного комплексу в контексті цифрової трансформації та післявоєнного відновлення економіки України. Підкреслено, що будівельний сектор відіграє стратегічну роль як ключовий драйвер післявоєнного відновлення національної економіки, індикатор інвестиційного клімату та інструмент забезпечення соціальної стабільності. Проаналізовано міжнародний досвід впровадження BIM-технологій та інноваційних підходів до управління будівництвом у провідних країнах світу. Обґрунтовано класифікацію інновацій будівельного комплексу за типами, напрямками застосування, джерелами фінансування та спрямованістю. Розкрито роль Єдиної державної електронної системи у сфері будівництва (ЄДЕССБ) як ключового інструменту цифровізації галузі: наведено показники масштабів її функціонування, продемонстровано вплив на зменшення корупційних ризиків, прискорення дозвільних процедур, інтеграцію з іншими державними реєстрами та сервісами відновлення пошкодженого майна. Особливий акцент зроблено на взаємозв'язку BIM-технологій із розвитком концепції Smart Cities, де інформаційне моделювання виступає основою створення «розумних» будівель та інфраструктур, інтегрованих у міські цифрові платформи, що дозволяє підвищити енерго- та ресурсоефективність, якість послуг і комфорт проживання в умовах наростаючої урбанізації. Проаналізовано еволюцію поглядів на роль держави у розвитку будівельного комплексу, зокрема в частині дерегуляції, децентралізації управління, інтеграції принципів сталого розвитку та екологічно безпечної модернізації. Доведено, що інноваційно-інвестиційне забезпечення будівельного комплексу є критичним чинником підвищення його конкурентоспроможності, інвестиційної привабливості та ефективності післявоєнного відновлення національної економіки.

Ключові слова: будівельний комплекс; інноваційно-інвестиційне забезпечення; BIM-технології; цифрова трансформація; післявоєнне відновлення

Introduction. Contemporary global economic relations are characterized by profound transformational processes driven by globalization, digitalization, geopolitical conflicts, and climate challenges. In this context, the construction sector takes on strategic importance as the foundation for implementing infrastructure projects, an indicator of the investment climate, and a tool for social stability.

For Ukraine's national economy, devastated by Russian aggression, the role of the construction sector takes on particular significance. This concerns not only supporting the economy but also mechanisms for its recovery following deep crises. Since Ukraine adheres to the doctrine of sustainable development and is actively integrating into the European community, the construction sector must meet the requirements of environmental and social responsibility, technological modernization, and transparent governance.

In the face of wartime challenges, the issue of establishing systematic, effective state management of innovative and investment-driven development in the construction sector has become critically important. This requires long-term strategic planning, the revitalization of

investment activity, the promotion of innovation, and the creation of transparent mechanisms for public-private partnerships.

Analysis of the Current Situation. Amid the challenges of wartime and the destruction of industrial and social infrastructure, the issue of post-war reconstruction and the reintegration of the national economy has become significantly more acute in Ukraine. Since the construction sector is a key player in the recovery process, the issue of establishing systematic, effective government oversight of its innovation and investment development has become particularly urgent. This involves long-term strategic planning, boosting investment activity, stimulating innovation, and creating a transparent and accountable mechanism for public-private partnerships.

The aim of this study is to substantiate contemporary concepts for innovation and investment support in the construction sector based on an analysis of international experience in the implementation of digital technologies and to identify the prospects for their application in Ukraine.

The methodological foundation of the research is

based on systematic, comprehensive, and interdisciplinary approaches. Methods of systematic and comparative analysis, abstraction, and synthesis were used to substantiate the role of innovation and investment potential in the reconstruction of Ukraine's national economy, as well as the expert assessment method.

Analysis of Key Achievements and Literature. An analysis of concepts regarding innovation and investment support for the construction sector reveals that scholars' approaches tend to be dynamic in light of current conditions; however, the foundation remains the improvement of government regulation of the construction industry.

Thus, O. Marusheva, Y. Prav, and D. Barzilovich hold the view that it is necessary to implement a project-oriented approach to identifying the causes of risks and selecting optimal methods for their assessment. The authors emphasize the need for the systematic application of modern approaches to regulating socio-economic relations in construction and timely monitoring, and believe that such an approach will contribute to ensuring more effective project management in the construction industry and the selection of key directions for its modernization. [1]

The researchers identify the following main conceptual approaches to state regulation of socio-economic relations in the construction sector: deregulation of entrepreneurial activity, decentralization of construction management, development of regions and local communities, and a transition from functional to project-based management, which is based on the principles of risk management.

