Features of the information modeling use of real estate objects in the housing market

Boris Khrustalev\textsuperscript{1*}, Pyotr Grabovy\textsuperscript{2}, Kirill Grabovy\textsuperscript{2}, and Alexey Kargin\textsuperscript{1}

\textsuperscript{1}FGBOU Penza State University of Architecture and Construction, 28, German Titov Str., 440028, Penza, Russia
\textsuperscript{2}NIU Moscow State Construction University, 26, Yaroslavskoye Shosse, Moscow, Russia

Abstract. The article is devoted to the application and formation of new scientific approaches and practical recommendations for the use of information modeling technology in the activities of enterprises of the construction complex at the stages of the life cycle of the construction of real estate objects. Research methods are theoretical analysis and empirical study. The object of analysis is the enterprises of the construction complex in the conditions of the formation of the factor space at all stages of the life cycle. Quantification of factors influences the outcome. The article proposes new scientific, practical approaches to the functioning and development of enterprises of the construction complex in conditions of risk, as well as factors of uncertainty in construction production based on the use of information modeling technology, the use of effective models for managing the construction of facilities. A flexible management model is proposed that allows you to respond to all changes in the external environment, timely manage costs, including the timing of work, which allows you to quickly adjust the progress of production processes in space and time when any types of risks occur.

1 Introduction

The world economy is actively recovering, ahead of the expectations of most experts. One of the leaders among industries in increasing development is construction. The reasons for this accelerated recovery are the development of cities and territories, an urban comfortable environment, and an institutional rental housing market, which leads to an increase in the competitive advantage in the struggle to preserve human capital at the level of both the country and individual cities. Global growth is supported by stimulating fiscal policies implemented in the largest developed countries.

In 2021, housing commissioning in the Russian Federation amounted to 92.6 million square meters, which is 11.23\% higher than the same period in 2020. As of September 1 2022, housing commissioning in the Russian Federation amounted to 66.1 million square meters, which is 26.4\% higher than the same period in 2021, of which apartment buildings - 25.3 million square meters, which is 9.5\% higher than the same period in 2021, individual

\* Corresponding author: hrustalev_bb@mail.ru
housing construction - 40.8 million square meters, which is 39.8% higher than in the same period in 2021 [1, 2]. Detailed dynamics in recent years is shown in Figure 1.

Fig. 1. The volume of housing commissioning.

At this stage of development of the construction industry, in difficult economic and geopolitical conditions of operation and development of enterprises of the construction complex, it is necessary to develop fundamentally new scientific and practical approaches to the need, the possibility of using information modeling technology at production processes and stages of the life cycle of construction of real estate objects in conditions of risk, as well as factors of uncertainty of construction production. The construction industry today remains the least susceptible to digital transformation, so the creation and implementation of an information model is a fundamentally new approach to the design, construction, equipment, operation and repairing of the building [3, 4, 5].

2 Materials and methods

The well-established system for managing and planning the construction of capital construction facilities is based on calendar and network planning and is displayed in a graphical image of processes in the form of a Gant chart, the implementation of which is necessary to achieve the set goal.

The analysis made it possible to identify factors affecting the development of enterprises of construction complexes and the industry in the context of the risk and uncertainty factors of construction production. Modern management theory and practice classifies environmental factors into internal and external. The basis of this classification is the principle of dividing the environment into external and internal [7].

External factors include such conditions and circumstances generated in the external environment, regardless of the activities of a particular business entity and located outside it, which the enterprise cannot change, but due to their significant influence should be perceived as something unchanged. Directly external variables form risk-generating factors and risk
causes associated with uncertainty, complexity and dynamism of the external environment, which can lead to negative development of events and, as a result, to a negative deviation from the set goal, the plan for the implementation of the investment project or the general plan for the development of activities of construction enterprises [8; 9].

Internal factors are situational variables that are within the economic entity itself and have a constant and direct impact on its functioning and development. By its purpose, the internal factors of the enterprise are the source of its development at all stages of the life cycle of the construction system, which contains the potential that makes it possible to effectively function in changing external conditions.

From the point of view of the method of impact, environmental factors should be divided into factors of direct impact that have a direct impact on the current activities of the construction enterprise, and factors of indirect impact - influencing indirectly and beyond management [10].

By expert means, it was established that external factors of direct impact - 33.54%, then internal factors - 33.49% and external factors of indirect impact - 32.97% have the greatest impact on the sustainable functioning of the construction complex enterprises [11].

By the nature of influence on economic objects, one can distinguish common factors that equally affect all enterprises, regardless of their size and form of ownership, and private ones that affect the activities and interests of an individual object.

