Organizational and technological solutions using information modeling technologies in the implementation of construction projects

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Abstract. An effective management system in the implementation of construction projects has particular significance. The transition to a digital economy determines the efforts of introducing innovations in the field of transforming activities of organizations in the construction industry, which allow the implementation of investment and construction projects while ensuring the established deadlines, costs and quality, as well as minimizing possible risks. In order to reduce uncertainty and improve the efficiency of the implementation of construction projects at the present stage, it is important for construction companies to use modern information technologies in production, including information modeling technologies.

1 Introduction

Construction plays one of the main roles in the socio-economic development of the country and is an important factor in its stability [1]. Capital construction improves the material and cultural state of society, solves housing problems, and develops the national economy. Despite the positive dynamics of the volume of work performed and the number of operating construction organizations, the industry has a number of limitations and difficulties [2, 3]. Currently, actual problems of the construction industry in the Russian Federation are the increased deadlines for the implementation of projects and the construction of buildings and structures, the constant increase in the cost of construction work and materials, the lack of skilled workers, the industry's low readiness to introduce innovative technologies, the weak competitiveness of companies in domestic and foreign markets [4, 5].

The ever-increasing complexity of construction projects, the dynamic change and uncertainty of conditions, the impossibility of carrying out full-fledged engineering training and the high-quality implementation of control and supervision activities are the reason for the introduction of innovative technologies and the search for new organizational and managerial solutions to improve the efficiency of the implementation of investment and construction projects [6, 7]. The introduction of innovations in the implementation of construction projects at all stages of their life cycle brings a positive economic effect,

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including by reducing costs at each stage of the investment, construction and operational processes [8].

2 Research materials and methods

Currently, the construction industry, the housing and communal services of the Russian Federation are experiencing a number of difficulties and have serious external and internal problems. Factors limiting the production activities of construction organizations, as per data of the Unified Interdepartmental Information and Statistical System, are shown in Figure 1.

Fig. 1. Factors limiting the production activities of construction organizations in the fourth quarter of 2022 (share of organizations from total number, in percent) [9].

The high cost of materials, structures and products, as well as the high tax rates form the main factors that limit the development of organizations and enterprises in the construction industry [10]. Construction contractors are hardly able to change this situation. The impact of external factors forces construction companies to conduct their activities with a decrease in profitability.

The uncertainty of the economic situation in the country (high probability of economic changes in terms of exchange rate and inflationary dynamics, the impossibility of determining the direction of regulatory influences) forces the construction business to shorten the horizon of strategic planning, since an unexpected fundamental adjustment of plans leads to serious costs, especially with long production and investment cycles, which is especially typical for the construction industry [11]. As a result, the investment and innovation activity of enterprises slows down, the technological renewal of industrial production and the growth of labor productivity slow down [12].

The low labor productivity and losses in production processes in the manufacture of building resources and the performance of construction and installation works lead to high prices for structures, products, equipment and services, which increases the final cost of building an object [13]. With low aggregate demand, this is one of the main factors in the
deterioration of the financial standing and competitiveness of companies, and necessitates the introduction of progressive methods for managing investment and construction projects using modern innovative technologies, including information modeling (BIM) technologies.

3 Results and Discussion

Currently, the design documentation in Russia is in most cases provided in the form of two-dimensional drawings. Such projects may contain various kinds of errors and conflicts that are not visible during the development and examination of project documentation, because there are no tools for combining all elements (documentation sections) developed and calculated by different specialists into a single three-dimensional information model (BIM) [14]. Design errors entail serious time and material costs at the construction stage.

Structural and space-planning solutions of the building, engineering communications systems, estimate documentation, etc. are formed by various specialists and departments [15]. Changes made to the project during the construction process lead to an increase in the time and cost of work. The later changes are made to the project, the higher the construction costs will be. Integration of software products is an absolute advantage of BIM technologies, because it allows to reduce the cost of modeling and simplify the visualization of the designed building.

One of the main tasks in the management of investment and construction projects is to establish a balance of interests between the technical customer, designers and builders, as well as a fair distribution of risks between all project participants [16]. Currently, there are no unified forms of contracts in Russia to regulate the relationship of all participants in investment and construction activities and the distribution of risks. The implementation of complex construction projects using integrated contractual relations is not widespread in domestic practice. The consequence of this is the lack of common goals and harmonization of interests among the participants in the investment and construction process. This leads to a decrease in the quality of design, construction and installation works, an increase in the periods and costs of project implementation. Thus, the current conditions in the construction market are shifting the development vector of construction industry organizations to the development and implementation of new tools and technologies as the main resources for future growth [17].

At present, one can observe an intensive qualitative development, which generates fundamental changes in construction organizations [18]. The instability and uncertainty in the market forces organizations to become flexible, i.e., be able to adapt to new circumstances. The most relevant areas today include the development of digitalization and information modeling technologies, the application of quality management and modern management methods at all stages of the project life cycle, as well as risk mitigation in individual and group activities [19, 20].