A. Berkuta's work focuses on examining the construction industry from the perspectives of economic stability and investment stimulation. The researcher is convinced of the need for active state participation in creating a favorable investment climate for construction, since dynamic development in this sector is impossible without state support [2].

Scholars V. Gorbatenko and V. Tsvetkov also examine the development of the construction sector through the lens of state regulation of economic activity, holding the view that the construction industry serves as a catalyst for structural changes in the economy, contributing to the formation of modern infrastructure and the improvement of the living environment [3].

The scientific concepts of Ukrainian researchers regarding innovation and investment support for the construction sector in the later period are advancing and aligning with European standards and norms. Thus, in D. Isaenko's works on ensuring the sustainable development of the construction sector, the emphasis is placed on the need to integrate the principles of sustainable development into state policy for managing the construction sector, taking into account environmental, economic, and social aspects [4].

Authors I. Skorokhod and L. Gorbach emphasize innovative eco-safe development as the primary means of addressing many challenges across nearly all spheres of life, a factor that defines the quality of a country's socio-economic system. The researchers argue that to stimulate innovation and investment in eco-safe development, its

prerequisites must be identified, taking into account the assessment of opportunities for introducing innovations and attracting investment to Ukraine's regions [5].

A. Gavryliak, S. Gursky, T. Petruska, and S. Petryshak analyze the specifics of managing innovation and investment activities in the construction industry in their study. The authors' concept boils down to the idea that ensuring the sustainable development of construction enterprises requires a coordinated solution to the problems of forming technological, institutional, and organizational structures capable of uniting all necessary elements into a general reproductive process of economic potential growth [6].

However, insufficient attention has been paid to the issues of innovation and investment support for the construction sector in the context of digital transformation and post-war reconstruction.

Presentation of the main research material. Given current global trends in the development of economic and social relations, innovation and investment support for the construction sector is defined as the process of investing funds and resources from various sources (government and private funds, funds from international organizations, voluntary contributions from citizens) using digital technologies and metric-indicator assessments of investment attractiveness and investment risks.

Innovations in the construction sector encompass not only the construction industry but also the building materials industry, the production of building structures and components, and design, engineering, and research institutions. Value chains in the construction sector are long and complex by nature.

However, innovations encompass various aspects of the activities of enterprises in the construction sector, including design, the production of materials and construction equipment, and the management of construction processes [7].

In economic science, a classical model for classifying innovations in the construction industry based on various classification criteria has been developed, as presented in table 1.

This classification makes it possible to more clearly define the directions for developing the conceptual foundations of innovation and investment support for the construction sector as a key sector of the national economy.

The concept of innovation and investment support for the construction sector should be based on key approaches and components that take into account strategic planning technologies for the model of innovative development and its investment support, the introduction of modern information technologies into production and management processes, the optimization of resource provision, and the development of the intellectual component of human capital.

Referring to international experience in innovation management in the construction sector of leading countries, we note that scientists and experts consider the experience of the United States, Japan, Germany, the United Kingdom, and Singapore to be among the best practices in this field [8].

