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Nataliia Levchenko, Dr. Sc., full Professor, Dmytro Ivanenko, PhD student, Polina Bielousova, student, Arif Hadzhiverdiev, student
(National University Zaporizhzhia Polytechnic, Zaporizhzhia)
Nadiia Storchai, Dr. Sc., Associate Professor (Prydniprovska State Academy of Civil Engineering and Architecture, Dnipro)

WAYS TO OPTIMIZE CONSTRUCTION PROCESSES FOR ENHANCED RESOURCE EFFICIENCY

The article analyzes the possibilities of resource-efficient construction in the context of post-war recovery of the country. Focusing on key aspects such as sustainable development and energy efficiency of infrastructure, the article emphasizes the importance of implementing green technologies and resource-saving approaches in construction to achieve sustainable development. The impact of innovative projects on the regional economy, inter-industry cooperation, public acceptance and participation in construction, as well as technological and digital transformations in modern construction, is considered. Special attention is given to the adaptation of these approaches to the conditions of post-war infrastructure recovery, which contributes to economic stability and improves the quality of life. This article contributes to the deepening of understanding and practical application of sustainable construction concepts in the context of contemporary economic and social challenges.

Keywords: **innovative construction, sustainable development, country recovery, digital transformations, construction production, resource conservation**

Introduction

Modern cities face numerous challenges, including environmental sustainability, depletion of natural resources, and increasing energy consumption, especially in the context of ongoing conflicts. In the post-war recovery context, there is an urgent need to study and analyze the impact of innovative and resource-efficient approaches in construction on economic and social development. It is essential to assess the potential integration of these methods to ensure infrastructure sustainability, implement green technologies,

and expand inter-industry and regional cooperation for sustainable development.

The construction industry, as one of the primary factors impacting the environment, requires significant changes towards economic and environmentally safe solutions. Therefore, resource-efficient construction is becoming increasingly relevant. This approach involves the implementation of new technologies and methods that minimize resource use, reduce environmental impact, and create a comfortable and healthy environment for people.

Literature review

According to the report by the World Green Building Council «The Business Case for Green Building» [1], green buildings can be economically beneficial for owners and tenants, offering significant energy savings, reduced operational costs, and increased property value. The article [2] explores the economic and social benefits of green building, analyzing the strengths and weaknesses, opportunities and threats, and the life cycle cost assessment for green developments. The study [3] assessed the economic impact of resource-efficient construction on the U.S. economy, finding that it creates jobs, stimulates economic growth, and saves taxpayers money.

Domestic researchers, including Donenko V.I., Bobrakov A.A., Balandina I.S., Shapoval S.V., Lysenko K.O., and others, have also addressed resource conservation in construction. For example, in the work [4], it was concluded that the use of modern technologies in construction allows construction organizations to efficiently conserve resources and reduce the time needed to solve tasks by automatically determining optimal strategies, ensuring quick adaptation to environmental changes and overall optimization of activities.

The social aspects of resource conservation are considered in the study [5], which summarizes scientific data on the impact of green buildings on the health and well-being of people living and working in them, revealing that they can improve air quality, productivity, and overall well-being. The scientific article [6] explores the connection between green buildings and social equity, arguing that green buildings can help reduce health inequalities and improve the quality of life in disadvantaged communities.

These studies indicate the potential of resource conservation in building construction as a means of ensuring economic benefits, improving the quality of life, and enhancing social equity.

Main content

The construction industry is one of the largest sources of environmental pollution and greenhouse gas emissions. According to the annual report by the World Green Building Council for 2022 [7], the construction industry accounts for 28% of global greenhouse gas emissions (more than any other industry except for the power sector), 36% of global primary energy consumption, 40% of global waste production, and the logging of 40% of the world's forests.

Innovative construction reflects an approach to designing, building, and operating buildings based on the implementation of cutting-edge technologies, materials, processes, and methods aimed at enhancing the efficiency, quality, and sustainability of structures [8]. Resource efficiency in construction refers to the ability to maximize the use of resources (such as materials, energy, time, and labor) during the construction process, with the goal of reducing waste, optimizing costs, and minimizing negative environmental impact.

