

INNOVATIVE MODELS OF CHOICE AND SUBSTANTIATION OF ADOPTION OF OPTIMAL ORGANIZATIONAL-TECHNOLOGICAL DECISIONS OF CONSTRUCTION PRODUCTION

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Abstract

In this work, the scientifically based results of the implementation of construction logistics as a modern innovative platform for solving the organizational and technological problems of increasing the efficiency of the construction sector are displayed. The influence of the triad of construction processes (organizational, technological, economic solutions) and logistics measures on the complexity and cost of construction production, including the assessment of the economic feasibility of introducing additional capital investments, is determined. The substantiation of the theoretical and methodological direction based on the use of the tool "Construction Logistics" as a modern innovative platform for solving the organizational and technological problems of construction using a quasilinear optimization model is carried out.

The expediency of using the quasilinear optimization model, which considers the triad of construction processes in the form of organizational and technological measures, characterized by a set of basic parameters, is shown, in addition, each directly implemented organizational and technological event can be modified by the introduction of logistics measures, in the form of additional parameters, this will optimize the construction process, and contributes to the saving of production costs of construction and installation works, reducing the complexity of building production and obtaining economic benefits.

Keywords: organization of construction production, construction logistics, organizational process, organizational and technological solutions, logistics measures, quasilinear optimization.

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INTRODUCTION

The construction process begins with preparations for construction, including the stages of the implementation of complexes of technologically completed works in the construction of buildings and structures, and also provides for the management of the accompanying processes of providing finance, material resources, technological equipment, transport and construction machines, ensuring the quality of construction products taking into account environmental requirements, fire safety etc.

In modern conditions of development and functioning of the construction industry, there is a need for the use of a triad of construction processes (organizational, technological and economic solutions) in the management and organization of construction processes.

The term "Organizational and technological solution" is often used in relation to the process of organizing construction production.

Under the organizational and technical solution understand the specific description of the technical foundations and technological schemes for the implementation of the processes of building production, using technical, economic, regulatory and other measures of an organizational nature.

Therefore, of particular importance is the planning of organizational and technological measures that determine the financing and provision of construction with material and labor resources, the development of appropriate design tasks and documentation, which determines the organizational and technical conditions for the activities of all departments of the construction organization - the conditions that are necessary for the rational use of material technical, financial and labor resources and timely completion of construction works [1, 3-5,7-9].

The development of optimal organizational and technological

measures is one of the key components in the construction process of the facility.

An important role in the organization of construction production is played by the possibility of applying modern management methods and mechanisms, using the industry of knowledge of construction logistics and systems engineering [13-15].

MAIN MATERIAL

Optimization model of organizational, technological and economic processes in construction

Currently, the most common model for solving the optimization problems of the development of construction is a linear model consisting of a set of restrictions on the values of variable parameters in the form of a system of linear inequalities and a linear objective function, the value of which needs to be optimized. The solution to this problem is determined by the basic theorem of linear programming. There are many methods for solving this problem [1, 2, 10-12].

However, a more in-depth analysis of the linear model and an increase in the number of factors affecting the behavior of the model allows us to highlight two main disadvantages of this approach to modeling economic processes in construction [1, 2, 4, 15].

First, the use of only linear constraints and the objective function greatly simplifies the model and complicates the search for the optimal solution if it is necessary to consider several sets of constant coefficients. With this approach, models with different values of the inequality coefficients and the objective function are different models. For each of them, you can find the optimal value of the objective function, but how to find the optimal solution for all possible sets of coefficient values? Of course, it is possible to form an array of sets of coefficients, for each set to find the optimal value of the objective function and select the global optimum from them. However, the number of

different sets of coefficients exponentially increases with the number of different values of each coefficient. In addition, in the case of choosing a coefficient value from a continuous interval, this approach is simply not applicable.

The way out of this situation may be the transition to the use of a nonlinear objective function, but for such problems there are no general solution methods.

If we use linear equations instead of constant coefficients in the objective function equation, supplementing the constraint system with inequalities that impose restrictions on the range of coefficients, we can obtain a quasilinear optimization model for which finding the optimal solution will not be much more difficult than for a linear model.

Secondly, the use of a scalar function as a target does not allow optimization of models in several ways at once, and this is often necessary.

In this regard, it is of interest to use vector functions (i.e., the function of a vector argument whose value is a vector) as the target. In this case, the problem of ordering vectors can be solved by introducing different norms on the space of vectors-values of the objective function, moreover, using different norms for one model, it is possible to differentially change the significance of each parameter in the optimal solution.

We have proposed a model that takes into account and links the triad of construction processes (organizational, technological and economic solutions) with logistic processes, reflecting the unity of the cycle: choice of solution - production - distribution volumes - efficiency from implementation.

General quasilinear optimization model of organizational, technological and economic processes in construction

When constructing an object in order to reduce labor costs, cost and increase the annual economic effect, n organizational and technological measures are implemented (OTM). Moreover, each OTM requires additional capital investments.

Each unit of OTM ($X_i, 1 \leq i \leq n$) provides a reduction in the cost of work by a_i UAH, a reduction in labor costs when carrying out work on b_i , increases the annual economic effect on c_i UAH and requires d_i UAH, additional capital investments. In this case, the maximum volumes of the introduction of OTM are m_i units.

In calculating the total annual economic effect, additional capital investments participate taking into account the normative coefficient E_{Hi} . Thus, each OTM is characterized by a set of parameters $X_i (a_i, b_i, c_i, E_{Hi} * d_i, m_i)$, (at $1 \leq i \leq n$).