Based on the analysis of the problems of the construction industry, it can be concluded that the introduction of information modeling (BIM) technologies, modern methods of managing investment and construction projects, integrated contractual relations, innovative technologies in the production of construction products, as well as improving pricing systems and bidding for contract work are priority tasks of the national economic program. Thus, the following key goals for the development of the domestic construction industry can be distinguished:

- reduction of cost and terms of implementation of investment and construction projects;
- improving the quality of survey, design and construction work;
- increasing the competitiveness of Russian organizations in the domestic and foreign markets;
• increasing the readiness of the industry and organizations to introduce innovations;
• improving the efficiency of construction companies.

Achieving these goals is possible by adapting the Russian construction market and technical regulations of the industry to international standards, as well as the transition of construction companies to the concept of sustainable construction using modern information technologies. The use of BIM technologies in the construction industry makes it possible to prevent errors in documentation and ensure the safe operation of buildings, to save funds for budgets of various levels and businesses, and also to increase the speed of construction processes by 10-30%.

4 Conclusion

The use of BIM technologies implies, first of all, the creation of a digital building information model. Next is the actual construction of the object. Therewith, the BIM model helps to quickly resolve the current tasks that arise during the implementation of investment and construction processes, and also allows to make the most effective organizational and managerial decisions.

The digital information model of the building is formed at the very beginning of the investment and construction design. The designer develops a 3D model of the building using specialized software, and elements of such model will have different levels of detail at different stages. With the development of the project, the 3D model is supplemented with new information, and errors that occur in the project are automatically detected. After correcting all problematic issues and various kinds of conflicts, the release of construction documentation begins. Thus, in order to perform work, a civil engineer receives information of a qualitatively new level, which reflects a reliable picture of what the object under construction will be like.

The main advantage of BIM at the design stage is the ability to save time. Therewith, due to the time spent on organizing the process and training employees, it is difficult to note such savings at the very beginning of the introduction of BIM technologies in the implementation of investment and construction projects. However, in the future, BIM technology allows to effectively manage the working time in the implementation of projects which will lead to the need for less time, and the total time required to complete the project can be reduced by 20-50%.

The use of BIM technologies saves resources by reducing the number of design errors or eliminating them altogether, which makes it possible to secure the construction process. Elimination or avoidance of errors and conflicts is possible even in the case of a construction company switching to the use of BIM systems when the design process was carried out in 2D and a trained specialist will control and test the model in 3D.

The BIM technology makes it possible to increase the efficiency of the development of estimate documentation through the use of information databases and specialized software, due to which it is possible to monitor and analyze costs at each stage of construction work, as well as to identify deviations from budget and planning standards.

When implementing an investment and construction project, its actual cost may differ from that planned during the design of the facility. Often this is due to the use of aggregated standards when assessing the scope and cost of works. Therewith, during the construction of the facility, changes can be made to the project and work schedule, which can ultimately lead to a failure in the construction deadlines, a decrease in the quality of construction products and an increase in the cost of the facility. Outdated design practices and imperfect methods of construction supervision lead to differences in planned and actual construction costs. Thus, there is an obvious need to create a system of objective control of documentation for the construction site in terms of the volume and cost of works. With the
use of BIM technologies, the customer has the opportunity to monitor and control the progress of the design, construction, operation and commissioning of a capital construction facility, as well as control the spending of funds at all stages of the life cycle of an investment and construction project.

Thanks to BIM technologies, which allow creating highly informative 3D-models of buildings and high-precision projects, as well as due to the possibility of reducing the time of construction operations, the construction production process is gaining new benefits. The mobility of monitoring the progress of construction and compliance with the work deadlines allows for optimization of the staff in construction organizations.

The operation stage is usually the longest in the life cycle of a project and stretches over decades. The presence of a BIM model of the building brings significant benefits and advantages to the owner of the facility, because the model makes it possible to effectively organize the system of technical operation of the facility, to develop plans for repair work, as well as accounting for resources and costs spent on operation. However, presently not all capital construction projects have an information model, due to the fact that many buildings were built a long time ago or the design of facilities was carried out using outdated technologies. Therewith, BIM technologies make it possible to form a digital information model of an object based on the available design documentation, as well as on the results of a survey of buildings or structures. Thus, the use of BIM allows saving resources at all stages of the life cycle of an investment and construction project, but it is possible to increase the efficiency of project implementation to the greatest extent only when applying an integrated approach to the introduction of modern information technologies. The more complete and accurate information is included in the BIM model, the more funds the investor will save. In addition, the optimization of the economic, environmental and energy parameters of the object in the BIM model will save resources for the future owner of the building. However, the lack of organization and culture of working with BIM systems has a negative impact on the dynamics of their application by organizations in the construction industry, which makes it relevant to determine the goals and objectives of BIM application at each stage of an investment and construction project and the need to develop appropriate regulatory and technical documentation.

Currently, one can observe a trend of active implementation of BIM technologies with state support. In Russia, the use of BIM becomes mandatory for construction projects financed from budgetary funds of any level from 1 March 2022. And in July 2022 the Uniform Institute of Housing Development "DOM.RF" announced development of the national standard containing requirements for information models of residential buildings. Thus, the interest in BIM in Russia has grown significantly, both at the state level and among organizations in the construction industry. Therewith, construction companies introduce modern information technologies with varying degrees of efficiency in the implementation of investment projects. The costs of implementing BIM for companies depend on the general features of this process, typical for most organizations, as well as the individual characteristics of each individual business structure.

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