The principles of sustainable construction include integrating ecological and resource-efficient practices at all stages of a building's lifecycle: from design to operation and demolition. The main elements of these principles are the use of environmentally friendly materials, waste minimization, ensuring energy efficiency, and creating comfortable and healthy conditions for occupants. Sustainable construction also involves adapting to climate change, ensuring accessibility, and implementing innovative technologies.

Energy-efficient technologies play a key role in reducing greenhouse gas emissions and energy consumption in buildings. The use of thermal insulation materials, energy-efficient windows during the construction phase, heat recovery systems, and renewable energy sources such as solar panels and heat pumps contributes to reducing energy consumption. Buildings equipped with energy-efficient heating, ventilation, and air conditioning systems significantly reduce the need for fossil fuels and CO2 emissions.

Thus, sustainability and energy efficiency are interconnected concepts that promote environmentally responsible and economically efficient construction. The implementation of these principles allows for the creation of buildings that not only meet

contemporary needs but also ensure a healthy and sustainable environment for future generations.

Resource-saving technologies include rainwater harvesting and utilization systems, energy-efficient lighting and heating systems, solar panels, and heat pumps. These technologies significantly reduce energy and water consumption, which lowers the operational costs of buildings and contributes to the reduction of greenhouse gas emissions. An important aspect is also the use of passive construction technologies, which optimize the use of natural resources, such as sunlight and heat, to maintain comfortable conditions in the building without additional energy expenditure.

There are many successful examples of projects that use green technologies. For example, the «Edge» office building in Amsterdam is considered one of the greenest buildings in the world due to the integration of innovative energy-efficient systems and technologies. The building uses rainwater collection systems, rooftop solar panels, and an intelligent energy management system. Another example is One Central Park in Sydney, which features vertical gardens that improve air quality and provide natural insulation, reducing the need for air conditioning.

Successful projects demonstrate that the integration of green technologies and resource-saving approaches is both feasible and beneficial. This allows for the construction of environmentally responsible, economically efficient, and socially attractive buildings that meet the challenges of the modern world. Innovative and resource-efficient construction helps reduce the environmental and economic impact of the construction industry. By implementing new technologies and methods, it is possible to reduce energy and resource consumption, decrease greenhouse gas emissions, minimize waste, and improve people's quality of life. Investments in innovative and resource-efficient construction are advantageous from both ecological and economic perspectives.

Digital platforms and tools play a key role in modern construction, providing effective planning, management, and project optimization. One of the most important technologies is Building Information Modeling (BIM), which allows for the creation of digital models of buildings with all their characteristics. The use of BIM simplifies the design process, improves communication among project participants, ensures coordinated work, and provides accurate cost estimates.

Building Information Modeling enables the optimization of construction processes during post-war recovery by integrating various tools and data into a single system. Project management platforms coordinate the work of contractors, plan the project schedule, track expenses, and control construction quality, thereby increasing efficiency, reducing risks, and ensuring timely project completion.

The implementation of digital tools contributes to reducing resource and energy use, decreasing waste, and creating energy-efficient buildings with a lower carbon footprint. Digital platforms ensure transparency and accountability in projects, reducing corruption risks and enhancing the competitiveness of companies.

Initial costs for innovative materials and technologies are reduced through government programs and incentives, such as the Ukrainian «Energy Efficiency in Buildings» program. Additionally, innovative buildings have higher ownership value due to lower operational costs and reduced environmental impact. Innovative construction stimulates economic growth, creates jobs, and promotes the rapid and effective recovery of cities after the war.

Examples of successful community initiatives, such as the «Green Roofs» project in Hamburg or the «Eco-Quarter» in Freiburg, demonstrate how active public participation contributes to the implementation of resource-efficient projects, creating a comfortable and sustainable living environment that can serve as a model for other cities.

Innovative and resource-efficient construction promotes the formation of a sustainable and progressive society, improving the quality of life and ensuring balanced development. Below are examples of how innovative and resource-efficient technologies are used to construct sustainable buildings.

Vancouver City Hall (Vancouver, Canada): The construction process of Vancouver City Hall involved the application of several innovative and environmentally friendly technologies. The process included the use of special membranes to protect against water and roots on the green roof.

Fig. 1. Vancouver City Hall (Vancouver, Canada) [9]

Solar panels were integrated into the facade and roof of the building for maximum solar energy collection, connected to the internal energy network. A heat recovery system was installed to use waste heat from ventilation systems to heat the premises in winter. Thanks to these practices, Vancouver City Hall became 40% more energy-efficient than average office buildings in North America.

