Facility life cycle management during operation with application of an information model

Boris Borisovich Khrustalev, Alexey Alexandrovich Kargin, Anna Anatolievna Kargina, Nikolay Igorevich Korolev, Sergei Vladimirovich Zakharov

1Penza State University of Architecture and Construction (PGUAS), 440028, st. German Titova, 28, Penza, Russia
2Moscow State University of Civil Engineering, 26, Yaroslavskoye shosse, Moscow, 129337, Russia
3International Centre for Judicial Expertise under the European Arbitration Chamber; 146, Avenue Louise, B-1050, Brussels, Belgium

Abstract: The article is devoted to the review of information modeling technology at the stage of operation of capital construction facilities. The use of information models in the operation of real estate objects is an urgent area. The main issues discussed in the article are the principles of organization during the operation of real estate objects and the expected effects of reducing the operating costs by means of the introduction of information models. Creation of a unified information space for planning organizational issues for the period of operation of the capital construction facility. An option was developed to form a data architecture and sources of information. The article considers measures to improve environmental sustainability and stability of buildings at the stage of operation.

Keywords: information modeling technology, operation of real estate object, life cycles of real estate objects, information model of capital construction object, environmental stability and strength.

Introduction

One of the most important tasks of the construction complex today is to increase the efficiency of management, reduce costs at certain stages of the life cycle of the capital construction object. In the Russian Federation, when creating living conditions, there are several state programs, including "Comprehensive Development of Rural Areas" and "Providing Affordable and Comfortable Housing and Utilities to Citizens of the Russian Federation." Simultaneously with the construction of capital construction facilities, there is a need for the development of communal infrastructure. Affordable and high-quality housing should also be economically feasible at the same time. At the same time there are some tasks for the safe operation of capital construction facilities beside the issue of direct construction.

The main stages of the life cycle of the construction object are the stages of design, construction of the object and its operation. The longest stage of the life cycle is the stage of operation of the facility. From the point of view of the consumer (property owner), this stage is

*Corresponding author: hrustalev_bb@mail.ru
the most important. At the stage of feasibility study of the capital construction facility, an information model is formed. Climate change, a constantly changing environment make environmental sustainability a component of the construction industry obligatory.

**Methods**

During the study, the following main scientific methods were used: "dialectical," "systemic," "dynamic," "variant," "balance," "modeling." "The information model of a capital construction object is a set of interrelated information, documents and materials about a capital construction object, formed in electronic form at the stages of engineering surveys, architectural and construction design, construction, reconstruction, complete overhaul, operation and (or) demolition of a capital construction object" - this definition is given in the Urban Planning Code [1] and other scientific works [2, 3, 4].

In Russia, a plan was adopted for the development of digitalization of the construction industry by the Order of the Ministry of Construction of Russia "On Approval of the Plan for the Phased Introduction of Information Modeling Technologies in the Field of Industrial and Civil Construction" [5]. This document, adopted and supported at the state level, will undoubtedly contribute to the transition to the creation of information models of facilities and the development of the industry.

At the first stage, when designing the facility, the solution to the problem of reducing the cost of housing construction is carried out today by introducing information modeling technology (TIM). The creation and implementation of an information model is a fundamentally new approach to the design, construction, equipment, operation and repair of capital construction facilities [2, 3, 4].

The stage of building operation has no final purpose. The main task at the operation stage is to ensure the safe operation of the facility throughout the life cycle with constantly changing external factors of the facility operation.

During the operation phase, the main goal of modeling is the technological processes related to the operation and use of a building, as well as the integrated management of these processes. One of the most important aspects of the facilities operation is to ensure necessary repair and emergency work on engineering networks. This is especially important during repair work during the heating season. Rapid detection of faults on engineering networks based on the implementation of information models will reduce the time for detection and repair of damage, which will ultimately reduce the cost of maintaining the entire capital construction facility. The integration of security and fire alarm and fire safety systems (smoke removal, automatic fire extinguishing system) will increase the level of reliability of these systems. One of the main tasks during operation is to ensure the safety of the capital construction facility. To ensure the integrated safety of structural elements and engineering networks of buildings, it is reasonable to provide for a functional building management system with the ability to monitor the technical condition of engineering communications and equipment. The implementation of the basic regulatory requirements for ensuring the building in working condition will ensure the implementation of environmental stability of the facility throughout the facility life cycle. Some important factors for maintaining environmental sustainability are the reduction of energy consumption, through the use of LED and other energy-saving lighting systems to reduce energy consumption, the design of buildings taking into account the effective insulation of enclosing structures, to reduce heat and cold losses, which leads to a decrease in energy consumption for heating and cooling.

