Modernization of the competencies of construction managers in the implementation of projects using BIM

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Abstract. The use of Building Information Modeling at the construction stage of the facility involves not only the use of new technologies, but also the revision of the functional roles of participants in the implementation of the investment and construction project. The purpose of the study is to identify functional changes in the organizational structure of the State Customer (Developer) in the process of use Building Information Modeling at the stage of construction of a capital construction facility. The novelty of the research lies in the comprehensive consideration of the issue of the formation and development of digital competencies through the clustering of the organizational structure and the formation of a reference model of interrelated processes. As a result of the research, a scheme of functional roles has been developed in the context of the organizational structure of the State Customer (Developer), necessary to ensure the effectiveness of construction project management using information modeling technologies the formation of information models both at the stage of architectural and construction design and at the stage of construction and installation works.

Introduction

The strategy for the development of the construction industry and housing and communal services of the Russian Federation until 2030, as part of the formation of a digital management system at all stages of the life cycle of a capital construction facility, provides for the transition to the use of building information modeling technologies (BIM), the introduction and development of a management system based on BIM. The practical application of information modeling technologies will become mandatory from September 1, 2023 at capital construction facilities financed with the involvement of budgetary funds of the Russian Federation, from July 1, 2024 when implementing shared-equity construction projects [1,2]. According to experts, 16% of developers have competencies in the application of information modeling technologies in housing construction, and 50% of design companies in the design of buildings and structures [3, 4]. The transition of a significant part of developers to the mandatory use of information modeling technologies

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requires an operational update of the organizational structure, the formation of digital competencies and the building of a system of interaction of structural units (departments) in a single information space.

To date, the Program of renovation of the housing stock in the city of Moscow (Renovation Program), carried out within the framework of the state program by the Moscow Residential Renovation Fund (Renovation Fund, State Customer), is implemented using information modeling technologies [5]. The renovation program is large-scale and long-term, presents opportunities for the development of the construction industry in modern technological directions: BIM is used in the pioneer mode at the design and construction stages of pilot facilities. Considering the state policy of the Russian Federation of advanced import substitution and entry into the international market with its own digital technologies, it is obvious that the testing of domestic software in the renovation of capital construction facilities is considered as an opportunity to improve domestic software and form a new technological landscape of the country's construction industry [7].

Methods

The authors of the article implemented a research project on the pilot application of BIM at the construction stage of an apartment building included in the Renovation Program. As part of the study, organizational and technological processes of construction project management have been tested, modernized due to digitalization. The processes are integrated into a single information space deployed in a common data environment (CDE). The implementation of processes requires new competencies in the application of information modeling technologies.

A significant number of participants are involved in the implementation of the investment and construction project, from the executive authorities coordinating the program to contractors performing design and construction and installation work directly. Within the framework of the Methodological Recommendations, the focus is shifted to the functional role of the State Customer (Developer) and the functional roles of the Technical Customer and the Competence Center (Engineering Center) that arise either within the framework of the allocation of functional blocks in the organizational structure of the Developer, or when transferring such functions to specialized organizations involved. Considering the specifics of the topic, the consideration of processes is focused on these functional blocks and the transfer of information to higher levels – for the coordination and management of complex programs [6-8].

One of the tasks of the State Customer (Developer) is the sustainable functioning of economic activity. Sustainable functioning consists of the functioning of individual business processes, including basic and security ones. Let's consider a graphical representation of the previously highlighted processes using the example of a reference model of business processes (Figure 1). The reference model assumes the allocation of the main processes and security. In this case, the security processes are separated into a group and separated from the main business processes not by the criterion of importance, but by the criterion of an end-to-end functional role. The process is carried out throughout the life cycle of the investment and construction project. The group of main processes is formed based on functional roles implemented by the State Customer (Developer) at the stage of construction and installation works and partially related stages: the stage of preparation for entering the construction site and the stage of delivery of completed works and transfer of the object to the balance of the operating organization [9-11].

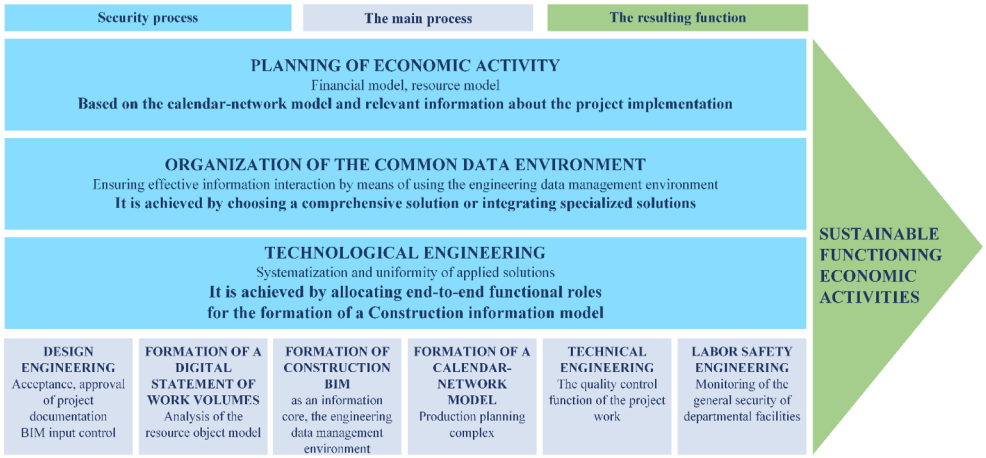

Fig. 1. Reference model of business processes as part of the investment and construction project management system

