TECHNOLOGY AND ORGANIZATION OF CONSTRUCTION

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MECHANISM OF DEVELOPMENT OF ORGANIZATIONAL SOLUTIONS BASED ON A TECHNOLOGICAL INTERACTION BETWEEN CONSTRUCTION WORKS AND PROCESSES

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Statement of the problem. The aim is to address the question of improving the reliability of organizational and technological decisions in the construction of objects based on qualitative and quantitative assessments of the technological dependencies between jobs.
Results. Research of technologies of construction of buildings and structures allowed one to identify a model of technology parameters such as qualitative and quantitative estimation of technological relationships, time-domain performance of works for making organizational decisions. Based on a model technology of construction, a proposed method of making organizational decisions is proposed in order to form the parameters of the construction object for each planning period using the identified characteristics of the model of technology of construction.
Conclusions. Development of organizational solutions based on the characteristics of technological links between works improves the reliability of organizational and technological solutions in the construction of different objects.

Keywords: organizational and technological decisions, qualitative assessment, quantitative assessment, object construction technology, planning period, organizational decision model, power type resources.

Introduction. Complex, labour-intensive works, probabilistic nature of construction, variety of ways of organizing them leads to a great number of optimization tasks to handle to find and utilize differeny types of resources for enhancing the efficiency of various buildings and structures [2]. Nevertheless the methods associated with organizational and technological decisions (OTD) are still prioritized [1, 10].

Presently the base for forming OTD is still the approach relying on the principles of systemic technology of construction [3, 13]. As aprt of the research field Russian specialists have been developing different methods of improving the efficiency of OTD. They are the methods of classifying organizational and technological decisions into different groups based on their reliability [4], development of methodological bases of designing organizational and technological processes to ensure systematic and technological connection between functional subsystems and informational and analytical tasks in informational and computational environment [6], implementation of the formalization of reverse connections between functional systems [14], methods of improving the reliability considering the risks in designing organization, technology and management of construction under conditions of uncertainty [5], “the project approach” that takes into account market foundations of construction design [7], development of projects of organizing construction by means of integration of a flow with the principles of complex mechanization and use of cyber systems of construction management [8, 9, 14, 15]. Researchers abroad point out the methods based on the strategy of the management of a buffer [17], design of an integrated metrics for quantitative evaluation of the stability of interdependent systems [19], safety of processes in construction [20—22].

But despite a high degree of development of the problem, the general issue of improving the reliability which is associated with considering the features and character of the interaction of organizational and technological factors emerging in construction of buildings and structures of different types still remains insufficiently investigated. This paper aims to address the problem and set forth new mechanisms of making a system of OTD.

1. Studies of the technology of construction of buildings and structures. Construction of objects of any degree of complexity involves attracting a large number of enterprises, use of a great amount of materials, structures, products with different construction and technological properties. Construction of any objects is associated with a great deal of technological processes and operations with specific characteristics and parameters [16].

Therefore it is necessary to first of all consider the character of the interaction of the interconnected technological processes within a technology of construction of buildings and structures that make up OTD, their internal interconnection and intertwining in space and time for their function in the construction of objects of different types and consideration of this interaction of different organization decisions.

According to the previous studies of OTD, the following results were obtained:

— the processes or works are mutually connected at the start and end, i.e. in the interaction technological connections between the starts and technological connections between the ends of associated processes or works are involved;

— the qualitative and quantitative evaluations of technological dependencies that determine the character of the interaction between associated processes and works are identified.

In Figure there is a graphic interpretation as a linear diagram of technological dependencies between associated works performed during the construction of an object.

In Figure the vertical arrows depict technological connections at the start and end of works and their technological sequence is identified. Dots identify quantitative aspects of the technological dependencies that represent minimal delays of the end of subsequent work from the previous one and a minimum acceleration of the start of the previous work in relation to the start of subsequent work. A minimal amount of work that are used to determine a qualitative minimal delay and acceleration are identified by means of a method developed by the author [11, 18].

The identified quantitative and qualitative evaluations of technological dependencies are restrictive for determining times of works with a quantitative evaluation giving no specification of exact times of works. These can take different values for each type of works within a time range and be specified in the development of organizational and other decisions for each specific work.

