To the Question of the Choice and Evaluation of Organizational and Technological Decisions in the Construction Production

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Abstract. At present, the diversity of organizational and technological solutions used, the variety of tasks, and dynamism directly characterize the process of building buildings and structures. The main problem in the construction of buildings and structures is the choice of the most optimal solutions from the point of view of the organization and technology of construction production. To this end, it is necessary to timely improve existing or develop new organizational and technological solutions. The article discusses the main programs for building linear models of calendar plans (to evaluate OTD, you need to decide on the method and method of measuring them). The authors chose a method of expert assessments, conducted a survey and ranking decisions. For an objective assessment of the OTD, it is necessary to be able to feedback the final result with the indicators, which, for example, are formed in the process of developing or adjusting the work schedule. According to the theory of management, construction production is considered effective if in the considered situations the interests of all construction participants are respected, and the possible consequences of the uncertainty of construction production are eliminated by making effective organizational and technological decisions. The adoption of organizational and technological solutions will ensure the achievement of maximum efficiency of the functioning of construction enterprises through the adaptation of production activities to the destabilizing factors of production. To do this, the authors using the method of expert evaluation ranked OTD.

1. Introduction

To increase the competitiveness of the construction company, it is necessary to pay attention to organizational and technological solutions, both at the preparation stage and during construction. This will prevent losses, increase the effective functioning of the construction company in the market, strengthen its business reputation.

Organizational and technological solutions (OTD) are understood as a set of measures (organizational, technical, technological) aimed at achieving the final result - putting the facility into operation in accordance with the established deadlines and the required quality.
Table 1

| 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 options under consideration, difficulties arise in making rational organizational and technological decisions on the erection of buildings and structures. This is due, primarily, to the limited number of variances and the low-objective approach to the comparison of the options used.

In this regard, the issue of identifying the relationship between production and the choice of organizational and technological solutions for the construction of buildings and structures is relevant.

Each solution must meet the specified conditions by comparing the options for the selected criteria. A large number of OTD is accepted during the development of the work schedule (hereinafter - the KPRP). KPRP on the object is a design and technological document that establishes the sequence and deadlines for the work, the need for labor resources and construction machines with their fixation in stages and work packages.

Consider the basic program for building linear models of calendar plans [1].

Open Plan Professional is a professional program with powerful tools for material, technical, labor and financial planning. It offers solutions for managing large-scale investment projects. It is worth noting that this program allows you to simulate possible risks, calculate their probability and consequences [2].

Microsoft Office Project is one of the most popular software systems, allowing to dynamically simulate the use of material and labor resources and make adjustments in parallel with the construction of the facility or objects. Its relationship with other programs, such as Microsoft Excel or Outlook, is the ability to convert and interconnect goals, tasks and required resources into descriptive schedules, which is much more convenient compared to other software packages [3].

Primavera Project Planner and Microsoft Enterprise Project Management are used to manage projects in large construction companies and have a common database that allows you to interconnect projects with each other, both in time and in resources consumed. An important advantage of this comprehensive program is the operational organization of workflow at various levels of organizational structures of an enterprise [4-6].

The widespread use of linear models in the organization of work complexes due to their clarity, a clear correlation of work to time, as well as simplicity of the image. Interpretation of the calendar plan in the form of a linear model is very convenient for servicing and coordinating the timing and duration of individual work at various levels by all participants in the process. In addition, on the basis of the linear work production schedule, the need for material, labor and technical resources for each type of work is made. This allows at any time to determine and predict the need for resources necessary for the production of works [7].

With the help of linear schedules, it is possible to visually display an unambiguous relationship and sequence of work. However, with complex dependencies between works, such graphs are ineffective.
As follows from the analysis of existing models, they should have the following characteristics: complexity, accessibility, versatility and variability.

The accessibility characteristic is determined by the desire of the company's management to create conditions under which specialists of any level could understand the content of the model, and the process engineer, the manager would think in categories and model parameters so that it could be formed, practically applied and timely adjusted in the dynamics of production situations in the construction of buildings and structures [8].

In order to achieve accessibility, the models produce enlargement of certain types of work (hereinafter referred to as “UVR”) performed by separate teams. Formation of water management should be carried out using the estimate documentation, which displays the types of work, volumes, performers, mechanization, cost. This information should serve as the basis for developing the OTD in order to carry out all further operations on modeling the process of building an investment construction object.

The characteristic of universality is due to the fact that the model allows to “play” various types of organization of construction and installation works, as well as a variety of features of these types.