In addition, each directly implemented OTM can be modified by carrying out k_i logistics activities (LA).

Every LA unit ($Y_{ij}, 1 \leq i \leq n, 1 \leq j \leq k_i$) additionally provides for the corresponding OTM ($X_i, 1 \leq i \leq n$) reducing the cost of work on a_{ij} UAH, reducing labor costs when conducting work on b_{ij} , increases the annual economic effect on c_{ij} UAH and requires d_{ij} UAH additional capital investments.

At the same time, the maximum implementation volumes of LA ($Y_{ij}, 1 \leq i \leq n, 1 \leq j \leq k_i$) make up m_{ij} units.

Thus, each LA is characterized by a set of parameters $Y_{ij} (a_{ij}, b_{ij}, c_{ij}, E_{Hi} * d_{ij}, m_{ij})$, (at $1 \leq i \leq n, 1 \leq j \leq k_i$).

Such an extension of the optimization model leads to the fact that the parameters of the OTM $X_i (a_i, b_i, c_i, E_{Hi} * d_i, m_i)$ cease to be constants and are expressed as linear functions of the parameters LA ($Y_{ij}, 1 \leq i \leq n, 1 \leq j \leq k_i$).

In this case, the objective function determining the total annual effect takes the form (1):

$$\sum_{i=1}^n ((a_i - E_{Hi}d_i) + \sum_{j=1}^{k_i} (a_{ij} - E_{Hi}d_{ij})Y_{ij})X_i \rightarrow \max \tag{1}$$

The complete set of restrictions on the value of unknowns of the quasilinear optimization model can conditionally be divided into three groups:

1. The maximum volumes of implemented OTM, taking into account their non-negativity
 $0 \leq X_i \leq m_i$, for each i from $1 \leq i \leq n$.

2. Maximum volumes of injected drugs for the corresponding OTM, taking into account their non-negativity:
 $0 \leq Y_{ij} \leq m_{ij}$, for each i from $1 \leq i \leq n$ and j from $1 \leq j \leq k_i$.

3. Additional restrictions on the general parameters of the model.

3.1. Formula cost reduction (2):

$$\sum_{i=1}^n (a_i + \sum_{j=1}^{k_i} a_{ij}Y_{ij})X_i \geq A \tag{2}$$

3.2. Reducing labor costs by the formula (3):

$$\sum_{i=1}^n (b_i + \sum_{j=1}^{k_i} b_{ij}Y_{ij})X_i \geq B \tag{3}$$

3.3. Additional capital costs according to the formula (4):

$$\sum_{i=1}^n (d_i + \sum_{j=1}^{k_i} d_{ij}Y_{ij})X_i \geq D \tag{4}$$

The combination of the above constraints in the form of inequalities and the objective function is a general formulation of a quasilinear optimization problem with constraints.

Description of the algorithm:

1. The value of the point and attempt counters is checked. If at least one of them reaches its maximum value, then the program terminates.
2. A uniform random number is generated in the range from 0 to the maximum value of the variable. The number is formed N times, where N is the total number of primary and secondary variables. The maximum value of the variable is selected for the corresponding variable. The result is a point in an N -dimensional space whose coordinates do not exceed the maximum value of the corresponding variable.
3. The affiliation of the point of the region in which the solution is sought is verified. For this, the coordinates are substituted into the formulas of additional constraints and, if all the inequalities become true, the point belongs to the region. Otherwise, the point of the region does not belong and is discarded. The point counter does not change, the attempt counter is incremented by one.
4. If the point belongs to the region, the coefficients of the objective function and the constraints for the values of additional variables from the coordinates of the obtained

- point from the region are calculated. The quasilinear problem becomes linear.
5. The obtained linear problem is solved by the standard simplex method. A solution to the quasilinear problem is formed, while the values of additional variables are taken from the coordinates of the point, and the values of the main ones are taken from the obtained solution. The value of the objective function for the generated solution is determined.
 6. The coefficients of the objective function and constraints for the values of the main variables from the coordinates of the generated solution are calculated. The quasilinear problem becomes linear.
 7. The obtained linear problem is solved by the standard simplex method. A solution to the quasilinear problem is formed, while the values of the main variables are taken from the previous solution, the values of the additional ones are taken from the obtained solution.
 8. The value of the objective function for the generated solution is determined.
 9. If the value of the objective function obtained in step 7 is greater than that obtained in step 5, the solution obtained in step 7 is taken as a solution, otherwise steps 4 through 7 are repeated, and the solution obtained in step is taken as the point of the region for step 4 7. Otherwise, the processing of the point of the region obtained by the Monte Carlo method [3,5,6,8] stops
 10. The value of the objective function obtained in step 8 is compared with the maximum value of the objective function obtained by processing the previous points of the region. If the last value is greater than the previous one, the point obtained in step 8 and the maximum value of the objective function for this solution are taken as the solution.
 11. Goes to step 1.

CONCLUSION

The scientific innovation of the article determines the need to implement the processes of construction logistics as a modern innovative platform for solving the organizational and technological problems of increasing the efficiency of the construction sector in the market conditions of Ukraine. Based on the possibilities of logistic approaches and their use as an expedient toolkit, which significantly improves the management methods of the triad of construction processes, reflecting the connections of organizational, technological and economic solutions.

A model of quasilinear optimization of construction production as the main subsystem of the construction industry is developed, which considers the possibility of efficiently managing the triad of construction processes using a modern building logistics tool, taking into account the introduction of logistics measures, which allows to reduce the cost and labor costs of construction and construction works, analyze the solution in the relationship and dynamics of construction processes and certain activities, and justify a rational option.

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