Basic factors of modeling and optimization of technological processes of construction production

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Abstract. The article analyzes the main goals, objectives, directions of modeling and optimization of technological processes of construction production. The basic tasks and factors of organizational and technological modeling of construction industry, as well as their influence on the change in production volumes, labor productivity growth and the efficiency of construction enterprises have been determined. The main directions of optimization of technological processes of construction production are formulated based on the modernization and development of production and technological capabilities of construction enterprises.

1. Introduction
Construction can rightfully be considered one of the most important sectors of the national economy, since it creates not only buildings and structures for housing and civil purposes, but also the main production assets, in terms of their passive component, for all industries.

Consequently, it is necessary to intensify attention to the increase in production volumes, growth of labor productivity in enterprises of the construction industry. In the conditions of development of crisis phenomena, both in the national and global economy, there is an increase in competition in the market, which is explained by the increasing demands on the quality, safety and environmental friendliness of construction products, especially in housing construction.

Determination of basic tasks and factors of organizational and technological modeling of construction production will allow evaluating their impact on the change in production volumes, labor productivity growth and the efficiency of construction enterprises.

2. Study of factors of modeling and optimization of technological processes of construction production
The main goal of the organization of construction industry is the practical implementation of targeted organizational, technical and technological solutions aimed at ensuring that the construction of the facilities of the required quality has been commissioned on schedule. In addition, the construction company should strive to minimize production costs, incl. unproductive costs at all stages of construction, starting with pre-project preparation.

Achieving these goals is possible on the basis of modeling and optimization of construction production by improving the organization of production, since it represents the interconnection of all
technological processes of production of the final construction products in space and time, which, ultimately, allows optimizing types of resources and the duration of the construction of facilities and their complexes significantly.

The problems of compatibility (logical, methodological, informational, mathematical, etc.) subsystems of organizational and technological design with adjacent subsystems of architectural and construction design, construction of facilities and design of management decisions are actual in modern conditions. A distinctive feature of the construction process, in addition to a large number of parameters affecting its final cost, is the use of a large number of different types of resources and the ability to create various combinations of these resources in the form of rigid clusters of sequences. The totality of construction resources is presented in figure 1.

![Figure 1. The complex of construction resources.](image)

Construction is one of the most resource-intensive sectors of material production, which is confirmed by figure 1. Resources in construction production include both material resources and resources in the form of services, as well as animate resources in the form of labor force. The latter implies some degree of uncertainty in the meaning of key parameters affecting the cost of production.

There is a need to address a wide range of issues related to the automation of pre-production, which arise during the processing of design and estimate documentation (DED), the formation of promising and annual plans for construction and installation works (CIW), organization of logistics and equipment. The organization of interrelations of crews, mechanisms, vehicles and services ensuring the supply of structures, materials and semi-finished products is far from perfect.

Practice shows that modeling the work of construction enterprises in the use of resources is the most important factor influencing the increase in the pace of construction, productivity growth, commissioning of construction projects in a timely manner.

Objectively, the work of enterprises of the construction industry is significantly affected by the creation of an optimally constructed structure of interaction of resources that can ensure the flow of work. At the same time, the main negative factors counteracting the maintenance of the flow of
construction, installation and special works should include simple resources with a continuing need for these resources in the future, as well as an open front of work with a lack of resources, that is, to continue the production cycle which is currently unavailable for consumption.

Therefore, it is necessary to highlight the following factors when setting the basic tasks of organizational and technological modeling of construction industry:
– reduction of terms for implementation of a complex of works (or an indicator of deviation from the established deadlines for the objects to be delivered) under given resource constraints;
– optimization of indicators (in terms of quantity and quality, delivery, the size of production stock, etc.) of the use of resources for a given period of project implementation.

When modeling the construction industry, the following basic elements should be considered first:
– amount of work to be performed;
– terms of work;
– resource endowment.

In the process of optimizing schedules, it is necessary to remember all the elements of this triad and that in case of a change in one of its elements, the remaining two are transformed, either positively or negatively, depending on the specific project or construction conditions. In order to make sure that the identified changes will not become critical for the implementation of the project, the other two elements must also be assessed.

Properly developed work plan will ensure the growth of labor productivity by several times.

Research on this issue revealed the absence of a systematic approach to the integrated assessment of the level of organization of construction process, based on such parameters as continuity, uniformity, combination, rhythm and intensity. The results of the analysis create the prerequisites for automation and modeling of the work of enterprises for the construction of objects [4].

3. Directions of modeling and optimization of technological processes of construction production

The main goal is to minimize costs, shorten the construction of facilities, to provide consistent high-quality work, and, ultimately, maximize profits with any method of modeling in the preparation of construction plans.

