The Choice of Organizational and Technological Solutions Based on the Modeling Option

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Abstract. The construction industry in Russia, whose activity affects the economic development of the country's economy, is changing. This is expressed in the development of new laws, building codes, rules and relevant organizational and technological solutions at the level of construction production.

In this regard, construction production needs to improve organizational and technological solutions, taking into account modern regulatory requirements and production conditions. The selection of traditional methods for updating these decisions is an urgent task that requires proper research.

The analysis of organizational and technological decisions of the organization and technology of construction production showed that organizational models of construction production need to be refined and optimized in accordance with the new realities that the participants in the construction industry have encountered.

This primarily concerns construction organizations operating in conditions of destabilizing production factors.

Construction managers, including engineers and technicians, need to pay close attention to organizational and technological solutions at various stages of the implementation of an investment construction project, especially when drawing up a work schedule.

An important task when using the theory of experimental design is the selection of factors and the determination of their influence (values) during the experiment.

In this regard, the author conducted research to plan and conduct theoretical experiments based on the method of expert survey. Also, given the totality of factors that are random in nature and affect the result, the object for research described in the article (construction production) is considered in the form of a black box cybernetic system.

Research conducted by the author will allow:
- prevent the emergence of destabilizing factors in the construction industry;
- improve the effective functioning of the construction industry;
- elimination of the risk of construction in progress.

The final choice of organizational and technological solutions based on variant modeling using simulation and other methods will improve the quality of technical and economic indicators of both construction production and the investment project as a whole.

1. Introduction

Organizational and technological solutions (hereinafter referred to as OTS) are understood as a set of measures (organizational, technical, technological) aimed at achieving the final result - commissioning.
of buildings and structures for various purposes, in accordance with regulatory or directive deadlines and the required quality for construction, installation and finishing work.

The main organizational and technological solutions are developed before the start of design for construction production (see tab. 1). For this, it is necessary to obtain comprehensive information of a technical and other nature about the future construction project.

In connection with the difficult situation observed in the construction industry of the country, we can conclude that in most cases, the developed solutions and sets of measures that can be guided by were not effective enough.

Table 1. The choice of organizational and technological solutions for the construction industry.

| Source Data Analysis                        | The choice of possible technological and organizational methods for the construction of buildings and structures | Final decision choice based on variant comparison |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| 1. Geotechnical surveys                    | 1. Established methods                                                                                     | 1. Feasibility study of selected options           |
| 2. Climate research                        | 2. Progressive methods of erection of buildings and structures                                             | 2. Comparison of technical and economic indicators for the proposed options |
| 3. Production surveys                      | 3. The possibility of introducing new construction methods                                                  |                                                  |
| 4. Architectural and construction solutions |                                                                                                            |                                                  |

Despite the existence of certain stages in the selection of the options under consideration, difficulties arise with the adoption of rational organizational and technological solutions for the construction of buildings and structures for various purposes.

This is due, first of all, to a limited amount of variation and a low-objective approach to comparing the options used.

In this regard, the urgent issue is the identification of methods and relationships between production and the selection of appropriate OTS.

Each solution must meet the specified conditions by comparing options for the selected and specified criteria. It is worth noting that a large number of OTS is taken during the preparation of the work schedule (hereinafter-KPRR). KPPR for an object is a design and technology document that establishes the sequence and timing of work, the need for material and technical and labor resources, as well as the stages of financing with their fixing according to the stages and complexes of construction and installation works [1].

It is worth noting that construction production is a complex system that must be evaluated from the point of view of a system engineering approach. For this, it is necessary to consider the organization and the construction industry itself as a whole, and the structural units of the organization and resource requirements as separate elements of the system under study.

The organization of construction production at all stages of the life cycle of a construction object is characterized by complexity, the presence of a large number of interrelated internal and external factors (organizational, technological, labor, material and technical), prone to destabilizing factors.
The main factors, as can be seen from Figure 1, which arise during the implementation of a construction project are factors of an organizational and technological nature, material and technical, as well as factors that arise in the field of labor organization.

The system-technical approach to the organization of construction production is based on the universality of the principles of organization and development of complex systems. A common feature is the requirement of high organization, reliability, profitability, adaptability, flexibility, etc. The practical application of the systems approach has proved its uniqueness in many fields of science and technology.

The author’s analysis in the field of studying the principles of organization of construction production showed that the issues of assessing destabilizing factors are quite important, as they lead to the emergence of adverse situations and the corresponding risks of construction in progress. Therefore, the study of destabilizing factors and the actualization of OTS is an urgent task requiring proper research [2-4].

