Methods for calculating the reliability and energy efficiency in the construction of real estate

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Abstract. Organizational and technological reliability in the construction industry is the ability to maintain performance parameters within specified limits and to obtain a planned result under given production conditions. Carrying out repair and reconstruction works always requires large resource costs, so it is necessary to increase the efficiency of using the work with the application of new approaches to the organization of repair and reconstruction works at the real estate. To do this, it is necessary to improve the efficiency of managing a complex of works on the preservation and reproduction of real estate. It is necessary to effectively improve organizational and technological reliability with the help of competent mathematical tools to justify the strategy of repair work. For reliable functioning of the construction strategy, it is necessary to take into account the loss of reliability during repair and reconstruction work at the real estate. It is at this point that this article is based.

1 Introduction

To quantify the influence of factors on the loss of reliability during repair and reconstruction works as well as the change in the duration of work, the following needs to be taken into account:

1) considering the loss of reliability, it is necessary to consider each element of organizational and technological system based on the local, private, comprehensive, and integrated indicators;
2) the rationality of the repair and renovation work depends on the situations that the work is taken place in P_1-P_3
3) the reliability of organizational and technological system of repair and renovation work usually depends on the intelligent combination between the reliability of work, the organization and conditions of work W_1-W_3
4) the functioning of organizational and technological system of repair and renovation work result leads to an increase in the duration of effective operation of the building and compliance with the requirements of normative-technical documentation [2-4].

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2 Experimental section

The table 1 shows the factors selected for the expert survey:

Table.1. The factors selected for the expert survey.

№	Name of factors	Symbol
1	The level of prefabrication of materials and structures	X_1
2	For concurrent work	X_2
3	The degree of deviation from quality standards	X_3
4	The frequency of violations of sequence of work	X_4
5	Technological risk (variation of work indicators)	X_5
6	Mobility (Speed of movement and concentration of labor collectives on the main redistribution)	X_6
7	The degree of implementation of their own units (no contractors)	X_7
8	The ratio of the technological and substantive specialization (the ratio of specialized brigades to the total number of brigades)	X_8
9	Organizational risk	X_9

The formula for determining a local integral indicator of organizational and technological reliability (OTR):

$$OTR_{wor} = \sum_{i=1}^{I} W_i' * V_i' \tag{1}$$

Where N_i' is the value of the private indicator of the OTR works; V_i' is the weight of the private indicator of the OTR; i is the number of partial indicators, members of the local integral indicator of the OTR.

Considering the influence of the factors X_1, X_2, X_5, the specific indicators of the reliability of the work needs to be assessed.

The formula for determining the percentage of concurrent works (X_2):

$$K_{comb} = \frac{\sum_{i=1}^{n} \frac{K_b' + K_e'}{2}}{n} \tag{2}$$

Where n is the number of types of work;

K_b is the coefficient of combination at the beginning of work performed:

$$K_b = a_1 / (a_1 + a_2) \tag{3}$$

K_e is the ratio combining at the end of works:

$$K_o = B_2 / (B_1 + B_2) \tag{4}$$

K_b shows the amount of the previous work which must be performed by the beginning of the follow-up one, and K_e shows which part of the follow-up work should be outstanding by the end of the previous one. Changing the proportion of concurrent jobs between 0 and 1.

Technological risk X_5 is determined by using the average value of the coefficient of variation of the duration of the works:

$$V_{techn} = \frac{\sum_{i=1}^{n} \frac{\sigma_i}{\overline{x_i}}}{n} \tag{5}$$

Where σ_i is the standard deviation of the length of the i-ro type of work, $\bar{\bar{x}}_i$ is the arithmetic average of the length of the i-th type of work, *n* is the number of works [5].

The level of prefabrication of materials and structures X_1 is determined by the ratio of the estimated cost of prefabricated structures and parts for an estimated cost of all materials, structures and components.

$$y_{pr} = \frac{S_{est}^{pr}}{S_{est}^{all}} \qquad (6)$$

Local integral indicator of the OTR organizations conducting repairs and reconstruction is determined by the following formula:

$$OTR_{org} = \sum_{i=1}^{m} W_i^{"} * V_i^{"} \qquad (7)$$

Where $W_i^{"}$ - the value of the private indicator of the OTR organizations; $V_i^{"}$ is the weight of the private OTR indicator of the organization; *i* is the number of partial indicators, members of the local integral indicator OTR.

The probability of obtaining an additional income or losses due to the inefficient organization of the production process at each facility reconstruction reflects the assessment of organizational risk X_9 and is calculated according to the formula:

$$R_{org} = \frac{\sum_{i=1}^{n} \frac{\sigma_i}{\bar{s}_i}}{n} \qquad (8)$$

Where σ_i - the standard deviation value of the i-th repair and renovation work, s_i is the arithmetic mean value of the i-th repair and renovation work, *n* is the number of completed repair and renovation work [6].

Local integral indicator of the OTR situation and the conditions of repair and renovation work at the real estate is determined by the formula:

$$OTR_{sit} = \sum_{i=1}^{n} W_i''' * V_i''' \qquad (9)$$

Where N_i''' - the value of the private indicator of the OTR situation; V_i''' is the weight of the private indicator of the OTR; *i* is the number of partial indicators, members of the local integral indicator OTR.