**Discussion**

When forming an information model of a real estate object, an initial array of data on the object is created, including the main technical and economic indicators for the object: building area,
areas of various types of coatings, landscaping areas, general, residential areas, areas of common areas, etc. A list of use equipment (elevator equipment, pumping stations, ventilation equipment, dispatching systems, etc.) is formed. When adding attributes to the equipment data in the model on the standard service life of the equipment and its service life, it becomes possible to plan repair work and draw up a procurement plan for the necessary consumables in an automated mode. These solutions save the working time of employees engaged in the maintenance of the building by excluding the processing of information on paper and redistributing it in the intellectual direction (advanced training through the exchange of experience, study of new equipment operation technologies) [6, 7].

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 [8, 9, 10]. Diagram of interaction, acquisition and generation of data for the stage of capital construction facility operation is given in Figure 1 [11].

![Diagram of interaction, acquisition and generation of data for the stage of capital construction facility operation](image)

**Figure 1.** The scheme of receiving and formation of data for an operational phase of a capital construction project

**Notes to Figure 1:**
1 - The developer begins to form an information model with initial data on the land plot on which the capital construction object will be located, technical specifications for connecting to engineering networks, etc. The developer has the right to transfer its legal functions in urban planning activities to the technical customer.
2 - The technical customer forms and maintains an information model on behalf of the developer.
3 - The general contractor carrying out the erection of the object refers to the model to form the necessary lists for ordering equipment and materials. During the execution of works, the contractor develops an executive documentation. Based on the results of the work, the
information model is updated taking into account the actual structures, engineering systems and installed equipment.

4 – The design organization develops the project and generates data on the capital construction facility.

5, 6 - Manufacturers of materials and equipment extend the unified electronic library of materials and equipment, filling it with models with all characteristics, certificates, conclusions of Rospotrebnadzor (Russian Consumer Supervision), the cost of manufactured products. From the database, the information model will receive information on actual service life, repairs, service intervals and, if discontinued, offer alternative equipment and material.

7 - Communication between the information model of the object and the unified electronic library, if necessary, is carried out to track up-to-date information about equipment and materials promptly.

8 - The management company, after receiving the information model, becomes its main user after the commissioning of the capital construction facility.

From the information model, the management company receives the data necessary for planning the maintenance of the building. In the future, when carrying out any scheduled or emergency work, all information about the processes will be entered into the information model of the building. Equipment manufacturers, when receiving this information, with a more accurate probability will be able to predict the life of the equipment, as well as the reasons for its failure. They will have the opportunity to adjust the operating parameters quickly. Using the same information model, the process of organizing work on the repair and maintenance of the building, including the purchase of consumables, is automated. Information on repair works shall be entered into the model and transmitted to the manufacturer. In some cases, human intervention may not be required, actions will be carried out in automatic mode. When using the information model of the facility, the structures and equipment of the building are monitored using special sensors installed during construction and connected through special protocols. To monitor energy resources, meters for the consumption of electricity, water, heat are also connected to a single BIM model, and information from them is automatically transmitted to power supply enterprises [12, 13, 14].

9 - At all stages of the facility life cycle, the customer interacts with authorities of various levels through the information model. At the stage of operation, inspection authorities have the opportunity to receive information on the availability of planned measures for preparation for the heating season, measures for preparation for the winter period, etc.

10 - Power supply enterprises, through access to the information model, will receive data on the readings of instruments by recording indicators remotely [11]. You can analyze the statistics of readings in real time with data on excess consumption, which indicates that there is a loss in systems and accidents. Using real-time data, excessive emissions into the atmosphere are reduced and energy consumption of all resources is reduced.

Results
At the present stage, there is also the problem of providing qualified personnel for the maintenance of buildings. The formation and maintenance of an information model of real estate objects makes it possible to predict the necessary resources for the operation of objects, such as labor (management, engineering personnel, building maintenance workers, janitors) and material ones (machines, tractors, consumables, cleaning equipment, etc.). If you have complete forecast information about the numerical need of the required number of employees for the operation of real estate objects, it is possible to form a personnel reserve, which makes it possible to minimize the external risks of the object due to the provision of labor resources.

The main effects of the use of information modeling technology include the potential to reduce costs up to 30% at the stage of operation of the facility; and also reducing administrative costs associated with the routine functions of engineers (information exchange processes) up to...
40% [15]. In addition, the use of information models increases the environmental sustainability and safety of capital construction facilities.

Conclusions
At the stage of facility operation, the information model (digital model of the capital construction facility) will allow the management company to carry out dispatching and monitoring of the state of engineering networks and building elements, and in some cases the state of load-bearing structures. The expected effect of the introduction of the information model of the capital construction object and the information modeling technology is to reduce the cost of maintaining the building, which will lead to the optimization of tariffs for servicing real estate objects. The use of TIM in the process of managing an object during operation streamlines management processes and reduces risks. In addition, at the design stage, the information model will allow in advance to form the required personnel reserve and material support in a single system of information space for the further operation of capital construction facilities. The use of information models increases the environmental sustainability of capital construction facilities at all stages of construction.

References