Bullitt Center: This school is considered one of the most sustainable buildings in the world. It uses a range of innovative technologies to reduce energy consumption, greenhouse gas emissions, and water usage.

Fig. 2. Bullitt Center (Seattle, USA) [10]

The construction process of the Bullitt Center was marked by the use of advanced ecological practices. The layout planning of the

solar panels was designed for maximum energy collection. The panels were then installed and connected to the building's internal energy network. A rainwater harvesting system was installed to collect and filter rainwater from the roofs, which was then used for domestic needs and irrigation. A composting system was set up to recycle food waste, and the resulting compost was used for landscaping the school grounds.

Auroville Ecovillage: An experimental ecovillage where people from around the world live. Auroville uses a range of innovative technologies to reduce energy consumption, greenhouse gas emissions, and water usage.

Fig. 3. Auroville Ecovillage (India) [11]

The construction process in Auroville Ecovillage included planning the placement of solar panels and wind turbines for maximum energy collection, their installation, and connection to the local electrical grid. A rainwater harvesting system was installed for storage and subsequent use. Composting systems were placed to recycle food waste into fertilizers for the settlement's agricultural needs.

In the context of post-war recovery, integrating such approaches is crucial for the sustainable development of Ukraine. Implementing resource-saving technologies will not only restore the destroyed infrastructure but also ensure its long-term sustainability and economic efficiency. This will promote regional economic growth, create new jobs, and improve the quality of life for residents.

Conclusions

Resource-efficient building technologies have significant potential for improving economic and social outcomes, especially in

the context of post-war recovery of the country. They can reduce construction costs, shorten project completion times, enhance energy efficiency, and make housing more affordable. For example, energy-efficient building technologies, according to the National Institute of Building Sciences in the USA, can save up to 30% on utility costs.

There are promising directions for further research that will contribute to resource conservation in construction. The integration of Building Information Modeling (BIM) for planning and managing construction processes is crucial. BIM allows for the integration of various tools and data into a single system, which helps optimize resource use, reduce waste, and increase construction efficiency. The use of BIM promotes the resilience of buildings and the creation of affordable housing through effective planning and resource management [12].

In the context of post-war recovery, the implementation of resource-saving technologies and BIM is key for the rapid recovery and long-term sustainability of infrastructure. This will facilitate the creation of new jobs, stimulate economic growth, and improve the quality of life for residents. Thus, innovative and resource-efficient construction becomes a vital element of the sustainable development strategy in the face of contemporary economic and social challenges.

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Левченко Н.М., д. держ. упр., професор, Іваненко Д.С., аспірант, Бєлоусова П.В., студентка, Гаджівердієв А.А., студент, (Національний університет «Запорізька політехніка», м. Запоріжжя), **Сторчай Н.С., д.т.н., доцент,** (Придніпровська державна академія будівництва та архітектури, м. Дніпро)

ШЛЯХИ ОПТИМІЗАЦІЇ БУДІВЕЛЬНИХ ПРОЦЕСІВ ДЛЯ ПІДВИЩЕННЯ РЕСУРСОЕФЕКТИВНОСТІ

У статті аналізуються можливості ресурсоефективного будівництва в контексті післявоєнного відновлення країни. Зосереджуючись на ключових аспектах, таких як сталий розвиток та енергоефективність інфраструктури, стаття підкреслює важливість впровадження інноваційних технологій та ресурсозберігаючих підходів у будівництві для досягнення сталого розвитку. Розглядається вплив інноваційних проектів на регіональну економіку, міжгалузеву співпрацю, громадське сприйняття та участь у будівництві, а також технологічні та цифрові трансформації у сучасному будівництві. Особлива увага приділяється адаптації цих підходів до умов повоєнного відновлення інфраструктури, що сприяє економічній стабільності та покращенню якості життя. Ця стаття сприяє поглибленню розуміння та практичного застосування концепцій сталого будівництва в контексті сучасних економічних та соціальних викликів.

Ключові слова: **інноваційне будівництво, сталий розвиток, відновлення країни, цифрові трансформації, будівельне виробництво, ресурсозбереження**