BIM-technologies: organizational aspects in different stages of investment and construction project

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Abstract. BIM using is one of the most crucial and integral parts of building management. A complex BIM-model gives a precise picture of the project's final cost and can be used as a tool of budget measurement. BIM provides an opportunity to calculate all material and instead of manual calculating, it will change project cost estimate automatically if something in the project changes. In addition, it improves project economy and reduces the rate of random mistakes while project documentation assembling. However, experts in the construction industry acknowledge that the challenges that design companies face today in the transition to BIM are becoming more and more urgent. The article is devoted to the formation of a comprehensive view of the information model by stages of the life cycle. Through the implementation of information technologies in the field of investment and construction projects, achievable main problems allow for a new level of digital processing. Based on project lifecycle management, possible solutions to the identified problem blocks are proposed and their effectiveness is evaluated. Taking into account these changes, it will be possible to maximize the effective use of information modeling technologies at all stages of the life cycle of an investment and construction project.

Based on statistical data, we can answer that construction is one of the most capital-intensive industries by its characteristics, while maintaining the status of the most unpredictable and conservative industry among all eight basic sectors of the country's economy. Due to changes in the legislation on shared-equity construction and the transition to escrow accounts, as well as due to a decrease in demand for construction services in 2018-19, the number of companies with low financial security and profitability increased. The housing sector is trying to regain its position as a driver, but in general, the construction industry is stagnating. Probably, that is why there are no forecasts for the construction of public housing for 2020, the adaptation of the industry to the new government laws is not yet complete, and a full transition to project financing is ahead.

Over the past two years, the main driver of increased sales in the construction industry has been delayed demand. In the context of the covid-19 pandemic, the market will not be able to return to pre-crisis indicators for a long time, and we can hardly expect this soon. In the context of the pandemic, specialized information technologies got crucial importance, which provided a remote mode of work of designers in the on-line mode. The pandemic itself set the vector for the development of a construction management system based...
on information modeling, as a tool aimed at improving the quality of blueprints and reducing unproductive losses during construction and installation work.

Time and practice show that the development of BIM technologies is a logical and irreversible process of the evolution of design and construction technology. The development of BIM technologies in Russia lags behind Western countries, but it is already becoming a significant factor in the competitiveness of the project organization in the market [1].

Information technology is an intangible asset of a construction company. In the modern world, intangible resources are gradually beginning to play an increasingly important role in the development of almost all sectors of the national economy. It is obvious that in the process of managing such an intangible asset as an information modeling program, a sufficient number of problems arise that reduce their wide application. Based on this, the purpose of the article is to form a comprehensive view of the use of the information model at the stages of the project's life cycle through the introduction of integrated design solutions. The formation of a comprehensive view will allow you to work out methodologies and create tools in order to establish interaction within the framework of the implementation of an investment and construction project.

When considering the relevance of this research topic, the theoretical base formed based on the works of Russian and foreign scientists who made a significant contribution to its formation and development was analyzed. Scientific works of Russian scientists, including Buzyrev V. V., Kossov V. V., Lipsits I. V., Shvandar V. A., made a significant contribution to the development of the project management theory. The use of BIM technologies in the construction industry in Russia is described in the works of Bogolyubskaya Yu. V., Bakalets I. A., Kostyukova T. A. Largely, the need for the development of BIM technologies in Russia and the processes of their implementation in production are considered in the works [2,3].

Since 2007, the world has been developing information modeling standards. Western countries have approached this issue fundamentally, ensuring the unity of standards and classifiers of structural elements by creating associations and non-profit organizations that maintain these standards in an up-to-date form and spreading the best practices in the use of information technologies. In the Russian Federation, the transition of sectors of the national economy, including the construction industry, to the digital format is impossible without fundamental changes in such areas as regulatory regulation, information infrastructure, and personnel retraining. And these areas are reflected in the program for the introduction of information modeling of construction approved by the Ministry of Construction in December 2014, as well as the federal project "Digital Construction" designed for 2018-2020 [4].

At the end of 2020, most designers and builders in the Russian Federation associate BIM with three-dimensional modeling and the use of Revit by Autodesk, but there is no further understanding that our future lies behind this new technology. Many subjects of the investment and construction process have a false opinion and consider the information model exclusively as a three-dimensional image. In reality, the information model is a digital representation of a physical object, filled with various kinds of information: geometric, physical, economic, information about the developers and manufacturers of products. The complexity of the model lies in the presence of a large number of users who create, update, and use the data. At the same time, the information model can bring the maximum benefit to the project management system, procurement system, calendar planning system, etc., becoming a source of a large amount of data.