Table 1 - Classification of Innovations in the Construction Industry

Classification criterion	Type of innovation	Description
Types of innovation	Grocery	Development of new building materials and components, including energy-efficient, environmentally safe, and other types
	Procedural	Improving construction processes through the use of new manufacturing and information technologies and equipment
Areas of application	Technological	Development and implementation of new construction technologies, guided by the principles of sustainable development
	Organizational and managerial	New organizational and management structures, both for individual entities within the construction sector and at the industry level, such as the establishment of responsibility centers within companies, the formation of vertical or horizontal clusters, and public-private partnerships in production and research, etc.
Sources of funding	Using the business's own funds	Use of internal funds raised from internal sources (retained earnings, depreciation and amortization, divestment of obsolete production facilities) and external sources (stock issuance and placement on the securities market)
	Through government funding	The introduction of preferential lending and grant programs for companies that develop and implement innovations, as well as subsidies for training and professional development programs
	Using investment resources from foreign and Ukrainian businesses	Expanding opportunities for business entities to raise capital, building the image and investment appeal of the construction industry, and participating in large-scale innovation and investment projects as well as joint ventures with international companies
	Using venture capital	Establishing funds to support startups and innovative projects in the construction sector, and creating a favorable environment to attract business angels and venture capitalists
	Funded by taxpayers	Posting socially or environmentally appealing projects on crowdfunding platforms; raising funds through the issuance of bonds that are attractive to investors
Level of implementation	Businesses	Implementation of innovations at the enterprise level using research and development projects from scientific institutions and the acquisition of patents
	Industry-specific	The widespread adoption of new technologies and standards in the construction industry to foster development and strengthen competitiveness
	Government	Developing national strategies for the innovative and investment-driven development of the national economy and roadmaps for supporting strategically important sectors, particularly the construction industry
Orientation	Eco-friendly	The adoption of new technologies and materials that reduce the negative impact on the environment and human health
	Energy-efficient	Implementation of technologies and processes that reduce energy consumption during the production and use of construction products
	Economic	The use of resource-saving technologies; innovations in production and technological cycles aimed at shortening these cycles, improving quality, and extending the service life of construction products

Source: Compiled by the author

Thus, the United States is characterized by the concept of integrating digital technologies and investments in startups. The country is a leader in the implementation of digital technologies in construction:

- BIM (Building Information Modeling) – is widely used in public and private construction projects;
- drones and IoT are used to monitor construction sites in real time, which enhances safety, timeliness, and efficiency in construction;
- in Silicon Valley, startups developing cutting-edge technologies for the automation and digitalization of the construction industry are thriving;
- American specialists developed LSTC (light-gauge steel thin-walled structures) technologies, which have opened up new possibilities for improving construction quality and precision while reducing costs and shortening production times. LSTC construction is used in Canada, Japan, and other countries around the world [9]. The United Kingdom has the highest percentage of LSTC systems in the total volume of residential construction—about 20 percent (by comparison, according to estimates

by domestic market operators, the corresponding figure in Ukraine did not exceed 2 percent prior to the start of the military invasion). [10]

The concept of innovative development in the construction sector in the UK is based on integrated project management and sustainable construction. The following innovative project management methods for the construction sector are actively being developed in the country:

- IPD (Integrated Project Delivery) – an integrated approach to construction project management that involves all stakeholders in the process as early as the planning stage;
- The «Construction 2025» strategy is a national program aimed at reducing harmful emissions in the construction sector by 50% and costs by 33%;
- BIM Level 2 – mandatory use of Building Information Modeling technologies for all public construction projects [11].

Energy efficiency and government incentives for the adoption of environmental standards are key drivers of

innovative development in the German construction sector. Specifically:

- The «Energieeffizient Bauen» program is in effect – a government initiative that provides funding for the construction of energy-efficient buildings;

- the use of «smart» materials – the introduction of self-healing concrete, innovative insulation materials, and «passive house» technologies;

- BIM national strategy – the government promotes digital modeling in construction to enhance project productivity and transparency.

The Japanese model of innovative development in the construction industry is based on the concept of robotization and automation. Japan is a global leader in the use of robotics and automated solutions in construction, specifically:

- the use of automatic floor jacks has led to a sharp reduction in construction time: high-rise buildings in Japan are erected approximately twice as fast as with traditional methods;

- a construction corporation has developed autonomous robots for bricklaying and structural reinforcement [12];

- the widespread use of 3D printing and modular construction for the erection of residential and commercial buildings, which significantly reduces construction time. An automated modular construction system not only drastically reduces construction time but also achieves a significant reduction in labor intensity and workplace injuries. Thus, according to experts' estimates, when constructing a twenty-story building using this technology, labor costs – measured in man-hours – are reduced by 30% on average, and construction time is cut nearly in half compared to traditional methods [13];

- Seismic-resistant or earthquake-proof structures – the development of innovative technologies, such as vibration dampers and special materials, designed to prevent the collapse of buildings during earthquakes.

In many countries in Southeast Asia – including Singapore, Hong Kong, Taiwan, and South Korea – innovative programs for the large-scale construction of high-rise and super-tall residential buildings are underway, as these countries face an acute shortage of land for development.

The construction concept in Singapore involves smart construction and high-quality government regulation.