In accordance with the hierarchical structure of the environment of the enterprises of the construction complex, it is necessary to distinguish:

- mega-level factors representing phenomena, processes and trends generated in the global world sphere (globalization; economic relations between countries; international monetary relations; the presence and number of any military conflicts; international division of labor, etc.);
- macro-level factors - external variables covering financial, economic, political, legal, socio-demographic, scientific, technical, technological and natural-geographical features of the national economy as a whole;
- meso-level factors reflecting directly regional and sectoral features and significantly affecting the efficiency and stability of the operation of construction enterprises (the economic state of the region and the construction complex as a whole; the level of prices for land and construction objects; economic policy of credit institutions in the region; features of the structure of the regional construction complex; the policy of the authorities in relation to the construction business; socio-demographic indicators that shape the demand for housing; as well as technological and geographical features);
- microlevel factors - components of the immediate environment, which are directly interacting with a particular business entity and on which the setting and achievement of goals directly depend (consumers; suppliers; competitors; intermediaries; contact audiences);
- minilevel factors generated and functioning within a specific enterprise certain interconnected components directly affecting the process of conversion of incoming resources into final construction products (social; organizational and structural; production; financial and economic; technological; technical; innovative; marketing and operational components)
- nano-level factors - individual-psychological variables that determine the specific behavior of the individual in the process of developing and making management decisions (professional competencies; liability; self-discipline; initiative; information perception and evaluation; psycho-emotional state, etc.).

Environmental factors can be divided into:

- predicted factors are those variables whose changes can be foreseen in advance, analyzed and estimated with great accuracy;
- difficult-to-predict factors - are characterized by complexity in preparing an advance
forecast and approximate measurements;
- unpredictable factors - are expressed by the manifestation of unexpected events and circumstances, which cannot be predicted and evaluated.

The designated three classes exist in each group of external and internal factors. Factors are evaluated using mutually complementary methods of qualitative, quantitative and combined analysis.

The influence of environmental factors of enterprises of the investment and construction complex is very diverse: some factors affect all aspects of the operation of enterprises, others - on a certain business process; some have a stronger effect, others act weaker. In this regard, it becomes necessary to classify factors based on the dependence on the degree of influence on the activities, goals and decisions of the business entity:
- factors of strong influence - the most powerful affecting both the enterprise as a whole and the individual business process in particular;
- moderate influence factors - having acceptable impact,
- factors of weak influence - the impact of which for a particular enterprise is insignificant.

Thus, the most powerful influence of the investment and construction complex enterprises is experienced by internal factors, inherent (factors of the immediate environment) and regional and sectoral factors [10, 11]. When analyzing the impact of environmental factors on the activities of construction enterprises, it is necessary to take into account, that the vast majority of the components of the external and internal environment are in a state of interconnection and interdependence, which determines the stability of development in space and in time of all production processes,, the functioning of the enterprise and the entire investment and construction complex - a change in one of the components leads to a change in many other components and a decrease in the overall stability of the construction system.

The influence of external and internal factors may differ in persistence and duration of exposure. So, by the constancy of influence, factors can be grouped into:
- constant factors - always present and continuously affecting the activities of construction enterprises;
- periodic factors - appearing and influencing from time to time or with a certain frequency;
- sporadic factors - manifesting and influencing once at random.

By duration of impact:
- long-term factors - characterized by long-term positive or negative effects of influence;
- medium-term factors - the influence of which is limited in time and manifests itself gradually;
- short-term - instantaneous influencing factors [12].

Thus, the study of the constancy and duration of the influence of factors on the activities of construction enterprises allows us to conclude that for the effective functioning and implementation of the set goals, enterprises should take into account constantly affecting internal, internal and regional industry factors. The periodic influence of the vast majority of external factors has long-term consequences and creates general conditions for the existence of business entities. This conclusion logically implies the feasibility of classifying environmental factors depending on the possibility of managing them by the construction enterprise:
- controlled and managed factors - controlled and managed in order to increase the positive and reduce the negative impact from their changes;
- conditionally uncontrolled factors - variables, the influence of which can only be taken into account;
- uncontrolled and unmanaged factors - not subject to any control and management.

The results of the analysis show that, in general, internal and external inherent factors in the majority with varying degrees of control and management by enterprises, what can not
be said about other external factors, the influence of which can only be tracked, research, analyze and take into account in the formation of goals, development of business plans and management decisions and create the necessary reserves through organizational and economic mechanisms in the activities of enterprises. Data analysis shows that the efficiency of the construction complex enterprises is influenced by a combination of external and internal factors [12, 13]. 

Implementation of construction facilities management mechanisms using information modeling technology in the construction facilities management system will allow to quickly respond to the influence of undesirable changes in factors in terms of reducing the likelihood of negative events that entail serious financial consequences. The use of information modeling technology to optimize the construction time and the planned implementation of the work schedule for the period of construction of the facility will streamline the losses of the first kind, excluding the losses of the second kind. At the construction stage, two more measurements are connected to the work on the object. The fourth dimension - 4D becomes time, the fifth dimension - 5D, the cost of construction. Construction of the project construction management process during the construction period using such models that take into account various external and internal factors, as well as allowing to quickly take into account the changing external and internal environment, including the introduction, practically in real time, of changes in the work schedule for more flexible management of construction processes.

