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USING INNOVATIVE DESIGN METHODS FOR THE SUSTAINABLE DEVELOPMENT OF THE CONSTRUCTION INDUSTRY

A. S. Budagov (a), R. V. Molchanova (b)*
*Corresponding author

(a) Saint-Petersburg State University of Aerospace Instrumentation, Saint-Petersburg, Russia, dean8@aanet.ru
(b) Saint-Petersburg State University of Aerospace Instrumentation, 67 Bolshaya Morskaya str., Saint-Petersburg, Russia, reginamolch@yandex.ru

Abstract

This article examines a set of basic features that form the basis for the stable development of the construction industry. One of the main decisions is seen to increase the demand for construction services, as well as the creation of comfortable competitive conditions in the market in order to form more favorable offers for the Russian consumer. This study also examines the basic principles and potential uses of information modeling technologies, building modeling. The influence of these factors on the environmental, economic and social problems of modern society deserves special attention. The authors of the work emphasize the importance and necessity of high-quality and efficient allocation and use of resources and building materials, as well as the establishment of specific priorities for environmental protection in order to ensure the stable functioning of the entire construction industry. A review was also carried out of a set of relevant literature concerning the principles of development of the construction industry, the main approaches and measures used. Based on this information, it becomes possible to form generalized conclusions about the impact of the sustainable functioning of the construction services sector. An important aspect is a significant impact on increasing the investment attractiveness of the sector, as well as creating a competitive national economy. The study determines the importance and impact of innovative structural design methods in relation to improving the efficiency of business processes at enterprises and organizations, modernizing industrial potential and gaining competitive advantages of the Russian Federation.

Keywords: Energy efficiency of buildings and structures, industrial construction, information modeling technologies, innovation, investment activity

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1. Introduction

To ensure the sustainable development of the construction industry, first of all, it is required to ensure a full set of safety standards and conditions that have a beneficial effect on the principles of human activity, as well as are accompanied by the absence or limited impact on the environment.

The construction industry should be seen as a collection of interrelated and interacting construction companies, structural design bureaus and expert organizations, as well as financial and development institutions. As part of their activities, it is required to consider the creation, preservation and placement of the future building, as well as its subsequent repair, reconstruction and re-equipment.

The negative dynamics of macroeconomic conditions has a negative impact on the construction industry, which is part of the economic sector. There is a significant decrease in demand for construction services, which is associated with a freeze in investment activity. However, this does not affect the housing construction segment, which has revived and is currently experiencing an increase in demand and activity following the adoption of a program of state support for housing construction and an improvement in mortgage policy.

Among the main factors that ensure the effective functioning of the construction industry are:

- increased human and research potential, as well as high qualifications;
- innovation as an effective tool for gaining competitive advantages, allowing to increase profitability and increase the profitability of an enterprise;
- modernization of legislative and technological norms and rules;
- minimization of the number of unfinished buildings;
- wider dissemination and use of information modeling technologies at various stages of the object's life cycle;
- integration of additional administrative, management and construction processes;
- using artificial intelligence to regulate urban planning processes.

At the moment, about half of the investment costs are for industrial construction. The main sources of financing for companies are equity capital, which covers about half of the investments, another 30% (Mercader-Moyano & Esquivias, 2020) comes from the federal and local budgets.

The availability of investment funds is a key factor from the point of view of macroeconomics, since it makes it possible to determine industrial capital construction, as well as to implement enterprises' own investment projects. Special attention should be paid to infrastructure projects aimed at increasing the level of satisfaction of the population, as well as creating demand for construction products.

Investment activity is influenced by a large number of factors, among which one can single out the company's equity capital, debt financing, foreign direct investment, as well as financing from government agencies.

In the Russian Federation, negative factors hindering the development of capacities and the transition to innovative and high-quality products include a high level of depreciation of assets and their

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obsolescence. At the moment, large-scale capital investments are required in various sectors of the national economy.