Also, according to the author, an important aspect in the study of qualitative indicators of construction production is the issue associated with the occurrence of destabilizing factors (hereinafter referred to as “DF”) and uncertainty at various stages of the implementation of construction projects.

Uncertainty in the construction industry is an event of which little is known, and if conditions arise that result in adverse consequences, the result of various events that can be predicted in advance based on statistics, observations, or an experimental assessment.

The priority task of the organization of construction production is to obtain the final product, characterized by reliability and quality. Each individual element of the construction production system directly affects the quality and reliability indicators throughout the entire life cycle of a construction project. Therefore, it is necessary to pay special attention to DF and uncertainty arising in the process of production activities that affect individual elements of the system [5-7].

Construction production consists of the following stages:
1. Preparatory period
2. Zero cycle
3. Work on the construction of the aerial part of the building
4. Commissioning.
Each stage includes various types of work, during the implementation of which DF and uncertainty may arise.

2. Methods

The most suitable, in our opinion, for assessing DF and OTS to minimize the occurrence of uncertainty is the expert survey method (expert estimation method). This method is based on collecting assessments of qualified specialists with sufficient production experience and professional knowledge in the field of activity to be evaluated. The expert assessment method has undeniable advantages, since it allows you to collect information remotely, for example:

- via the Internet (speed of obtaining the necessary information);
- provides a high level of standardization (since all respondents are asked the same questions);
- Provides the opportunity to conduct a thorough analysis using consistent clarifying questions.

At the initial stage, it is necessary to form the composition of the expert group. To obtain the most reliable result, it is necessary to select the optimal number of experts. For this we use the well-known formula (1). Such an assessment of DF and, accordingly, OTS is necessary at the stage of design, development and timely adoption of OTS in order to minimize the impact of the considered DF on the production process [8].

\[
E = \frac{h^2 r_a r_o}{\Delta^2},
\]

where \(E\) - the minimum required number of experts;
\(h\) is the confidence coefficient;
\(r_a\) - the proportion of the elements of the sample with the presence of this characteristic;
\(r_o\) - the proportion of the sample elements with the absence of this feature;
\(\Delta\) - the error of representativeness.

The experts were invited to fill out a table in accordance with which they assessed their knowledge in the field required for the survey on a given scale for assessing factors.

Based on information about knowledge in each field and taking into account the coefficient of the degree of influence of the source of argumentation on the expert’s opinion, the level of competence of respondents was determined.

Further, the experts were invited to evaluate the degree of influence of the uncertainties that arise at the initial stage of the construction project.

As a result of processing expert assessments, factors that are of the greatest importance for construction production and requiring a set of measures aimed at minimizing them were identified.

A survey was conducted in which the DF and uncertainties for each life cycle of a construction object were described [9-11]. To obtain reliable survey results, it is necessary to calculate the consistency of expert opinions and as a result of the calculations, a sufficient level of consistency was obtained. As a result, the survey results were classified on a scale.

**Figure 2.** Scale of estimation of uncertainty factors.

| Average score factor | Uncertainty factor description                          |
|----------------------|--------------------------------------------------------|
| [-1; 0]              | the uncertainty factor does not arise in the construction industry; |
| [0; 0.5]             | the probability of an uncertainty factor in construction production is less than 10%; |
| [0.5; 0.7]           | the probability of occurrence of the uncertainty factor is approximately 25%; |
| [0.7; 1]             | the probability of occurrence of the uncertainty factor is approximately 50%; |
| [1; 1.5]             | the probability of occurrence of the uncertainty factor is approximately 75%; |
- [1.5; 2] - the probability of the occurrence of the uncertainty factor is close to 100%.

In the face of uncertainty, the most rational is the comprehensive model of the organization of construction production, which allows you to evaluate DF and contribute to the development of OTS with further research to evaluate the developed OTS [12].

In the theory of experimental design, the region of vector space is represented by a combination of factors that are random in nature and significantly affect the object under study. The object of research in this case is the construction industry, considered in the form of a black box cybernetic system (Fig. 3).

![Figure 3](image)

**Figure 3.** The scheme of the object of study is the production capacity of the enterprise in the form of a black box cybernetic system.

"The arrows on the right in the figure depict the numerical characteristics of the research objectives - optimization parameters $y_j$. With one output parameter, as a rule, the problem has a solution and it is possible to find it by various methods. The arrows on the left show the effects on the “black box” (the object of the study is construction production) - factors (inputs of the “black box”, variable variables) $x_i$. A fixed set of factor levels determines one of the possible black box states. All possible sets of states determine the full set of the output parameter, from which the optimal value of the optimized parameter and the set of factor levels corresponding to it can be selected."

