Main aspects of innovation development of the construction industry

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Abstract. The paper analyzes main aspects of innovation development of the construction industry. The study revealed the relevance of the issue under consideration, studied works dealing with this issue, analyzed the concept “innovation in the construction industry”, identified main requirements to innovation activities in the construction industry, types of innovation activities in the construction industry, examined examples, identified factors hindering development of innovation in the construction industry and suggested measures for their elimination. One of the manifestations of progressive development of technical civilization is improvement of the construction technology, changes in construction processes. In current conditions, it is important to determine the strategy for increasing qualitative and quantitative indicators of the construction industry based on the accurate development forecast which will be probabilistic in nature. In Russia, the modern construction site is significantly different from the one which existed two or three decades ago. It can be argued that the technology of civil construction has changed over the last twenty years.

1. Introduction

The construction industry as one of the largest sectors of the economy should develop. The main tool for developing the construction industry is innovative activities of construction companies. Today, this issue is studied by a large number of researchers. For example, A.A. Solovey identified and analyzed features of innovation activities in the construction industry [3]. A. V. Dergunova described innovation activities in the capital construction industry, and A. Dotdueva determined the level of development of innovation activities in the construction industry [1].

2. Materials and methods

In the course of studying this issue, the main aspects of innovation activity in the development sphere were considered. Methods for studying theoretical material are the study and synthesis of material, analysis and synthesis. These research methods allow conducting a study of the collected facts, to develop concepts and judgments, to draw conclusions and theoretical generalizations of this study, namely, to analyze the main aspects of innovation activity in the historical field. Identify problems and prospects for the development of innovative activities in the developmental sphere.
3. Results

Innovative technologies and materials used in the construction industry have to meet the following criteria [4]:

- Simplified construction process;
- Reduced construction time;
- Reduced construction costs;
- Increasing energy efficiency of the facility;
- Improving life cycle of buildings and structures.

The main types of innovation used in the construction industry are as follows [9]:

- Technology. The use of new construction technologies increasing the level of labor productivity and reduce construction time.
- Material. The use of new construction materials with improved performance and consumer qualities.
- Environment. The construction of resource-saving buildings, and the use of environment-friendly construction, heat-insulating, and finishing materials.

Thus, construction innovations are used at all stages of the production process. The following innovations are the most widespread in the construction industry [6]:

![Innovations most common in the construction industry](image)

**Figure 1.** Innovations most common in the construction industry.

At the macro level, innovative activities in the construction industry have the following positive results [8]:

- Increased level of construction efficiency;
- Improved quality of construction;
- Resource saving;
- Reduced cost of building maintenance.

In addition, innovation processes carried out by construction companies solve social problems by providing citizens with quality houses. To date, the construction sector is characterized by a low level of innovation development [7].

The main factors hindering innovation development in the construction industry are as follows:
Figure 2. The main factors hindering innovation development in the construction industry.

The measures for eliminating the above-mentioned obstacles to innovation development in the construction industry are as follows:

- Organization of competitions and programs aimed at the implementation of government financial support;
- Cooperation of construction research centers with foreign partners;
- Development of government support for small businesses;
- Organization of exhibitions and other events in order to familiarize customers with innovative products;
- Development of leasing relations [2].

The scale of housing construction, construction materials used, the quality of housing, the environmental safety and maintenance costs depend on new technologies. To this end, it is advisable to substantiate implementation of innovative technologies in the national and regional housing construction development strategies in the following areas [1]:

- building materials and technologies;
- architecture and urban planning;
- construction machinery and equipment;
- highways and road facilities;
- engineering networks and equipment;
- ecology and safety in construction.

The division is based on the experience of foreign countries. At the same time, it can be applied in Russia. A number of construction organizations are mastering new technologies aimed at reducing the cost of housing construction. For example, monolith-frame houses whose internal walls are built of reinforced concrete, while external ones are built of brick can be constructed. To facilitate the task, it is necessary to develop domestic production of high-quality building materials on an innovative basis. To this end, it is important to study foreign experience in order to apply it in Russia. Of course, it is not sufficient for the “building materials and technologies” area [9].

It is necessary to identify what innovative materials can be used for building structures, what technologies can be used for producing construction materials, what methods can be used for building structures and engineering networks. It is necessary to characterize the technical support of installation works, monitoring of construction parameters of buildings and structures during the installation, to
reveal features of the technological process planning, to describe technologies used for construction and installation works.

It is desirable to highlight design and calculation features, describe new design solutions for structures made of metal reinforced concrete, wood and plastics, determine regulatory loads and impacts on the structures, analyze experimental studies on construction, justify features of operation and reconstruction of buildings, structures and engineering networks and reliability of building structures, etc. Unfortunately, the process of innovation implementation into the “building materials and technologies” area is very slow.

As a result, about 30% of construction materials used are produced in Russia, while 70% of materials are produced abroad [5].