The Singaporean model is a prime example of the effective combination of government regulation and technological development, specifically:

- the activities of the Building & Construction Authority (BCA) – a government agency that oversees innovative development in the construction industry;

- the «Green Mark» program – a mandatory standard for green building that encourages the use of energy-efficient technologies;

- the widespread adoption of BIM – digital models used to coordinate urban development and infrastructure planning [14].

European countries recognize the importance of digitizing the construction sector, as it can significantly contribute to sustainable development in line with the EU 2020 strategy. With this in mind, the European Commission has developed a series of policies and initiatives under EU Directive 2014/24/EU aimed at supporting the digitization of the construction sector. In particular, the EU BIM Task Group was established, comprising 23 EU countries. The goal of this group is to unite national efforts toward a common and coordinated European approach to developing a world-class digital construction sector. The adoption of this directive has served as a catalyst for many European countries in the implementation of BIM technologies in construction.

An analysis of the characteristics of BIM technology implementation in various countries is presented in table 2.

An analysis of international experience shows that innovation management concepts in the construction industry are based on digitalization, automation, the widespread use of BIM technologies, energy efficiency, and environmental standards, as well as new approaches to project management. In the post-war period of rebuilding Ukraine's national economy, the construction sector will occupy a crucial strategic position. At the same time, the pace and scale of technological progress in the industry will depend on the extent and speed of the transition to automated construction methods and the widespread adoption of robotics and technologies requiring minimal human intervention.

Table 2 - Characteristics of BIM technology implementation in the construction sector by countries around the world

Country	Key considerations for implementing BIM technologies
United Kingdom	A leader in implementation at the national level. British companies are confident that BIM should become mandatory for all construction projects
France	A voluntary transition to BIM technologies in construction has been chosen. Promotion through a broad information campaign: new training programs, large-scale conferences, forums, and awards for successful BIM use by construction companies
Denmark	BIM requirements have been introduced at the legislative level for government contracts and procurement. Companies use BIM to create 3D visualizations, conduct performance analyses, and identify conflicts.
United States	The adoption of BIM technologies is uneven due to differences in legislation across various states. For instance, Wisconsin became the first U.S. state to mandate the use of BIM in all public projects. Today, most entities in the U.S. construction sector use BIM to achieve significant cost savings on their projects.
Poland	No mandatory requirements for BIM use have been established. Investments are focused on education, training, and raising awareness. For example, the Warsaw University of Technology offers training courses dedicated to the implementation of BIM technologies and digital construction.

Therefore, the national economy must be rebuilt on the basis of innovation and scientific and technological progress [15].

Regarding Ukraine's experience in developing innovation activities, it is worth noting that in the pre-war period, Ukraine was actively establishing a legal framework for innovation and investment in the construction sector that aligned with international standards and protocols. Thus, in 2021, the Concept for the Implementation of Building Information Modeling (BIM) Technologies in Ukraine was developed and approved. This document emphasizes that BIM should be viewed more as a specific tool or methodology that opens up new opportunities for the construction sector, although it is not an end in itself. Information modeling and its derivatives should be used for a whole range of tasks, including analytical, organizational, managerial, and strategic ones, and should carry no less weight than, for example, planning, forecasting, risk management, quality control, etc. [16].

As part of the Concept for the Implementation of Building Information Modeling (BIM) Technologies in Ukraine, the concept of "Smart Cities" is also being considered, which is one of the most pressing areas of development for modern cities. Due to global warming and the risk of resource shortages, the intelligent use of natural resources has become a priority in the search for new management solutions. This issue is particularly relevant for resource-intensive industries such as the construction sector. There are various interpretations of the term "Smart Cities," but in most cases they boil down to a city that utilizes modern energy- and resource-saving technologies to improve the quality of life within it.

Smart Cities technologies are integrated into relevant infrastructure to enhance service delivery, reduce costs and resource consumption, and improve communication and understanding with the public. In other words, through the intelligent integration of technologies at the scale of construction (building, neighborhood, city), Smart Cities offer residents the highest quality of life with minimal resource consumption. The trend toward increasing urbanization is growing. According to the UN, by 2050, 68% of the world's population will live in cities, so an important task is to ensure a better quality of life for city residents through Smart Cities technologies [17].