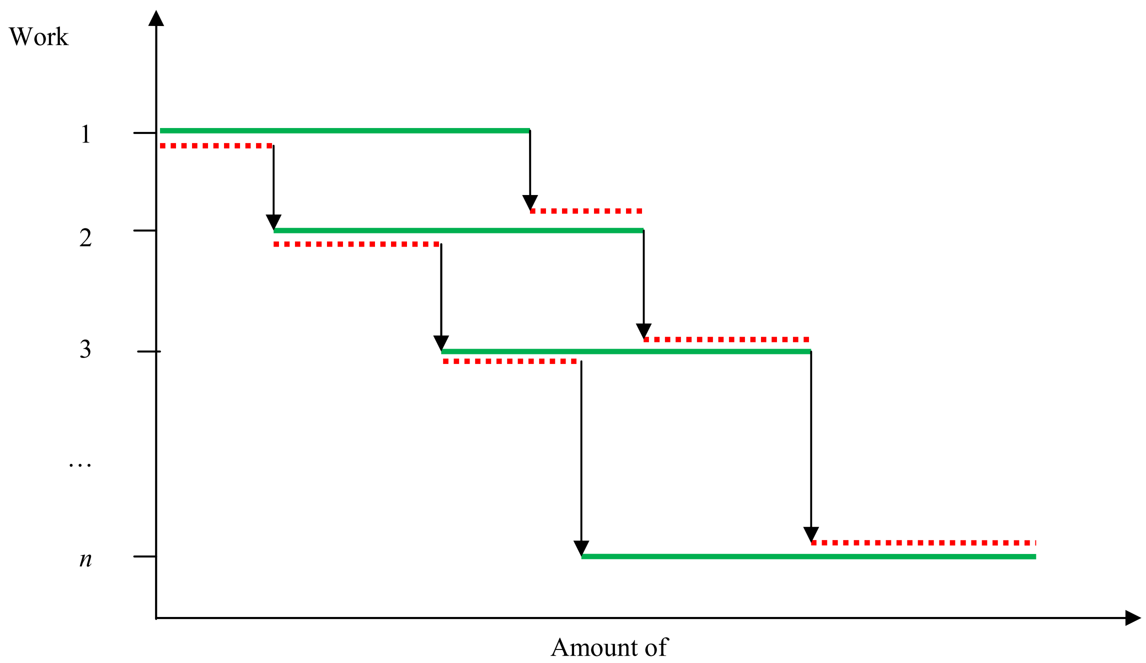

Fig. Linear diagram of technological dependencies of associated works

2. Order of the distribution of amount of construction processes in the planned periods of time. Distribution of the amount of construction processes in the planned periods is based on a construction task at hand while planning technical and economic aspects and involves a work plan as well as that of financial and technical provision.

The result of the task is a set of the amount of processes and works at each planned period, which is the objective of industrial activities of an individual construction enterprise (Table).

The development of a work plan in planned periods is based on the above method of modelling technological dependencies based on the developed quantitative and qualitative evaluations of technological dependencies between associated processes.

The distribution of the amount of construction and assembly works (CAW) in planned periods starts with determining a time range of the final work 4 that is restricted by a planned period of the end of the construction of an object and a minimal delay in the start of the work from the start of the work 3. Then similarly the remaining works are distributed with a necessary time restriction based on the connection between the start of the previous and end of the subsequent one based on a minimal amount. It is worth noting that amounts of CAW might vary in each planned period. They depend on a plan of technical and economic aspects in a planned period that eventually lead to further industrial activities of an enterprise.

Table

Example of the distribution of the amount of construction processes in planned periods

Work				
1				
2				
3				
4				
	1 planned period	2 planned period	3 planned period	4 planned period

3. Formation of organizational decisions. Development of organizational decisions is associated with determining the intensity, time of works, duties, start and end of construction processes and works, optimal range of combining technologically associated processes and works, etc. But their development first of all depends on available labour resources in each planned period.