BIM technology is widely used in the West, where not only 3D modeling is already practiced, but also 5D, 6D and even 7D, and these technologies are used both at the design and construction stages. In Russia, the use of information modeling systems is still at the level of applying local solutions that do not have a breakthrough character and do not significantly affect the quality of organizational and technological solutions developed both at the design and construction stages [5]. Based on this, it is necessary to analyze complex problems at all stages of the life cycle of the implementation of an investment and construction project. It is advisable to divide the main problems of project implementation into five main blocks (Fig.1).
Figure 1. Blocks of problems in the implementation of a capital construction project.

The first set of problems is related to the planning department of the investment and construction project. Most construction companies implement the timeline system in their operational activities, however, as practice shows, this system does not fully implement all the functions. First, it does not allow you to quickly make specific decisions and analyze the causes of deviations. To minimize the impact of this problem based on the principles of a systematic approach, it is advisable to develop a standard model of a comprehensive solution for the implementation of BIM technologies at all stages of the life cycle of an investment and construction project [6,7].

Transactional elements include the main project management systems. The project budget management element contains investment programs. Directly managing the operational processes of investment and construction activities is assigned to the investment management element. The KSP system has the functions of a consolidated timeline plan and network planning, as it is integrated with the design and survey work management systems, with the operational level of construction and installation work management and procurement management [8]. This allows you to integrate the plans into the overall system and organize their mutual influence.

In the form of supporting systems, one of the key systems is the engineering data management system, which provides the processes of storing and managing engineering data at all stages of the implementation of an investment and construction project. The next element is the maintenance of reference books of project...
elements, nomenclatures for the purchase of materials. The third element is the management of configurations, requirements, and changes. The process of detailing requirements and monitoring their compliance is regulated, monitored and controlled at all stages of the life cycle through this system. The next element is the simulation of the technological process of eliminating collisions and working with collisions, by computer-aided design tools [9].

The second set of problems is the lack of unified regulatory and reference information. Each subject of an investment and construction project uses its regulatory framework, reference books, regulations, classifiers, which leads to an information gap when transmitting data about an object from stage to stage of the life cycle. As a result, there is no end-to-end process for processing applications, orders, and write-offs of materials and equipment, which leads to inconsistency between the plan and the fact of material consumption and construction and installation work. The requirements of the subjects of the investment and construction project, designers, buyers, and operators are taken into account through the allocation of specific attributes that are allocated in the nomenclatures. It is also advisable to organize both the organizational and technical part, by developing regulations for the joint management of these nomenclatures and setting up technical participation [10]. Also, as part of the solution to this problem, it is advisable to implement a machine learning technique that has the attribute property of combining reference books.

The next block is the regulation of interaction. When implementing an investment and construction project, it is important that all participants function within the framework of an end-to-end process. In practice, there is a functional isolation of the divisions of specific blocks, which does not take into account the interests of all project participants.
For the functioning of all systems, it is necessary to ensure the development of regulations and methodologies that should accompany the implementation of a comprehensive solution for the introduction of information technologies, taking into account the design decisions and the structure of a particular enterprise.

Process regulation is an important step before implementing an information modeling system, defining the business logic of the project. Regulations for the implementation of an investment and construction project are usually developed, but they do not contain specific requirements and do not reflect the dependence of input and output data on the type of construction object [11]. This does not allow us to formulate the requirements for performers and does not ensure the end-to-end implementation of the regulations at all stages of the life cycle, which leads to the lack of tools for monitoring the implementation of these regulations. Therefore, regulation is the creation of end-to-end regulations of processes that must be implemented in information systems where control of their execution is organized.

The fourth block of problems is the management of construction and installation works. This block at the stage of implementation of capital construction projects accumulates the entire range of problems that occurred at the previous stages of the implementation of the investment and construction project. In general, these include design errors that manifest themselves during the construction phase, which hurt the directive terms of construction and installation work.