Construction companies need to overcome technological and technical backwardness from their Western counterparts, which today makes usually 10–15 years in order to be competitive. So, according to the vice-president of the Association of Russian Builders, Dr. Sc. Vladimir Utkin, equipment depreciation in the building materials industry reaches 60–70%. And the further development of the industry, in his opinion, is impossible without large-scale modernization.

Most of the issues that are directly related, in particular, with new construction, ranging from the allocation and design of the land, obtaining engineering support and finishing the commissioning of the final product, are extremely and artificially difficult in modern conditions. This is another factor that significantly inhibits the development of not only the industry, but also the economy as a whole.

A serious problem is the non-observance of technology and construction rules due to low organization of construction processes.

Studies have shown that the majority of enterprises in the construction industry do not observe incentives, as well as the conditions and grounds for making any significant investments in research and development, in modernization, due to the lack of confidence in making a profit. Even if we assume that the costs will pay off in five years, then it is necessary to be sure that all five years will be provided with full capacity utilization. But today, in particular, in the conditions of Novgorod region there is no large-scale construction, not so many integrated development projects, and, as a result, there are no major contracts for such a long period and the real prospect is a maximum of 1.5 years.

Thus, all of the above factors cause a decrease not only in production volumes, but also in the quality of products.
In particular, current situation in housing construction and provision of citizens with housing is highlighted in the Summary Report on the results of monitoring the effectiveness of local government bodies in the city district and municipal districts of Novgorod region in 2017. Thus, in 2017, in the territory of the region, 1,151 houses (3,360 apartments) with a total area of 231.6 thousand square meters were built from all sources of financing, including 1,128 houses (1,128 apartments) with individual developers with a total area of 123.1 thousand m². Thus, the introduction of housing in the whole region amounted to 64.0% comparing with the year 2016 and to 85.4% for individual developers.

In 2017, the volume of work performed by the company “Stroitelstvo” in Veliky Novgorod was 8.9 billion rubles or 78.8% compared with 2016. In the reporting year, 34 residential buildings with a total area of 104.7 thousand square meters of residential space were commissioned, including 13 apartment buildings with an area of 100.3 thousand square meters, 21 individual houses with a total area of 4.3 thousand square meters. Introduction of housing per inhabitant for the year made 0.47 m².

Consequently, the primary task of optimization of technological processes and production on the basis of modernization, automation and development of the production potential of a construction enterprise operating under conditions of external instability can be called as one of the most significant problems of modern science.

The solution of the tasks can be carried out by forming a variety of strategies, which should be understood as a future-oriented system of measures, which, in turn, is aimed at ensuring the achievement of the identified specific strategic goals to achieve the required state of the enterprise's production potential. This means that it is vital to form and implement a strategy aimed at choosing the desired direction of activity from the variety of options for the development of production potential of a construction enterprise in the intended direction [2].

The following factors should be considered as the strategy of modernization and development of production and technological capabilities of construction enterprises:

– mobilization of resources to achieve strategic goals;
– definition of responsibility centers in the implementation of each goal;
– stimulation of the activities of the management and direct implementers on the basis of a constant analysis of the results of implementation of strategic goals.

The following can be singled out as the basic strategic goals of modernization and development of production and technological capabilities of construction enterprises:

1. Technical re-equipment and reconstruction of fixed production assets in terms of their active component, which will make it possible in the framework of simple reproduction to significantly increase the economic efficiency of functioning without expanding the staff, i.e. additional manpower, making the most of the available human resources.

2. Modernization of buildings and structures, which may be limited by redevelopment of internal premises, as well as by improving existing engineering systems, which will improve the consumer and operational qualities of buildings without rebuilding them and eliminate their functional wear.

3. Improvement of the organizational and management system of the construction enterprise, by optimizing the organizational structure, which will allow to balance the ratio of the managerial and the linear staff, eliminate problems in the relationship of links with each other, as well as reduce labor costs [3].

4. Increased attention to the development of personnel intelligence, improvement of professional and qualification level, guaranteeing the competitiveness demanded by markets, both of employees and the results of their labor (processes, technologies, products, systems), which will ensure the acceleration of the processes of modernization, automation and development of production and technological potential construction enterprise and increase their efficiency. The important principles for the formation of a new innovative approach to improving production management and personnel development should be effective measures to create: permanently trained organizations, sites specializing in innovative
production; healthy socio-psychological climate in groups; teams (specialists) working on the basis of personal plans for business and creative growth.

5. Formation of a system of criteria designed to assess the process of managing the modernization of the construction industry, which will allow for a continuous analysis of the results achieved and to determine further areas of activity, and, in addition, to identify and eliminate shortcomings.