In order to ensure systematic technological development in the industry, the following factors are required:

- reducing the involvement of foreign technologies, as well as reducing dependence on them;
- creation of a number of full cycle construction companies;
- increasing the competitiveness of Russian construction contractors in terms of the implementation and implementation of global projects;
- modernization and improvement of modern legislative and technological norms and rules that govern industrial construction;
- expansion of the use of I&C systems at various stages of the object's life cycle;
- optimization of the time frame for administrative procedures;
- minimum duplication of information;
- wider use of standard projects and solutions in industrial construction;
- improving safety standards for technological development at all stages of the life cycle of a construction site.

Thanks to the beginning of the wider use of information systems, it will be possible to obtain the following results:

1) Reducing the time spent on construction work;
2) Reduced construction costs;
3) Increasing the energy efficiency of buildings and structures;
4) Increasing the service life of the buildings and structures being handed over.

It is very important to pay attention to the problem of using human resources. At the moment, most of the production processes, including construction, are not optimized too much, which leads to an excessive consumption of natural resources. The use of information technologies should contribute to solving this problem, since they can significantly optimize the full range of resources, as well as methods for their processing. AI-controlled tools function much more accurately, which also significantly reduces the amount of resources used.

Thus, at the moment, more and more specialists agree that the solution to the problem lies in the creation, development and modernization of more and more intelligent systems and routes that will allow achieving better results using fewer resources. Of course, such an effect is impossible without stable training of highly qualified personnel who will undertake the responsibility for operating such equipment.

This leads to the conclusion that it is necessary to completely revise the current cycle of organizing the economy and its industries, since companies that cannot cope with the challenges of the time will not be able to withstand the conditions of fierce competition, which will lead to their inevitable fall.

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However, in the realities of the modern world, significant developments in this direction are demonstrated. An increasing number of information tools are beginning to be implemented everywhere in human life. A similar upgrade is required for the construction area, which looks one of the most unprofitable in terms of resources, as well as environmental damage. Its modernization can significantly improve the performance of the national economy.

At the moment, we can talk about the interest of state bodies and authorities in the digitization of the following sectors of the construction industry:

1) Integration of information control systems at all stages of the life cycle of the project and the future structure.
2) Digitization of all existing processes and procedures in order to create a single digital space for the construction industry.
3) Creation and development of repositories of digital data and information.

2. Problem Statement

The need to form a comprehensive assessment of investment efficiency and profitability, taking into account all costs in the full life cycle of capital construction, leads to the development and distribution of integrated systems aimed at managing the life cycle.

This requires the achievement of a certain level of synergy between technologies and principles of multi-criteria decision-making, since only in this case it becomes possible to integrate a full set of relevant data on buildings, structures and projects.

When trying to consider the sustainable development of the construction industry, it is necessary to consider the following set of determining factors:

1. Decrease in investment rates and demand for building construction services.
2. Elimination of the main obstacle to an increase in the output of innovative and high-quality products, which are obsolete and worn-out fixed assets.
3. Too great influence of foreign technologies on domestic production.
4. Inconsistency of the existing legislative and regulatory framework governing this industry.
5. Incorrect approaches to assessing the life cycle of reused buildings and structures.
6. Problems with the accuracy of the data on buildings and structures obtained in the course of digitization, as well as the lack of a complete set of necessary information.
7. Losses related to environmental pollution.
8. Limited amount of natural resources.
9. Ineffective recycling and disposal of waste.

3. Research Questions

In the course of this study, the following problems and questions arise:

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1. The need to identify and discuss the principles that underlie the sustainable development of the construction industry in a modern economy.
2. Determination of the impact of information technology and decision-making technologies on economic, social and environmental development.
3. Identification of potential approaches to ensure the sustainability of the construction services industry.
4. Formation of justifications for the need to develop innovative design methods to find wider use in the design and assessment of each stage of the life cycle of capital construction on the basis of materials presented in the literature of this branch of activity.
5. Creation of a specific assessment of the impact of sustainable development and functioning of the construction industry on the volume and dynamics of investment development in order to create an efficient and competitive economy of the Russian Federation.