The practical experience of the pilot application of BIM at the construction stage of the capital construction facility establishes the need to revise the functional roles in the context of the organizational structure of the State Customer (Developer), the processes of interaction of departments, contractor organizations of the developer within the framework of joint work in a single information space [12,13].

In the study, the functional role is considered as an official duty of an engineering and technical employee of the department and contains the skills, abilities, knowledge, and experience necessary for the implementation of an investment and construction project at the construction stage [14-16]. The functions of the department consist of the functional roles of engineering and technical workers in accordance with the activities for the implementation of construction production. The description of functional roles in the implementation of innovations, including the introduction of information modeling technologies, is important for the subsequent distribution of roles between specific participants of an investment and construction project, as well as for the development of a training program, the development of existing employees and recruitment.

In the organizational structure of the developer, three enlarged blocks of structural divisions are involved in the implementation of the construction of the capital construction facility using information modeling technologies, distributed by type of activity: production, administrative and information technology block. The functions of the enlarged blocks of the developer are formed in accordance with the management of the investment and construction project [17-18].

When implementing the construction of an object using BIM, the following structural divisions of the developer are involved: information technology Department, contractor management department, logistics department, construction department, production and technical department. To aggregate the functions of the developer's departments, 4 types of functional roles of engineering and technical workers have been formed: Lost; Standard; Upgraded; Digital [19-20].

Results

Let's form definitions of functional roles according to the types. The lost functional role is an official duty performed by an employee before in manual mode, optimized by automating the processes of managing a construction project with the introduction of BIM.

Thus, the function is performed automatically and does not require labor. The standard functional role is an official duty performed by an employee in the usual mode, the introduction of information modeling technologies at the construction stage of the capital construction facility did not change the process of doing the work. A modernized functional role is an official duty performed by an employee through the use of information modeling technology tools. Digital functional role is a new functional role at the stage of construction of the capital construction facility, not performed before, the official duty is implemented by an employee using information modeling technologies.

We will consider in detail the implementation of functional roles in the context of the organizational structure of the developer in the process of applying information modeling technologies at the construction stage of the capital construction facility.

The Information Technology Department implements the upgraded functional roles of managing regulatory and reference information and quality characteristics of objects. The Information Technology Department carries out work on the development and management of the structure of the catalog of components of the building information model (BIM), the integration of existing information systems of the developer to form a unified accounting system for regulatory and reference information. As part of the implementation of digital functional roles, the Information Technology department develops, implements, and manages the developer's BIM standards to standardize the process of planning and managing the production of construction and installation works. To form a shared access to the use of digital data by the investment and construction project participants, the Information Technology department develops a shared data environment.

As a result of the department's refusal to automatically upload reports, the formation of reports on the work performed by the developer and contractors is attributed to the lost type of functional roles of all structural divisions of the developer.

The activities of the construction department that performs construction and installation work and laboratory tests during the construction of the construction objects belong to the standard type of functional roles. The function of the builder's construction control has been upgraded by registering identified defects during construction and installation works in the digital information model of the capital construction facility. The digital functional role includes the maintenance of a construction digital information model, as well as the use of laser scanning technologies to collect spatial data and create information models for the formation of digital counterparts of construction objects.

The functioning of the production and technical department (PTD) has been revised as much as possible, the functions of the department previously performed in manual mode have been assigned to a modernized type of functional roles. The introduction of electronic document management made it possible to modernize interaction with designers and maintaining documentation for the commissioning of the facility. Through the deployment of an integrated planning and management system for the construction of a PTD, calendar plans are developed and calendar and network planning is managed. The identification of actual deviations from the planned works, within the framework of the management of calendar and network planning, is carried out by regular visits to the construction site with the introduction of information into the construction building information model (CBIM). Monitoring of changes in the structure of regulatory and reference information is carried out by analyzing electronic applications for adjustments to the regulatory reference data. With the use of information modeling technologies, digital statements of procurement volumes are formed in relation to deadlines. As part of the implementation of the digital functional roles of the Production and Technical Department, the input control of the digital information model of the construction objects is performed, the CBIM is formed by combining the BIM and the calendar-network schedule.

Figure 2 shows the developed scheme of functional roles in the context of the organizational structure of the State Customer (Developer).