Among the features of the types of work organization can be distinguished resource and organizational relationships between works; combining the performance of work on objects (at the beginning and at the end); maximum possibilities of saturation of the fronts with material and labor resources, as well as the minimum allowable values of the number of workers (links) that can be placed on the object (front of work) when performing specific processes; the complexity of the processes and the consideration of their changes in the partial performance of work by production participants, changes in the resource capacity (capacity) of units (brigades) in time [9-13].

Evaluation of the effectiveness of calendar work plans is carried out taking into account the following indicators: the duration of construction; uniformity and continuity of resource consumption (material, labor, financial); cost of construction and installation work; labor productivity of workers. These criteria depend on the qualitative adoption of organizational and technological decisions. To evaluate the OTD, you need to decide on the method and method of their measurement. Some data processing methods are justified because they are generally understood and available for use in practice and application in theoretical studies [14-16].

In the process of research, methods are analyzed that are most appropriate in the case of evaluating OTD:

1. Pareto Chart - a method that allows you to objectively present and identify the main factors that influence the object under study. This method ranks the factors according to the degree of significance of influence on the result.

To hang the effectiveness and clarity of the research conducted using the Pareto method, you should use the Ishikawa diagram, a diagram of causes and results that reflects the relationship between the quality indicator and the factors affecting it.

2. The causal diagram of Ishikawa - a method that allows you to identify the most significant factors affecting the adoption of OTD. These factors are depicted in a fishbone chart. Options for using this method are described in detail in the works of Yu.P. Adler "We have no samples in any way." In the commonly used variant, the factors under consideration are grouped according to the corresponding categories of OTD, for example, according to the principle of 4 blocks: technical, technological, organizational, economic.

3. The histogram is a bar chart that allows you to visually assess the distribution of statistical data collected for a certain period and grouped by frequency of falling into a predetermined interval in order to identify the causes and find rational options for OTD. The histogram shows how our data is distributed between the respective limits.

4. Chart scatter (dispersion). The method allows to determine the type and closeness of the relationship (correlation) of the two considered process parameters. The scatterplot shows the dependence of the received OTD (abscissa axis) on the values of the factors (ordinate axis).
5. Evaluation of the OTD relative to the goal. The method of calculating the indicator OTD relative to the goal includes the following steps:
   a) building a mathematical model based on the goal-setting carried out and indicating the target area on the basis of the constructed model;
   b) determining the organization's functioning parameters of a random nature, and setting their distribution laws with determining the specific values of the parameters of these laws;
   c) the calculation of the quantitative indicator OTD.

6. Monte Carlo methods (MMC) - a group of numerical methods for studying random processes. The essence of the Monte Carlo method is as follows: the process is modeled using a random variable generator. This is repeated many times, and then, based on the obtained random data, the probabilistic characteristics of the problem being solved are calculated.

Thus, the authors considered methods for evaluating OTD, which are quite effective tools.

2. Methods

Qualitative research methods allow to reveal the significance of certain factors of a phenomenon through the analysis of competent opinions. In the case of studying the impact of advanced organizational and technological solutions on construction production, there are no measurable physical parameters, objects that are inaccessible to perception, and large volumes of statistical data. This suggests that empirical, theoretical and quantitative methods are difficult to apply for this study.

Therefore, the authors of this article chose the method of expert evaluation as a research method. The results obtained during the expert survey are subject to mathematical analysis, during which the correctness of the collected data will be established by determining the degree of consistency of expert opinions on the Kolmogorov-Smirnov statistical criterion.

To determine the required number of experts who should take part in the study to create a representative volume of statistical data, we use the formula (1) given in the article by TE Musatova and D.O. Zhelikhovsky “Methods of forecasting the effectiveness of an innovative project based on expert assessments", published in the online journal “Modern problems of science and education” in 2015 [……]:

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

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.

As an analytical model of the study, the expression (1) will be used, the value of which is the final complex effectiveness of the application of this organizational and technological solution:

\[ f(V) = K \times \sum_{i=1}^{n} V_i = K \times (V_1 + V_2 + \ldots + V_n), \]  

where \( f(V) \) - the indicator of solution efficiency;
\( K \) - coefficient depending on the number of evaluation criteria;
\( V_i \) - the assessment of the given organizational and technological solution according to the criterion having the sequence number \( i \);
\( n \) - the number of evaluation criteria.

Based on equation (1), we calculate the final efficiency of the considered organizational and technological solutions. The model values for each of the criteria are also calculated as the arithmetic average of the expert survey data from the summary tables.

The authors chose the following solutions for digitalization of construction production as the object for research:
automated control systems (ACS);
the use of optical-electronic equipment (EEA);
use of cloud data to access project documentation (OD);
creation of volumetric models of building elements (Revit);
digital control systems for quality control (CUCC).

