Innovation in the construction industry

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Abstract. The article analyzes the state of the construction industry in the modern Russian economy. The authors determined that construction products are the basis for the economic growth of the state, where the main condition is expanded reproduction, which is ensured through investment and the construction of new facilities and facilities. The main growth instruments for the development of the construction industry were government programs to support the construction of new housing, government support for mortgage programs in residential construction, and the launch of national infrastructure development projects in the regions. The most important role of automation and computerization systems, the latest measuring technology, automated control systems for technological processes in the implementation of technological processes in the construction industry is outlined. BIM technology is described that allows the creation of three-dimensional building models to represent the physical and functional properties of the project. The article presents the problems of the industry, which are solved with the help of innovative technologies, and lists the types of innovations in construction.

1. Introduction

The construction industry is a set of economic activities that form a complex economic system with stable organizational, economic, technical, production, technological and economic ties. In the construction industry, there are a large number of different organizations involved in the process of creating new objects and production facilities. All of them together form construction complex that is one of the most important sectors of the national economy. It combines various types of economic activity in the construction of buildings, production of building materials, products and structures, design and research in construction, etc. [1].

The construction market in Russia, despite the crisis in the economy in 2008-2009 and 2014-2016, resisted a complete collapse and ensured a positive trend in certain areas. After a noticeable decline in 2015-2016 and a slight increase in construction volumes in 2017, the 2018 became a record for the past few years. Rosstat in 2018 reported on a 5.4%, record growth in the volume of construction work in monetary terms over the past 10 years that reached 8.4 trillion rubles. The holding of the FIFA World Cup and the completion of most of the large and infrastructure facilities led to an increase in the pace of construction in 2018 [2]. In 2019, the commissioning of housing in January-May in Russia amounted to 24.1 million square meters, which is 2% more than the same period in 2018 [3]. Thus, the trend for an increase in construction volumes in Russia for the coming years continues.

The main growth drivers for the development of the construction industry were government programs to support the construction of new housing, government support for mortgage programs in the field of residential construction, and the launch of national infrastructure development projects in...
the regions [4]. However, this construction boom led to an increase in the number of construction companies of various sizes and specializations in the construction industry and subsequent high competition among them. Therefore, construction companies need to take measures to reduce the cost of work and improve the quality of services, which necessitates the introduction of various innovative technologies and technological solutions in construction and related industries.

2. Application of information technology in the construction industry

Technological processes in the construction industry at present cannot be implemented without automation and computerization systems that help to manage, measure and monitor the main technological parameters of construction processes and their deviations [4]. The reduction in the cost of microprocessor devices and automated systems, a significant expansion of their functions made it possible to create "smart sensors" that help to calculate the values of indirect parameters on the basis of direct measurements according to programmed formulas, show the parameter values on liquid crystal indicators, and convert the measured parameters into unified signals for their transmission through communication channels. Also, new measuring instruments have been developed, such as electromagnetic, ultrasonic, Coriolis flow meters, ultrasonic and radar level meters, etc. that facilitate construction process [5].

In addition to the automation of individual measuring instruments and equipment for the management and control of construction processes, construction enterprises are now also using automated process control systems (APCS). Innovations in the construction industry are associated with the introduction of automated information systems in the field of construction management at all stages of the life cycle of a construction project, the use of innovative materials and technologies in construction; and implementation of innovations in investment management and marketing in the implementation of construction projects.

Building Information Modeling (BIM) technology is an exemplary promising approach in the field of computerization of the construction industry. It involves the creation of three-dimensional construction models to represent the physical and functional properties of the project. Recent studies of the BIM potential for increasing the efficiency of building operation, as well as the barriers impeding its use, have shown that the potential of BIM arises due to the improvement of currently existing manual information transfer processes, for example, as-built documentation. It was noted that the technology also improves data accuracy and increases operational efficiency in terms of speed of access to property data [6]. BIM in property management is the process of generating and managing information about a building throughout its life cycle. For example, the UK government, as one of the leading countries in the use of BIM technologies, has authorized the use of BIM models for all public buildings since 2016, including the transfer of digital data required for the building operation phase [6].

Currently, one of the most important trends in the modern construction industry is the use of innovative technologies, environmentally friendly materials, energy-saving materials, information technology and automated equipment in home improvement. And although the Russian market lags significantly behind Western countries in its tendencies, nevertheless, new interesting solutions in the field of construction technologies are also being introduced in Russia.

3. Innovation in the construction industry

Currently, one of the most important trends in the modern construction industry is the use of innovative technologies, environmentally friendly materials, energy-saving materials, information technology and automated equipment in home improvement [7]. Innovative solutions in the construction industry can be divided into several groups depending on which problems of the construction industry are being addressed by innovations and technological developments (Table 1).

| Areas of innovation | Industry Problems Solved |
|---------------------|--------------------------|

Table 1. Problems to be solved in the construction industry through innovation.
Implementation of automated information systems

The introduction of automated information systems in the field of construction work management at all stages of the life cycle of a construction project can solve the following industry problems:
- increasing the efficiency of management of construction objects;
- improving the quality of modeling and design of construction objects;
- increasing the visibility of the design of architectural projects.