The “architecture and urban planning” area is of special importance, because it is possible and necessary to highlight architectural and artistic solutions for urban development, use of underground space and disturbed territories, ecological basis for development of the living environment, landscape architecture. It is extremely important to identify approaches and measures aimed at improving living standards, public transportation and urban spaces. Renovation solutions can improve this area. The housing renovation program developed in Moscow aims to resettle dilapidated low-rise houses constructed in 1957-1968 and construct new ones. Reconstruction of these neighborhoods will improve the quality of housing and environment and reduce social tension [3].

As for the “Construction machinery and equipment” area, it is important to consider samples of innovative construction machines, features of operation of construction equipment and monitor the construction machine health.

The “Roads and road structures” area involves development of innovative materials for road surfaces, development of modern design and calculation approaches, new design solutions for bridges, tunnels, road overpasses, etc., and innovative technologies for building road structures.

As part of the “engineering networks and equipment” area, innovative approaches to the design of drainage systems, heating, ventilation and air conditioning systems should be developed. New technologies for treatment and disposal of sewage sludge, flue gas cleaning technologies, energy-saving technologies used for wastewater and flue gas treatment have to be developed. This area also involves the designing of efficient thermal installations, diagnostics and forecasting of the health of engineering networks, improvement of the reliability of engineering networks [15].

4. Discussion

The ”ecology and safety” area aims at developing methods for assessing the degree of environmental pollution caused by man-made factors and energy-saving technologies; studying features of labor protection and improving the efficiency of the OSH management system. It is necessary to improve the efficiency of engineering systems using individual heating points and modern equipment produced in Russia, electric heating equipment (instead of gas one) regulated by construction standards and rules, heat pumps in heating systems, solar water heating systems in the southern regions. It is necessary to develop these systems in other regions using the latest solar technologies. According to experts, an extremely promising technology for rapid construction of energy-efficient buildings is the Thermod technology using thermal blocks [14].

This technology is similar to the monolithic construction method involving the use of a concrete-containing mixture poured into the formwork which shapes monolithic concrete or reinforced concrete structures. However, according to the Thermodom method, the formwork is not removed. It remains in the wall and performs heating sound-and water-proofing functions. The main advantage of this formwork is that the wall is a multi-layered protective structure resistant to heat transfer and constructed during one technological cycle. Thus, we can conclude that new housing construction technologies should be implemented in the following areas: building materials and technologies;
architecture and urban planning; construction machinery and equipment; highways and road structures; engineering networks and equipment; ecology and safety.

It is necessary to apply the experience of both domestic and foreign construction companies. New technologies can reduce construction time, costs, improve the environment through the use of environmentally friendly building materials, i.e., it is necessary to abandon traditional materials (asbestos, toxic types of plastics, some brands of concrete, etc.). New housing construction technologies will contribute to the quality of houses, make houses cheaper, and have a positive impact on the living standards and comfort of citizens [11].

Innovation enterprises need significant investment funds. Innovation and investment are interrelated in current manufacturing processes regardless of business scales. Investment in innovation activities aims to introduce new technology in company activities. However, it is necessary to understand that project profitability should be a priority. There are two investment purposes: purchasing of innovation products, licenses, patents; development of innovation products. Unfortunately, the investment structure is homogenous enough and depends on its raw material component. In developed countries, innovation activities are funded by public and private organizations.

Currently, there are the following funding sources for innovation activities:

- 1) federal and regional budget funds;
- 2) special non-budgetary funds;
- 3) owned funds of enterprises;
- 4) debt funds of financial and commercial organizations (investment funds, commercial banks, insurance companies, etc.);
- 5) conversion loans of research and manufacturing defense enterprises;
- 6) foreign investment funds;
- 7) national and foreign research funds.

Figure 3. Funding sources for innovation activities.

5. Conclusion

In modern conditions, it is important to determine the strategy for improving qualitative and quantitative parameters of the construction industry based on the reliable forecast of the construction industry development. This forecast will be probabilistic in nature. The degree of its reliability depends on the accuracy of selected spheres and their probabilistic states. For capital construction, the basic areas are needs of customers supported by financial resources and construction technologies based on improved materials. The modern construction site is significantly different from the one which existed two or three decades ago. It can be argued that Russian housing construction technologies have changed over the past twenty years.

Foreign earth-moving, road-building and lifting equipment, power tools, more advanced hand tools and devices are used in the Russian construction industry. They significantly improve the quality and accelerate construction and finishing works [12]. Inventory cabins change living conditions of
builders. Overalls and personal protective equipment are changing as well. Designing and development projects and technological maps are based on software products. Construction engineers and foremen use information technologies. Free access to the Internet allows engineers and workers to get information about new building technologies and use them in practice. The combination of these innovations has a significant synergistic effect on the construction industry providing favorable prerequisites for further technological development. At the same time, there are some dangers of progressive development in the domestic construction industry: intensive development of civil construction using simplified construction technologies; prevalence of foreign machinery and equipment (up to 70%); a significant share of foreign finishing materials (from 30% to 50%) [13]. These circumstances can constrain development of the housing construction industry, restrain its improvement based on the use of domestic scientific and technological products.

Thus, innovation activities in the construction industry are important for the national macroeconomics. Innovative products reduce production costs and increase the quality of building products and services.

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