The use of information modeling technology will make it possible to create models for the construction of capital construction facilities using various input parameters of a particular organization, assess and select rational parameters of enterprises for the rational development of production processes, the use of basic production resources (labor, material, technical, etc.), the functioning of enterprises of various forms of ownership and purpose, using methods of managing total risks [14, 15, 16].

During the construction period, in the context of external and internal risks, the availability of complete information on materials and equipment will simplify and automate the process of their delivery to the facility, as well as reduce the labor intensity of the construction supply process, which will ultimately lead to a decrease in risks during the construction of facilities [16, 17, 18].

At the most expensive stage of the life cycle of an object - construction - using information modeling technology, you can track the actual state of the object, monitor the expenditure of funds and budget execution, as well as receive information for making management decisions in real time. Implementation in a single model, preparation and control of uniform work execution plans, preparation of integral and differential capital investment schedules, requirements of materials and equipment, labor resources, machines and mechanisms when changing individual parameters or introducing new conditions into the process under the influence of external or internal factors (changes in the design, delivery time of materials and equipment) will allow you to quickly manage the work execution processes, as well as minimize and manage risks associated with the work execution time.

3 Results

The construction of real estate objects is characterized by continuity, multivariability of functioning and development of all types of production processes, cyclicity of repeatability of individual phases (collection, processing, analysis, storage, control of information; development and decision-making; organization of their implementation), unevenness, inertia, manifested in the lag in the development and adoption of management decisions.

The influence of different groups of factors of the external and internal environment in the process of construction of real estate objects as a result form various changes, which leads
to the transformation of conditions and situations of functioning, the development of enterprises of construction complexes and the need to develop new directions, ways of their development in conditions of implementation at all stages of the life cycle of real estate objects.

A large number of participants take part in the construction process, such as the customer (investor), designer, general contractor, specialized subcontracting construction organizations. In addition to direct participants in the construction process, dozens of manufacturers of technological equipment, construction machines and materials participate in the creation of construction products. Some of the materials, equipment and construction equipment used to create facilities are produced not only in Russia, but also abroad. Due to the large number of construction participants, the process of organizing construction production is formed under the influence of a large number of organizational factors. Factors indicate the importance of this industry and the need to constantly find ways to improve management tools.

The difficulty of studying the economic aspects of capital construction lies in a large number of organizational and economic forms of the construction production process, a large number of participants with different functional goals and objectives, and a significant dependence of the construction production process on natural conditions. The transformation of the management system and its improvement means a change in organizational relations and, accordingly, organizational forms of management of the construction system.

4 Discussion

In the current conditions for the development and implementation of information modeling technology (IMT) at all stages of the life cycle of the construction of a real estate object, it becomes necessary to form new scientific and practical approaches that are aimed at increasing the economic stability of the functioning and development of enterprises of construction complexes. The information model of a capital construction object (hereinafter referred to as the information model) is a set of interrelated information, documents and materials about a capital construction object, formed electronically at the stages of the life cycle of the object (preparation of a site for development, preparation of a technical assignment for design, execution of engineering surveys, implementation of architectural and construction design, passing of an examination, obtaining a permit for construction, construction, operation, reconstruction, major repairs and (or) demolition of a capital construction facility) [6].

The use of information modeling technology in construction and operation at the stages of the life cycle of the facility, as one of the main organizational and economic mechanisms, ensures an increase in competitiveness, quality of the final product and a decrease in its cost. In addition, the use of information models will allow you to variably search for optimal ways to reduce construction time in an automated mode.

5 Conclusion

The introduction of information modeling technology at all stages of the life cycle in conditions of risk should solve the issue of reducing the terms and total costs of erecting real estate objects, increasing the life of buildings, reducing the costs of maintaining and maintaining them, and will also create all the necessary conditions for the use of new forms of work management and real estate management.

At the design stage, the use of an information model will make it possible to analyze various situations to reduce external and internal risks during the construction, operation of
buildings and structures. At the stage of work execution, the use of information modeling technology will allow you to flexibly track and manage the execution time work, which will lead to a decrease in the cost of erecting the facility, and at the stage of operation - to a decrease in the cost of maintenance and repair of buildings and structures.

Acknowledgements

The research was carried out with the financial support of the Moscow State University of Civil Engineering within the framework of the 2022 competition for fundamental and applied research (R&D) by scientific collectives of the member organizations of the Industry Consortiums "Construction and Architecture" (contract No. 3/K of 16.05.2022) in order to implement the Development Program of the Moscow State University of Civil Engineering for 2021-2030 during the implementation of the Strategic Academic Leadership Program "Priority-2030".

References

4. V.V. Talapov, BIM technology: the essence and features of the introduction of information modeling of buildings (M., DMK Press, 2015)
12. K.P. Sauvant, Foreign direct investments from emerging markets the challenges ahead (N.Y., 2010)


16. N.A. Vyatskova, Algorithm to improve the efficiency of the enterprise based on the functioning of risk management system, PONTE Journal (2016)