The role of BIM technologies is to create, at the initial stage, a BIM model of a managed «smart building» and its utilities, which becomes a key component of Smart Cities and is used throughout the entire lifecycle of the construction project. With BIM models for all buildings and infrastructure facilities, there is a real opportunity to integrate them with other infrastructure technologies in the region.

For the public sector, BIM technologies enable savings and the most efficient use of budget funds, leading to an increase in the number of constructed and renovated facilities. Such technologies help minimize corruption risks. The public sector gains a tool for controlling government spending, while the private sector gains the ability to manage projects transparently and increase public trust.

Interest in BIM technologies for business stems from the ability to improve design quality, minimize risks and costs during construction, which will ultimately lead to increased profitability for construction companies. In addition, BIM will allow for the optimization of operational activities by eliminating outdated processes that hinder work, lead to inefficient duplication, or create an additional burden to meet established traditional requirements that are becoming obsolete in today's environment [16]. This, in turn, requires updating the regulatory and legislative framework governing production activities and relationships within the construction sector.

The concept for the implementation of Building Information Modeling technologies in Ukraine envisaged that its implementation would make it possible to: ensure the effective use of budget funds in the construction sector; integrate and interconnect government services and information systems; increase the accessibility, transparency, and openness of information about construction projects, as well as the investment attractiveness and competitiveness of Ukraine's construction sector; and contribute to the sustainable development of the construction sector.

The main destructive factor hindering the widespread adoption of BIM technologies is the war unleashed by the Russian aggressor, whose terrorist actions prevent Ukraine's national economy from developing according to the standards and principles of developed countries.

However, following Ukraine's victory over Russia, BIM technologies will be widely implemented across all government and business entities within the construction sector, as this is expected to yield significant economic and social benefits (fig.).

digital technologies. In July 2020, the Unified Electronic System for Urban Planning and Construction was established in accordance with the provisions of the Law of Ukraine «On the Regulation of Urban Planning Activities». The goal was to reduce the time required to process documents, minimize the risk of document loss, and combat corruption.

The system is operating quite actively even under martial law in Ukraine. Since its launch, over 30,000 professional users – entities in the construction sector – have registered, and the portal has been visited by nearly 2 million users.

EDESSB continues to digitize the construction sector: all operations are conducted transparently online, the time required for document approval is reduced, and stakeholders' trust in construction processes is growing, as access to information is open and understandable.

The platform's activity is evidenced by the fact that during the third quarter of 2025, over 7,500 new users joined the system – architects, designers, engineers, developers, as well as representatives of regulatory agencies.

In just the first nine months of 2025, 195,000 technical inventory records, 37,300 permits, over 12,000 design decisions, and 9,000 building passports were registered. The self-registration rate in the EDESSB system reached 32% among those documents for which this feature was enabled. Through the Diya portal, 33% of

**EXPECTED RESULTS OF THE WIDESPREAD SYSTEMATIC IMPLEMENTATION OF BIM TECHNOLOGIES
IN THE CONSTRUCTION SECTOR OF UKRAINE**