When working out the problems of the block "Management of construction and installation works", it is advisable to develop the process of implementing information technologies to maturity levels. The first level of basic informatization is carried out, including management of the SMR, organization of calendar planning of resource management, electronic document management system. The second level is based on the information model, estimates are formed, construction and installation work technologies are modeled, and engineering data management systems are integrated [12]. We work with the calendar network model by connecting the calendar schedule, the information model, and the estimated calculation through the project elements. The third level is the addition of digital tools-mobile devices, 3d scanning, drones, robotics, AV, VR sensors, which are used both on the construction site and in the workplace.
The lack of modeling of construction technologies leads to delays and losses, which are manifested in the presence of interdisciplinary collisions in construction processes. In addition, the information model in the management of an investment and construction project should be associated with calendar schedules, with data on the actual work performed in the form of visual reports.

As part of a construction project, there is always an estimated part, which is one of the main sections and precedes the start of construction and installation work. It contains complete information of varying degrees of detail about the scope of work and the cost of resources of the construction object. One of the areas of application of the BIM model is the process of developing and controlling the estimated documentation at the design and construction stages. Moreover, it is very important to use an information model for the formation of estimated calculations, in which the relationship between the design elements and the ciphers of the final calculations will be standardized, using machine-learning technologies. Thus, the information model becomes a source and repository of data about the object. Estimates provide a cost perspective on the implementation of calendar schedules, which allows you to manage and plan resources, taking into account the estimated constraints. The information model allows you to create not only purchasing specifications but also to ensure the relationship of the specification and items with the operations of the timeline schedule.

The fifth block is the problems associated with the requirements management system, configurations, and changes. As statistics show, about 50 percent of deviations in the implementation of capital construction projects are allocated to the area of requirements management. In the process of project implementation, the decision made by the customer is usually not analyzed in terms of the impact on the performance of the investment project. As a rule, no structure of the created product does not allow you to manage project changes.

Thus, the above problems should be solved using BIM technologies, which represent a comprehensive solution for all five blocks of problems. The problem of planning can be solved by developing a timeline and network planning system in terms of integration with the object's information model, as well as with the customer's transactional systems. The planning system will combine schedules for design, configuration and construction and installation work, which will ensure the control of the availability of resources in time. At this stage, it is very important to use the information model as a tool for modeling the object creation technology, which integrated into the planning system. The second set of problems should be solved by creating a single standard reference information that will take into account the requirements of all participants in the life cycle: designers, cost estimators, buyers and builders. In the area of the third problem, it is necessary to clarify the regulations of the "end-to-end" process, to develop data standards and methodologies that will apply not only to a specific functional block but also to take into account the entire end-to-end process of the project implementation. First, it is advisable to develop: standards for investment project management, BIM standards, and methodological support for project management. When managing construction and installation work, it is necessary to include the cost of construction and installation work in the project management process, including detailing schedules and organizing the management of construction and installation work resources of contractors. This will allow you to standardize and control the availability of resources to minimize risks during the project implementation [13]. From the point of view of requirements management, it is very important to type requirements, classify requirements management standards, to ensure the availability of information both for customers at the beginning of the project implementation and at subsequent stages of implementation, including when monitoring project decisions. It should be noted that the construction of an information model is a rather time-consuming and lengthy process, the expediency of which can be justified only in complex and large-scale projects [14]. The development of project documentation for small objects using BIM will simply increase the time and cost of work.

The effectiveness of the proposed measures can be traced on two levels. The first level will reflect the improvement of information interaction expressed in the elimination of information gaps through the
Introduction of basic automation, which should include unified directories, system integration, end-to-end integrated planning of work and resources. Insisting on and implementing these measures will reduce changes in the scope of work and construction deadlines, which will prevent an increase in the amount of project costs at the stage of construction and installation works and increase the average annual EBITDA by 10%. The second level directly evaluates the effects of using the information model at all stages of the life cycle. The estimated effects include a reduction of up to 20% of design errors, a reduction of up to 10% of operations associated with changing the configuration of an object or requirement, and a lead-time of up to 6 months for project implementation. In the result, the indicators of the implementation of the digital construction system are obvious: transparency of construction in online mode, significant reduction of communication costs, risks of information loss, time of approval of construction documentation and changes in the construction process, creation of an information system of operation in the construction process.

BIM attracts the attention of investors and developers both as a tool that reduces time and financial costs by automating routine operations and as a tool for monitoring the design and construction processes of an object in real-time, which helps to quickly respond and make the necessary changes to the project and improve quality. It is advisable to determine that the main task of creating an integrated hierarchically organized information technology is to ensure that at each subsequent level of management, the use of detailed information that arose at the previous level and takes into account the peculiarities of the regulatory regulation of construction in our country.

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