Table 2. Determination of the final effectiveness of the OTD.

| №  | Abbreviation | Labor Criterion | Erection speed criterion | The criterion of economic efficiency | The criterion for the duration of construction | FINAL EVALUATION EFFECTIVENESS |
|----|--------------|-----------------|--------------------------|-------------------------------------|-----------------------------------------------|-------------------------------|
| 1  | ACS          | 3.67            | 7.33                     | 4.33                                | 7.17                                          | 5.63                          |
| 2  | EEA          | 8.00            | 7.00                     | 5.50                                | 8.50                                          | 7.25                          |
| 3  | OD           | 6.17            | 7.17                     | 6.00                                | 5.67                                          | 6.25                          |
| 4  | Revit        | 5.17            | 6.33                     | 5.17                                | 6.67                                          | 5.83                          |
| 5  | CUCC         | 5.50            | 6.67                     | 8.17                                | 7.00                                          | 6.83                          |

As can be seen from the final estimated indicators table, 2, leading position among the considered organizational and technological solutions, gaining 7.25 points, took the technology, which implies the use of optical-electronic equipment on space satellites for conducting geodetic surveys at the beginning of construction.

The decisions taken should contribute to improving the efficiency, quality and manufacturability of finished construction products, and the most efficient use of the possibilities of production factors.

The main organizational and technological solutions (OTD) are developed before the very beginning of the design, they are required to obtain comprehensive technical information about the future construction project.

This is an important aspect in the design and future construction of hazardous, technically complex, unique facilities, which are characterized by the presence of networks of engineering and technical support - electricity, automation systems, sewage systems, the logistics component, etc.

Thus, the main idea of the article is to develop recommendations and proposals for assessing the adoption of the OTD, on which the achievement of the final results depends - commissioning facilities in accordance with established deadlines and quality requirements.

To reduce the negative impact of the risks of construction production, the authors will further develop organizational and technological solutions of a compensatory nature.

References
[1] Dokuchaev A V 2008 Algorithms and software tasks scheduling of production in conditions of uncertainty Review of Applied and Industrial Mathematics 2 pp 288-289
[2] Zhao R, Liu X 2007 WiCom 2007 pp 5312-5315
[3] Bolotin S A, Vikhrov A N, Gladiy N Ya 2006 Minimizing the speed of construction work in the Microsoft Office project management program News of higher educational institutions 6 pp 42-46
[4] Babenchuk S P 2011 Software for project management Collection of scientific papers SWORLD 1 pp 50-51
[5] Klimenko A B 2010 Some issues of software development planning Bulletin of the Adyghe State University Series 5: Economy 2 pp 151-158

[6] Voropaev V I, Gelrud Ya D 2014 Mathematical management models for the manager and the project management team (part 1) Project and program management 1 pp 62-71

[7] Sukhina N Yu, Leshova Yu V, Primakova V O 2016 Financial Crisis A research and development conference on Globalization Era

[8] 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

[9] Abramov I 2018 Systemic Integrated and Dynamic Approach for 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

[10] Lapidus A, Abramov I 2017 Formation of Production Structural Units within a Construction Company for High-Rise Development Projects HRC 2017 (HIGH-RISE CONSTRUCTION-2017) HRC 2017 E3S Web of Conferences 33 03066 https://doi.org/10.1051/e3sconf/20183303066

[11] Lapidus A, Abramov I 2018 Systemic Integrated Method for Assessing Factors Affecting Construction Timelines MATEC Web of Conferences vol 193 05033 https://doi.org/10.1051/matecconf/201819305033

[12] Volkov A, Shilova L 2016 Principles of formation of stability of construction projects Procedia engineering 153 pp 844-849

[13] Oleynik P, Sinenko S, Zhadanovsky B, Brodsky V, Kuzhin 2016 Construction of a complex object Matec Web of Conferences 5. Cep. "5th International Scientific Conference "Integration, Partnership and Innovation in Construction Science and Education" IPICSE 2016" p 04059

[14] Chulkov V, Maloyan G, Efimenko A, Kiselev A 2018 Organizational-technological solutions, risks and reliability of the preparatory period of the renovation of territories Advances in Intelligent Systems and Computing T 692 pp 367-375

[15] Abramov I L 2017 Formation of Integrated Structural Units using the High-Rise Construction Projects HRC 2017 (HIGH-RISE CONSTRUCTION-2017) E3S Web of Conferences 33 03075 https://doi.org/10.1051/e3sconf/20183303075

[16] Oleynik P P, Kuzmina T K 2017 Choice of rational decisions for reconstruction of textile industries News of higher educational institutions Technology of the textile industry 3(369) pp 11-16