4. Purpose of the Study

The main goal of this study is to develop an up-to-date and modern approach to assessing innovative design methods and their impact on the stability of the development and functioning of the construction industry in the modern economy.

5. Research Methods

The main goal and task of the model for sustainable development of the construction industry using information technology is the selection and subsequent use of those building components and materials that have the best indicators of efficiency and utility, as well as help to reduce the amount of waste and debris that is generated during construction work. An important factor is the disposal and recycling of waste in order to get the most out of the use of these products and structures.

The construction industry is largely based on the cyclical elements of the economy to ensure stable and sustainable development throughout the entire life cycle of buildings and structures, which makes it possible to increase the efficiency of the use of materials, as well as to significantly reduce the negative impact on climatic conditions and the environment.

According to Mercader-Moyano and Esquivias (2020), it is required not only to use energy-efficient technologies and materials in order to reduce energy consumption, which will lead to increased efficiency and productivity, but also to organize the construction process in such a way as to obtain certain advantages and priority in solving environmental problems associated with the implementation of various processes in the construction industry. At the moment, the use of building materials is a serious problem at the stages of distribution and subsequent use of resources in terms of their efficiency, sustainability and the possibility of subsequent renewal.

At the moment, it is believed that it is impossible to solve the problem of energy efficiency in urban construction due to the banal demolition of existing buildings and their subsequent replacement with new ones. This is due to the need to attract a significant amount of financial, material and energy resources.

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The main principle that forms the closed-cycle economy (Joensuu et al., 2020) is the maximum conservation of natural resources by eliminating the need to use primary materials, that is, waste is minimized due to the reuse of these materials, as well as cyclicality, which makes it possible to achieve significant savings in the resources used (Ye & König, 2021). In order to increase the intensity of use, as well as the subsequent increase in the service life of materials and equipment, it is proposed to use the following methodologies:

- management of a sustainable urban environment;
- development of urban services;
- organization of "clean" production and construction (Ye & König, 2021).

Also, at the moment, it is extremely important to continue studying the issues of reducing costs, as well as developing and using advanced approaches to the renewal of resources through the implementation of innovative integrated waste recycling systems, efficient use of fluids and energy.

In particular, the construction sector requires a more detailed study and the formation of an updated assessment of the life cycles of capital structures in terms of their potential reuse, the insufficient degree and level of development of modern carbon-free technologies and the potential risks of using such a hierarchy of waste destruction. The potential integration of such building and construction information makes it possible to improve efficiency in architecture, design and construction. At the moment, the first results have appeared, describing the prospects for the use of innovative tools in solving the problems of sustainable development, modernization and constructiveness (Tan et al., 2021).

In our opinion, it will also be possible to add solutions to this category that are proposed in terms of various environmental issues and environmental standards. At the moment, it is believed that the implementation of the economic transformation of innovative processes from the point of view of sustainable development requires the maximum reduction in the amount of waste produced, as well as the subsequent increase in the efficiency of resource use. Thus, information technologies will be widely used in the development of digital models of buildings and structures, which will make it possible to draw conclusions on specific tenders and planning of construction work (Ho, 2021).

From this point of view, a circular economy looks extremely effective, which in its essence implies the process of adapting production processes to cyclical schemes in order to improve the existing environmental standards in construction. The entire list of products and services in a circular economy must ensure resource intensity, as well as the potential re-efficient use of these resources in the future. To achieve this level, the implementation of new measures and points in the product use policy is required. Special attention should be paid to design to increase the likelihood of packaging reuse, disposal and recycling. The transition to a circular economy is a prerequisite in terms of ensuring sustainable development, since it requires more active social participation on the part of specific individual members of society and the community as a whole. The use of CIM-based tools demonstrates the potential of IMT in generating specific visual representations and models of urban environments in the processing of associated data for urban planning purposes.