The first condition (restriction) that is necessary in calculating the required labour resources for a planned amount of works in a certain planned period is considering a quantitative and qualitative characteristics of technologically associated works (processes) [12]. Planning of a necessary amount of works j is possible if

$$V_{j-k,i,\tau} + \sum_{\tau=1}^{\tau-1} V_{j-k,i} \geq V^{H}_{\min j,\, j-k,i} \quad (\tau = 1, 2, \ldots \bar{\tau}), \qquad (1)$$

where $V_{j-k,\,i,\,\tau}$ is the planned amount of the previous work ($j-k$) on the object i in the planned period τ that the work j is associated with technologically $\sum_{\tau=1}^{\tau-1} V_{j-k,i}$ is the amount of the previous work ($j-k$) on the object I performed (planned) in the previous planned periods; $V^{H}_{\min j,\,j-k,i}$ is a minimal amount that is necessary (or planned) on the previous work ($j-k$) for planning of a unit of the amount of work j.

The idea of the restriction is that while planning technologically associated works at a certain time period it is essential that it is possible while performing or planning the amount of work for subsequent work which is more technologically possible than the previous work. Therefore the end or start of the work j can be planned in a certain planned time period τ according to the character of the connections between the processes of the stage if the minimal amount of the previous work ($j-k$) is provided.

The second condition is the restriction of the planned amount of work j in the planned time period τ. According to this restriction, a planned amount of work should not be more than it is possible to carry out at a maximum workload with the following resources:

$$V_{i,j,\tau} \le V_{\max i,j,\tau}, \tag{2}$$

where $V_{\max\ i,j,\tau}$ is the amount of work that can be performed at a maximum workload for the labour force.

The third condition is the restriction or required support of the planned amount of work with financial resources:

$$M_{\mu,\tau} = \sum_{i=1}^{n}\sum_{j=1}^{m} n_{\mu,j} V^{пл}_{j,i,\tau}, \tag{3}$$

where $M_{\mu,\tau}$ is the amount of financial resources of the type μ that can be incurred by a construction enterprise at the time τ; $n_{\mu,j}$ is a norm of material consumption per a unit of the work j; $V^{пл}_{j,i,\tau}$ is the planned amount of work on an object in a certain planned period in natural measurements. Then the necessary resources that are required for the work planned in a certain time period are given by the following formula:

$$R^{h} = \sum_{j=1}^{m}\sum_{i=1}^{n} \frac{C^{ед}_{j} V^{пл}_{j,i,\tau}}{g^{h}_{\tau}} = R^{h}_{расч}, \tag{4}$$

where $C^{ед}_{j}$ is the cost of a unit of work; $V^{пл}_{j,i,\tau}$ is the planned amount of work on an object in a certain time period in natural measurements; i is the number of an object, i = 1, 2, … n; j is the number of work or process in a planned period, $j = 1, 2, \ldots m$; τ is the number of a planned period, $\tau = 1, 2, \ldots \overline{\tau}$; g_{τ}^{h} is the daily cost of the labour resources h.

The resulting ratio indicates the amount of the required resources for implementing the entire amount of works in a certain time period as part of technical and economic aspects as specified by a construction enterprise. But note once more that construction production is a probabilistic system that is influenced by a variety of destabilizing factors. For the case at hand, i.e. for balanced performance of the planned amount of works within a planned period, it is necessary that there is a constant workload established for every professional involved within the entire time period. For that, the entire amount of works should be planned so that at any moment there is the following amount of work being handled:

$$R^h(t) \geq R^h, \tag{5}$$

where $R^h(t)$ is the amount of labour resources that can be involved at the moment t:

$$R^h(t) = \sum_{j=1}^{m}\sum_{i=1}^{n} \frac{C_j^{e\partial} V_{\max j}(t)}{g^h k^h}, \tag{6}$$

where k^h is a planned coefficient of improving the productivity of the professionals h.

Conclusions. The model suggested for making organizational decisions in the construction of objects is advantageous in the way that within its parameter acceptable decisions can be specified, which contributes to the variety of possible decisions and thus balances them.

The method set forth for making organizational decisions in the construiction of objects allows an optimal calendar plan of OTD to be specified due to the following factors:

1) organizational decisions are identified in each planned period individually, which allows one to consider all the restrictions, reduce a range of decisions and pick one and thus improve their reliability;

2) organizational decisions are determined with no preliminary distribution of labour resources, no conditions of balance and continuity of OTD, which allows the start and end of works to vary with no disruptions to technological connections.

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