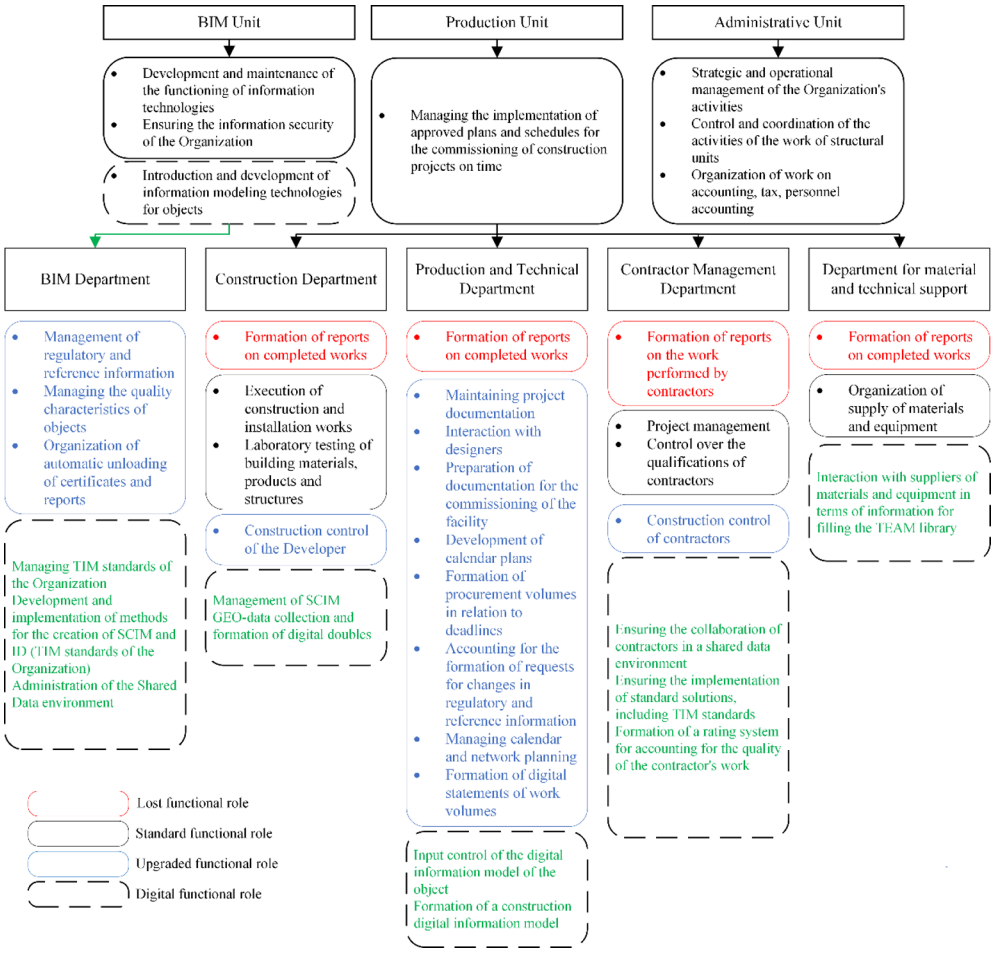

Fig. 1. Diagram of functional roles in the context of the organizational structure of the State Customer (Developer)

The Contractor Management Department performs the standard functional roles of project management, control over the qualifications of contractors. Conducting construction control of contractors refers to a modernized type of functional role. As part of the implementation of digital functional roles, the contractor management department organizes the joint work of contractors in CDE, as well as the introduction of BIM standards. Based on information modeling technologies, employees of the department monitor quantitative and qualitative indicators of the performance of work volumes to form a rating system for accounting for the quality of work of contractors.

The activities of the logistics department for the organization of the supply of materials and equipment are attributed to the standard type of functional role. The digital type of functional activity of the logistics department is carried out through interaction with suppliers of materials and equipment for filling the BIM library based on the formation of a structured catalog of building materials and equipment. The implementation of the digital

functional role requires constant communication with suppliers to form a digital base in conjunction with the specifications of materials and equipment.

Conclusion

The implementation of new functional roles by specialists who have the skills to work with information modeling technologies, computer-aided design systems, data analytics systems at the construction stage of the facility contributes to the intensification of the productivity of engineering and technical workers and transparency of the process of implementing the construction of the facility, as well as the further use of information models of capital construction facilities at the operational stage.

To date, the construction industry is experiencing a shortage of qualified specialists who possess digital competencies in the application of information modeling technologies at the construction stage. The shortage of qualified personnel requires the use of practice-oriented approaches to the organization of training of existing engineering and technical workers.

Acknowledgments

Currently, professional development programs are being implemented for employees of design organizations, but in addition to them, it is necessary to form educational courses for engineering and technical workers who organize construction and installation works. The implementation of advanced training programs, retraining of engineering and technical workers contributes in a short time to eliminate the shortage of specialists to cover the types of functional roles being upgraded at the construction complex facilities.

Along with these measures, it is advisable to form educational programs of higher education, including training programs for highly qualified personnel (postgraduate studies) together with the leaders of not only the construction industry, but also the information technology industry. There is a need for programs aimed at training complex specialists in the digitalization of construction production, able to meet the personnel need for the implementation of digital functional roles in organizations of the construction complex.

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