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As demonstrated in (Yosino & Ferreira, 2021), such an application is largely aimed at creating and then providing an effective and high-quality tool for using BIM-based models when creating plans and assessing the amount and structure of solid waste in urban settlements. In order to achieve a significant minimization of negative consequences for public health, it is necessary to organize an effective system for the disposal and processing of construction waste and garbage. It is also required to control the rates and types of emissions, which can also cause significant damage to human health and the surrounding world as a whole. One of the automated monitoring systems (Kang et al., 2021) has quite successfully established itself as a cost-effective system for organizing the stable measurement of pollutants in construction operations. The system has demonstrated high reliability, increased mobility, and ease of use when compared with similar developed systems.

The implementation and use of digital transformation (Molchanova, 2020) is an approach that can lead to the organization of a system for the optimal distribution and use of building materials at a wide variety of stages of the construction life cycle, which will lead to a balanced and adequate use of IMT, as well as Internet resources and artificial intelligence in the planning and creation of specific projects construction. At the moment, it is worth noting the high share of participation of digital tools in various sectors of the national economy, which is increasingly beginning to affect the construction industry. Recent studies (Wan & Bai, 2021) demonstrate that technologies based on BIM and IoT should find more and more widespread use in construction logistics in practice, since they can organize a completely new source of profit based on the implementation of innovative platform solutions and analysis of large amounts of information.

In order to organize the transition to a resource-efficient economy, it is necessary to develop a wide range of public and private instruments that contribute to the promotion and sustainable development of this vector of activity. At the same time, it is necessary to take into account the actual material and economic component, when resources become more and more limited and there is a stable degradation of the environment, which is formed due to the constant expansion of the infrastructure of the construction industry. The organization of a positive approach associated with the reuse of natural resources should have a positive impact on the biosphere, as it contributes to the renewal of resources, as well as more efficient energy consumption (Yosino & Ferreira, 2021). To determine the parameters for assessing the sustainability of materials and processes, it is required to be based on the combination of building materials according to their thermodynamic characteristics, since this parameter allows the development of a set of concepts for the reuse of resources and processing of construction waste and waste.

Thus, the stable interaction and joint efforts of all stakeholders, using the main innovative approaches to assessment and design, as well as digitization, provide a full set of tools that allow you to create an accurate assessment of pollution, as well as to plan the level of waste and pollution, so that it becomes possible to determine a set of measures to combat pollution to ensure the renewal and restoration of natural resources. Recent research demonstrates that the use of a method to reduce or eliminate errors in the preliminary planning and design stages using BIM can achieve high levels of accuracy and accuracy in assessing technical feasibility.

Thus, graphical forecasting software and applications enable forecasting and estimates of regulatory and regulatory parameters (Farias et al., 2021). However, the lack of a complete set of information on the

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required operational characteristics leads to a significant deterioration in the life cycle, efficiency and estimated cost. In turn, the use of BIM (Zanni et al., 2021) makes it possible to greatly simplify the decision-making process at the earliest stages of the formation and development of the project, as well as justify the use of the main innovative construction technologies (Darko et al., 2020). The use of this innovative structure of design modeling allows you to choose the most optimal option in terms of modernization (Passoni et al., 2021), the use of environmentally friendly technologies and building materials. This concept allows finding solutions to existing environmental, economic and social problems, but it lacks structural safety measures, which can lead to general degradation of the structure, as well as potential destruction as a result of extreme situations such as an earthquake (Furtatova, & Kamenik, 2020). The results of recent studies in this direction suggest the use of all aspects of construction safety and the implementation of modernization projects.

The most problematic issues in this direction of development is the minimization of the complex of external influences for the full period of operation of a building and structure, which requires additional research in order to obtain specific solutions. Moreover, some studies (Vladimirova et al., 2021) make it possible to determine the factors of the technological revolution, which include the implementation of the transition to the digital economy.

Engineering means a kind of symbiosis between technical and technological engineering in the field of capital construction, as well as in the implementation of investment construction projects. Construction engineering, when considered as a tool, means a complex of technical and economic feasibility studies for investments, design and construction works, as well as the use of a capital structure or a building and its disposal.