Under existing conditions, the replacement of obsolete capacities and maximum reduction of the influence of the human factor are considered as the most effective way to increase the level of competitiveness of an enterprise in the domestic market. Accurate, comprehensive or complete modernization of production of a building enterprise is accompanied by indisputable advantages that shape the relevance of introduction of high-tech equipment and automated systems into technological processes:

– Improving the performance of existing capacity;
– Improving the quality control of construction, installation and special works, as well as the quality of final products of the construction industry;
– Phased control of technological processes in automatic, manual, adjustment, or semi-automatic modes;
– Economical use of electricity and consumables;
– High precision dosing of structural components;
– Reducing the cost of the enterprise, calculated on the payment of human resources;
– Improving working conditions.

Since the modernization and development of production and technological capabilities of construction enterprises should be carried out on the basis of an innovative approach with maximum use of the achievements of STP, it is quite obvious that the role of the individual should be increased, both of individual performers - ordinary employees of the enterprise and managers [4].

As the most significant reserve of managers of construction enterprises, measures can be identified to improve the methods of implementing personnel management, both in group and individual form, requiring them to more fully utilize all types of resources and create new working conditions and incentives [5].

As the analysis showed, the majority of enterprises in the construction industry do not pay enough attention to the problem of insufficient use of the potential of their labor resources. To change the situation it is necessary:

– to form a continuous education system at the enterprise;
– to ensure that targeted information is available to all interested parties on achievements in the development of modern techniques, technology and organization of construction, application of best practices at similar enterprises;
– to organize professional skill contests at the enterprise;
– to improve, or develop a system of qualification certification of personnel;
– to improve job descriptions for employees of the enterprise, taking into account the constantly changing conditions of production activities;
– to ensure the availability of visual information on the strategic goals of modernization and development of production and technological capabilities and the results of achieving these goals;
– to fix the procedure for the adoption, study, evaluation and implementation of scientific and technical ideas;
– to increase attention to interpersonal relations in the team and to clarify the need to help employees of the enterprise in improving working conditions, study, life, etc., which will increase their motivation to more efficient use of their labor and intellectual potential;
– to develop and implement an organization standard on enhancing the scientific, technical and socio-economic corporate culture;
to establish constant monitoring of the implementation of measures and business plans for innovative modernization of production.

Implementation of the above activities will allow a more complete and effective involvement in the modernization and development of production and technological capabilities of construction enterprises of such an important resource as human capital. It should be noted that this direction of modernization of the enterprise does not require any significant financial costs.

4. Impact of the planned measures for modeling and optimization of technological processes of construction production on the economic efficiency of the construction company

The growth of technical equipment and the improvement of working conditions that accompany the proposed form of renovation of construction production, contributes to the improvement of personnel skills, makes working professions more attractive, since the technical re-equipment of the production potential has not only technical but also social significance.

The effectiveness of the planned measures for the modeling and optimization of technological processes and production of a construction enterprise based on the modernization and development of production and technological capabilities can manifest itself in several forms:

– reducing the duration of construction,
– reducing labor costs or increasing productivity,
– saving material and energy costs, including saving in physical terms of metals, timber, cement.

In addition, this may include:
– cost reduction of construction and installation works,
– increase in capital productivity, acceleration of working capital turnover and other results
– increase in the quality of the end product of the construction industry.

The annual economic effect is calculated based on the difference in reduced costs for events whose implementation requires capital expenditures. Indicators of economic efficiency are determined in accordance with the instructions for determining the economic efficiency of use in the construction of new equipment, inventions and innovation proposals.

5. Conclusion

Modeling and optimization of technological processes of construction production allows not only to evaluate and analyze the future nature of the construction of the facility, to identify those features that may arise, but also to have a direct impact on the construction process of facilities or their complexes.

It is proposed to focus on modernization, automation and development of the production potential of a construction enterprise as the main direction of modeling and optimization of technological processes of construction production due to:

– technical re-equipment and reconstruction of fixed production assets in terms of their active component;
– modernization of buildings and structures, which may be limited by redevelopment of internal premises, as well as by improving existing engineering systems;
– improving the organizational and management system of the construction company, by optimizing the organizational structure;
– increasing attention to the development of personnel intelligence, improving professional and qualification level;
– formation of a system of criteria designed to assess the process of managing the modernization of the construction industry.

In particular, when modeling the organization of construction, it becomes possible to obtain information about the behavior of the proposed organizational system of construction in real conditions.
based on which apply the most optimal solutions at the design stage to minimize production costs, reduce construction time and, as a result, increase the economic efficiency of the construction company.

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