There are several organizational and technological situations that could happen because of the variability of the data reliability: G_1 - occurs in the process of creation and accumulation the necessary capacity to perform the work by the system; the second one - G_2 - occurs in the process of using the accumulated potential by the system when performing work; the third one - G3 - occurs when the transition periods are being the most unstable and volatile [7].

The combination of all the works on the object of the reconstruction or repair can be considered as a single system composed of elements, subsystems, and organizational and technological conversions.

3 Result section

In the first situation, the supplier of building materials and structures creates and develops databases and their infrastructure, as well as the necessary power for the primary and subsequent work in the stream. Also, the basic Assembly processes and the process stages with a shortage of labor resources are created and highlighted, and they are attracted by the organizational recruitment in a construction company. During this process, it is necessary to improve technology of construction production and use new materials and structures [8].

This allows shortening the most time-consuming tasks and increasing the number of small specialized teams and sites.

In the second situation, the work is done with maximum intensity, and highly skilled construction crews are used. The incidence of conditions of mobility and uncertainty factors on the system within the facility are reduced.

Also, the special threads on the installation of structures and the enlarged blocks with a combination of substantive and technological specialization are formed. [9]

In the third situation, rapid movement and concentration of main elements of the construction system for the new facility are needed, provided that there is excess workforce due to a sharp decline in the volume of work at the completion of the reconstruction of the object at the «old» object.

The construction system is ready to implement its own functions in different contexts of mobility and in the presence of its design capacity only in the time when all components of the production and social sectors, infrastructures and temporary construction infrastructure are necessary and sufficient combination to deploy and provide the necessary concentration of building units and deploying specialized flows and smooth their functioning in different situations [10].

The change in principles and parameters in the operation of construction crews in the system due to impact of dynamic factors, the level of impact on the system depend on the organizational and technological situation.

In general, for the disclosure of the factor space, which determines the mobility of the construction system, the entire cycle must be divided into 3 States: 1st that is F1, 2nd that is F2, and 3rd that is F3.

The state of the system F1, the period of readiness of the production bases, its infrastructure, including temporary construction, will require for the main sources of these spheres to be moved and focused in their fixed and mobile offerings $(p_1; p_2; ….; p_n)$ with the necessity of forming the optimal combination to provide the required and sufficient conditions for the commencement of the functioning of the system of brigades and production processes of the property. The extent of the use of such facilities of the production based over time depends on the type: Di - the place of mobilization, Ei - a place of concentration, Cn - temporary construction infrastructure. The main feature of this condition is the creation of the conditions that are necessary for the functioning of the basic, auxiliary and service processes [11].

The time required for the movement and concentration of industrial and social bases that are necessary to ensure the required power of labour, technical and material resources on site, is considered to determine the reliability in the system from the conditions of mobility, that is, to determine the availability K_{gr1}:

$$K_{gr1} = {}^{\tau_r}\!/_{(\tau_r + \tau_{mov})} \tag{10}$$

Where K_{gr1} is the availability of the system from the conditions of mobility; τ_r is the estimated time, days, years; τ_{mov} - is the time in the movement and concentration of production base, days, years.

Time to move (τ_{mov}) under the influence of the factors of mobility describes the movement and concentration of facilities and regional conditions. The conditions include the range, speed and frequency of movement, labour and material and technical resources (concentration of power), accessibility, etc. [12].

The reliability of functioning of system of the organization ensuring the formation of these bases says about the time lost in case of failure due to the effect of uncertainty factors of the construction industry, τ_{OTC}, to the estimated interim fund and is calculated by the ratio of system availability – K_{gn1}:

$$K_{gn1} = \frac{\tau_r}{(\tau_r + \tau_{mov}) + \tau_{\text{отс}}} \tag{11}$$

The condition of building systems F_2 is provided with basic options for a balanced move with a concentration of resources. The system communicates with a period, providing forms for moving with concentration of all resources that are necessary for their reliable operation on construction sites.

In the second stage, the movement and concentration of resources are not associated with the operation of the system of processes, but with an additional preparatory period of its functioning. Therefore, in the conditions of influence of different factors (mobility and uncertainty process of moving from a concentration system of units and material and technical resources), there is a need to define a part of the General Fund of the time that it takes under the influence of these factors on the movement and concentration from the "old" to "new" object and form the industrial and social base [12-13].

State of the construction system F_3 defines the options for the establishment of a combination of enterprises resources with the influence of the conditions of the temporary construction infrastructure objects. In this stage, the connection with the movement of resources building production when performing work for their rational combination among themselves can be seen.

A characteristic feature of this stage can be determination of the effectiveness of activity of enterprises in a certain organizational and technological situation. The efficiency of resource use in the process of creating the final product that determines the degree of use of their accumulated expertise and economic sustainability will depend on a correct account of all the factors on the first two stages, defining the processes in the formation of potential of the enterprises [14].

4 Conclusions

Therefore, in the process of defining the factor space, the following needs to be considered: organizational and technological situation in which a system is being developed; the state of development of the system; and compliance of integrated blocks, which describe the conditions of mobility and the uncertainties of construction space, where the work of crews will take place and sites, with end-to-end flow while implementing repair and renovation work at the real estate [15].

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