6. Findings

The implementation of a sustainable development model in the construction industry requires widespread use and widespread use of innovative technologies, as well as unique structural design and project management techniques. In order to determine the area of growth, as well as the most important markets for innovation, it is necessary to take a closer look at the construction and related market segments, where some types of development are required.

The modernization of production is also affected by the constant intensification of environmental problems, which are becoming more acute in the conditions of modern society. Humanity is forced to solve the issues of minimizing waste and emissions, introducing resource-saving technologies, as well as integrating innovative technologies into the construction sectors of the national economy.

In order to make the transition to a resource-efficient economy, it is necessary to develop appropriate policies for the regulation and allocation of resources, which are necessary for the mandatory support of initiatives proposed in the sector of economic development (Thomas & Praveen, 2020). The scarcity of resources in the modern world is formed due to irregular extraction of minerals, constant consumption of natural resources, which become a source of infrastructure development. It also contributed to environmental degradation. Thus, at the moment there is an urgent need for the development and implementation of appropriate instruments that will allow regulating the extraction and distribution of

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resources in order to stabilize the state of the natural resource extraction industry and the environmental situation (Fořt & Černý, 2020).

Due to the constant intensification of the exploitation of natural resources, as well as the ineffective use of materials, an excessive amount of waste has been generated. The material chain must be completely overhauled in order to significantly reduce environmental damage.

Differentiation of the sustainable development strategy completely depends on the existing socio-economic conditions in the territory of a particular region, the degree of state participation in all ongoing processes, as well as on the degree of awareness of the involvement of the entire community in solving environmental problems.

To ensure the stability of the development of the construction services market and a wider geography of the use of innovative methods, it is necessary to create not only new tools, but also new jobs, which must be filled with highly qualified personnel. It is also necessary to increase the rate of capital investment and the competitiveness of the national economy.

It is expected that the stabilization of the industry and sustainable development will open up new opportunities for the development of business processes, as well as allow the national economy to enter completely new sales markets.

It should be noted that at the moment the digitization of the construction industry affects a significant number of areas. Now there is an active introduction of digital information technologies in all branches of human activity, which does not bypass business processes. Technologies make it possible to simplify internal workflow, accounting, advertising and promotion, as well as many other areas of activity.

To ensure higher safety standards during construction work, as well as to minimize all negative factors, it is necessary to significantly improve the qualifications and efficiency of employees, as well as to start using additive, cognitive and convergent technologies.

7. Conclusion

Based on the points discussed, we can conclude that the sustainable development model in the construction industry is aimed at the following:

1) Preservation of the most useful and valuable components and materials.
2) Improving the efficiency of materials exploitation.
3) Reducing the negative impact on the environment.
4) Reducing costs, as well as improving the logistics infrastructure.
5) Increase the durability of construction materials and equipment.
6) Using the most modern approaches and concepts for resource recovery.
7) Improving environmental standards in the industry.

Digital transformation, information technology, artificial intelligence, social and regulatory innovation are the basis for improving and accelerating the consumption of energy and natural resources, contribute to a more balanced distribution of jobs to modernize and restore the country's industrial potential

in order to create and subsequently maintain competitive advantages in the global economic market, as well as to preserve the available natural wealth and resources of the state.

The principles of sustainable development in the construction industry should have a significant impact on the growth of competence and qualifications of construction personnel, which should allow more efficient development of products and materials that will fully meet the highest quality and safety standards.

Thus, from all that has been considered, it can be concluded that despite the presence of positive trends in the development of the industry of optimization of building materials, construction processes, there is an insufficient number of research works and methodologies that would allow a qualitative breakthrough in this direction. Now it is necessary to attract widespread attention to the formed problem, so that more and more people and specialists begin to pay their attention to their solution. A general optimization of the resources used is required, since such an approach can significantly optimize the economy, as well as significantly reduce the negative impact on the environment.

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