Application of innovative materials

The use of new materials in construction allows us to solve the following problems of the industry:
- reduction in the cost of construction;
- improving the quality of construction;
- the use of energy-saving materials to improve the energy saving of real estate objects.

Using advanced technologies for construction

The use of advanced technologies for the construction of real estate objects allows:
- to reduce the cost of construction by reducing manual labor and increasing the mechanization of construction;
- improving the quality of construction;
- application of energy-saving technologies and energy-efficient solutions.

Thus, we highlighted the use of such innovative areas as the introduction of automated systems, the use of innovative materials and the use of advanced technologies for construction to solve problems in the construction industry. We can also categorize such innovations in the construction industry as organizational, marketing, technological and environmental [8] (Table 2).

**Table 2. Types of innovations in the construction industry.**

| Types of innovation | Characteristics |
|---------------------|-----------------|
| Organizational      | The use of new forms of organization of construction work, organization of jobs, new methods in the work of the management apparatus, changes in the organizational structure, management changes, etc. [9] |
| Marketing           | New methods of marketing research, new marketing strategies for reaching out and developing target segments, the introduction of new pricing strategies, a change in the organization's promotion policy, new forms and means of communication policy, new market segmentation strategies, the choice of methods to stimulate sales and attract consumers [10] |
| Technological       | The use of the latest models of machinery and equipment, the use of new building materials, the introduction of new effective building technologies, the introduction of new solutions in planning and architecture, taking into account the latest requirements for heat engineering [10] |
| Environmental       | Energy efficient, energy saving, and resource saving technologies. |
Technological innovation also includes the Dincel Construction System technology, which was developed by Australian engineers. This technology uses rigid fire-fighting polymer profiles that have hollow honeycombs filled with concrete. The material is not limited in length and shape, so columns of any height can be formed. These profiles are manufactured at the factories of the construction object itself. This technology is applicable for the southern regions of Russia in the construction of low-rise housing [8].

The real estate construction has also several trends and innovative technologies that include Panel-frame technology, prefabrication, energy efficient solutions, green building, green buildings, and smart home technology (Table 3).

Table 3. Characteristics of new trends and innovations in real estate construction.

| Real estate innovation                  | Characteristic                                                                                                                                 |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Panel-frame technology                 | The popularity of this technology in the world is associated with the good thermal insulation and moisture resistant qualities of the materials used. At the same time, the costs of heat energy are 3-4 times less than in houses built using traditional technologies |
| Prefabrication                         | This is the technology by which modules are produced, which are then, like a designer, assembled directly at the construction site. With its help, facade panels, pre-assembled engineering systems, some structural elements, etc. are manufactured. |
| Energy efficient solutions             | They involve innovative technical solutions in the field of thermal insulation of enclosing structures, the use of new glass and double-glazed windows with energy-saving technologies, the use of motion sensors, energy-saving lamps. This is the practice of construction and maintenance of buildings, the purpose of which is to reduce the consumption of energy and material resources throughout the entire life cycle: from site selection to operation, repair and disposal. Another goal of green building is to maintain or improve the quality of buildings and the comfort of the indoor environment. |
| Green building, green buildings        | The intelligent system "Smart Home" is a high-tech system that allows you to combine all communications into one and put it under the control of artificial intelligence, programmable and customizable for all the needs and wishes of the owner. |
| Smart home technology                  | Houses utilize the latest developments in ecological construction, fully provide themselves with energy, and do not depend on external sources. During the construction of an active house, the following technologies are used: a facade capable of independently changing its configuration (opens and closes) depending on the needs of residents and weather conditions; the use of "smart" ventilation based on air recuperation; solar panels on the roof; use of natural light; the use of |
Panel-frame construction can be distinguished among technological innovations [11]. This technology has been used in Europe for a long time, but in Russia it has been introduced relatively recently. The main advantage of this technology is the use of special sandwich panels with a multi-layer structure. All stages of production are automated, which helps to minimize errors in calculations and save materials.

Innovative activity in the construction industry helps to solve the housing problem and has a positive impact on the development of the economy as a whole. But unfortunately, Russian enterprises use mainly such innovations that can save money and shorten construction time. The main purpose of the application of innovations in foreign companies is considered to be the improvement of living standards, comfortable living along with functionality and resource conservation [8]. Therefore, the state, in addition to participating in programs to support the construction of new housing and mortgage programs, needs to pay attention to innovative activities in this industry.

4. Conclusions

Thus, high competition in the field of construction, an increase in the number of construction companies of various sizes and specializations determine the need to reduce the cost of construction and installation work and improve the quality of construction, which makes it possible to implement various innovative solutions. Innovations in the construction sector are associated with the introduction of automated information systems in the field of construction management at all stages of the life cycle of a construction project, the use of innovative energy-efficient materials and technologies in construction, and the introduction of innovations in the implementation of construction projects.

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