Optimization parameters associated with factors influencing the object can be expressed by the following equation (2):

$$ y = \varphi(x_1, x_2, ..., x_n) $$

(2)

"When planning a physical experiment and when searching for optimal conditions, it is desirable that the mathematical model (MM) be expressed by a fairly simple equation while maintaining the adequacy of the object."

Optimization is understood as the process of finding the maximum or minimum of the goal function (optimization parameter) (3):

$$ Y(x_1, x_2, ..., x_n) $$

(3)

provided that the image point in the space of variable factors $X (x_1, x_2, ..., x_n)$ belongs to the admissible set $D_x$, which is determined by the set of inequalities (4):

$$ H_i(x_1, x_2, ..., x_n) $$

(4)

where $H_i$ is a certain function of factors $x_1, x_2, ..., x_n$, imposing restrictions on the maximum permissible values of some of them.
Since the statement of the problem begins with determining the purpose of the experiment, when planning the experiment, it is necessary to determine the optimization parameter, that is, the characteristic of the goal, defined quantitatively.

An important task when using the theory of experimental design is the selection of factors including destabilizing ones and the determination of their influence (values determined using the expert method) during the experiment.

3. Conclusion

In addition to the main tasks of organizing construction production under conditions of destabilizing factors and uncertainty, there are additional tasks to stabilize the construction production by minimizing the occurrence of DF and uncertainty by developing organizational and technological solutions.

Thus, an integrated model was formed using various methods to optimize the organization of construction production. Using this model, it is possible to analyze and evaluate the DF, uncertainty and OTS at the stage of development of the work schedule. The model provides for a whole range of measures aimed at improving the quality of production activities and technical and economic indicators of the investment construction project.

In further studies, the approach described in the article can be used in a comprehensive methodology for developing new and improving existing organizational and technological solutions under the conditions of destabilizing factors and uncertainties arising at the stage of construction production in order to eliminate the risk of construction in progress.

References

[1] Dokuchaev A V 2008 Algorithms and software for tasks of scheduling production in conditions of uncertainty Review of applied and industrial mathematics 2 pp 288-289
[2] Sukhina N Yu, Leshova Yu V, Primakova V O 2016 Management of a Company’s Financial Sustainability in the Context of a Financial Crisis A collection of articles of international research-to-practice conference Scientific Research and Development in the Globalization Era
[3] Lapidus A, Abramov I 2018 Studying the methods for determining and maintaining sustainability of a construction firm MATEC Web of Conference 251 05017 https://doi.org/10.1051/matecconf/201825105017 IPICSE-2018
[4] Abramov I 2018 Systemic Integrated and Dynamic Approach as a Basis for Ensuring Sustainable Operation of a Construction Company IOP Conference Series: Materials Science and Engineering vol 463 Part 2 463 032038 https://doi.org/10.1088/1757-899X/463/3/032038
[5] Lapidus A, Abramov I 2019 Systemic integrated approach to evaluating the resource potential of a construction company as a bidder IOP Conf. Ser.: Mater. Sci. Eng. 603 052079
[6] Abramov I L 2019 Systemic integrated method as the basis for high-quality planning of construction production IOP Conf. Ser.: Mater. Sci. Eng. 603 052077
[7] Lapidus A, Abramov I 2018 Implementing large-scale construction projects through application of the systematic and integrated method. XXIst international scientific conference on advanced in civil engineering: construction - the formation of living environment "IOP Conference Series: Materials Science and Engineering" Institute of Physics Publishing p 062002
[8] Zhadanovsky B, Sinenko S 2018 The methodic for calculation for the need of basic construction machines on construction site when developing organizational and technological documentation E3S Web of Conferences Ser. "High-Rise Construction HRC 2017" p 03077
[9] Oleinik P, Kuzmina T 2017 Modeling the reduction of project making duration MATEC Web of Conferences p 00129
[10] Oleynik P, Sinenko S, Zhadanovsky B, Brodsky V, Kuzhin M 2016 Construction of a complex object MATEC Web of Conferences 5 Ser. "5th International Scientific Conference" Integration, Partnership and Innovation in Construction Science and Education " IPICSE 2016" p 04059
[11] Kazaryan R, Pogodin D, Shatrova A 2019 Aspects of scheduling processes and results of the
reorganization of projects in high-rise construction objects E3S Web of Conferences 97 04002
https://doi.org/10.1051/e3sconf/20199704002

[12] Shatrova A I 2018 Organizational and technological solutions to improve the efficiency of
strategic planning of construction production Science and business: ways of development 12(90)
pp 29-32