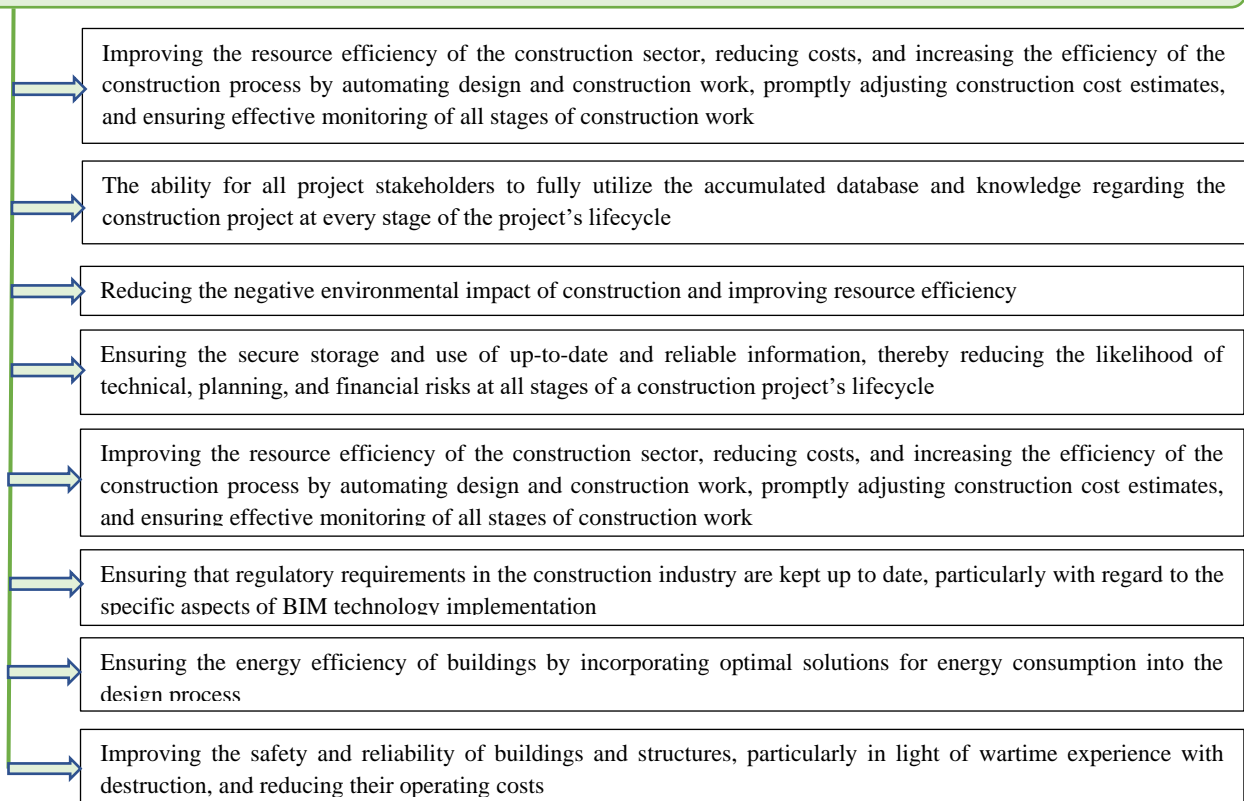


Fig. - Economic and social outcomes of the application of BIM technologies in Ukraine's construction sector (compiled by the author)

documents were automatically registered, and through the Administrative Service Centers (ASC), 30%.

EDESSB has strengthened its integration with the DREAM digital services and the Register of Damaged Property, enabling automated data exchange and facilitating the optimization of restoration processes and the monitoring of construction project implementation. In particular, the implementation of the system has enabled the creation of automated checks and the exchange of information with the information resources of the State Register of Real Rights to Real Estate, the State Land Cadastre, and others.

EDESSB is being implemented in cooperation with the Ministry of Community and Territorial Development and the Ministry of Digital Transformation of Ukraine. The system's ongoing development is supported by the «Digitalization for Growth, Integrity, and Transparency» project, implemented by the Eurasia Foundation and funded by UK Dev. [18]

Even amid the war, Ukraine is actively implementing

Conclusions. The construction industry has the potential and capacity to transition from the production of drawings to the generation and management of information as an intellectual and analytical asset. This fundamentally changes the approach to all processes and shifts the focus from a linear, step-by-step progression to a more interactive, collaborative, and open process.

An analysis of international experience shows that concepts for managing innovation in the construction

industry are based on digitalization, robotization, the widespread use of BIM technologies, energy efficiency, and environmental standards, as well as new approaches to project management (IPD).

In the post-war period of rebuilding Ukraine's national economy, the construction sector will occupy a strategic position. The pace and scale of technological progress in the industry will depend on the extent and speed of the transition to automated construction methods and the widespread adoption of robotics and technologies requiring minimal human intervention. Therefore, the national economy must be rebuilt on the basis of innovation and scientific and technological progress.

The implementation of BIM technologies, combined with IPD and Smart Cities concepts, lays the groundwork for the development of a fundamentally new framework for state regulation of the construction industry – an innovation-oriented and maximally transparent system. The successful operation of the Unified Electronic System for State Construction Supervision (UESSC) even under wartime conditions confirms Ukraine's readiness for the digital transformation of the construction sector. Innovation and investment support for the construction sector is a critical factor in enhancing its competitiveness, investment attractiveness, and the effectiveness of post-war national economic recovery. Further research should focus on developing a methodology for assessing the innovation potential and investment attractiveness of the construction sector, as

well as mechanisms for public-private partnerships in the field of innovation and investment activities.

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