Resistence enhancement of construction project organizational structure

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Abstract. This article integrate scientific studies in sphere of construction company organizational structure’s performance assurance in conditions of sharp and off-design changes of external and internal environment parameters. Organisational structure resistence is observed as a one of the most important properties of counteracting destructive effects of the external and internal environment. Objective and comprehensive description of resistance elements (reliability, durability, stability) is given. The paper substantiates a proposal to consider these organizational structure qualities from the standpoint of information science and the resource-based approach. This article particularly considers the question of organization structural stability, when its resistance is determined mainly by the organizational structure topology and not just by the qualities of system elements. This paper extends horizons of research and its borders, within which the organizational structure is able to implement its target function, release from particular resistance factors when analysing organizational structure and base on presented general approach. At the same time the paper does not renounce the studies of particular environmental factors impact on the organizational structure ability to resist their destructive effects.

1. Introduction
The main condition of any production structure successful functionality is the existence of competitive advantages that allow efficient realizing of its production program in the conditions of modern market relations. The foundations of properties that are necessary for successful work are laid at the stage organizational design. The repository of these properties is the company’s organizational structure, and in our consideration – construction project structure. Without renouncing the importance of competitive properties of economical, technological and social orientation this article considers the less studied capabilities of organizational structure as a system to resist the external and internal negative impacts in order to ensure its working efficiency in changing environmental conditions. In the domestic and foreign scientific literature a significant place has been given to the issues of organizational structures’ countermeasures to negative impacts [1-6]. However, there are still no full and comprehensive definitions of organizational structures resistance properties in the scientific community. This gap can be significantly clarified by referring to the information approach of systems analysis.
in isolation. Firstly, system consists from elements that under certain conditions can be considered as systems themselves. Secondly, system should be considered in the conditions of external environment. Based on these ideas, we can conclude that system is impacted by external environmental factors, which, as usual, cannot be influenced by the system, and internal environmental factors that can be changed in the interests of the system. Considering the interaction of the system with the internal and external environment, we can highlight specific features of this interaction. So, if the parameters of external and internal environments are permanent then the system, which is under these conditions, will exist endlessly since this state does not cause any disturbing impacts.

In case of permanent external environment the state of the system will be determined by the impact of internal factors with negative disturbances, by counteracting which the reliability of the system is ensured. Thus, the reliability is understood to be the ability of the system to ensure its working efficiency in case of changing parameters of internal environment in conditions of permanent external environment [7]. The condition of reliable system operation is to ensure the permanence of internal environment’s parameters, i.e.:

$$\frac{d\Psi}{dt} = R$$

(1)

Where: $\Psi$ - multidimensional vector of internal environment’s state; $R$ - resource that is required for counteraction to changing parameters of system internal environment.

Discussing in a similar way when considering the interaction of the system with the external environment, we come to determination of the durability property. By durability we mean system properties that ensures its working efficiency in conditions of parameters of external environment, which surpass the calculation value, and a permanent state of system internal environment [8]. System’s durability has a number of properties specified by its integrity against the system. Indeed, negative disturbances of external environment affect both the system’s elements and to connections of these elements. Either way, the destruction of elements or their connections leads to the system’s destruction. Therefore, it is very important to be able to evaluate system’s and its elements’ durability parameters, as well as to interpret various types of disturbances correctly from the point of view of their destructive capabilities. Considering the organizational structure’s durability we note its emergence, since the system’s durability depends on durability of elements and links, but not reduced to their properties.

We begin the consideration of system’s interaction with environment from the analysis of possible negative environmental factors impacts on construction project as system. When classifying negative environmental impacts, specialists distinguish economical, technological, social and other factors [9,10]. Despite the seemingly different origins of harmful factors they all are united by the one deep essence – their attitude to system resources. For example, the set of financial factors that reduce system’s financial resources is negative, and factors that increase amount of resources are considered as positive, i.e. promoting system’s operation. Therefore, it is advisable to consider negative impacts to the system by all kinds of factors through the prism of the resource-based approach, which allows unifying the methodology of counteracting disturbances influences.

The methodology of elimination of disturbances negative influences on the system is based upon a concept: if negative influences $F_i$ reduce resource $R_i$, then it is necessary initiate measures in order to restore the original value of this resource. In practice it looks like this: if temporary negative influence occurs then a certain resource reserve is created. Further, in any construction project design there are operational storages of necessary materials and components that allow ensuring construction process to continue in case of disruption of materials supplies. If an impact is permanent, then the technological process should be changed in order to obtain construction product with lesser resource usage. In the extreme case, production is reoriented to a more available resource type. It is also possible to modify resources.
As in any other type of production activity, immaterial resources have a special place in the construction operations’ system. First of all, this are knowledge, technologies and intellectual property. International economic science predicts that in the near future cognitive technologies development will has an explosive nature [11]. This resource is unresponsive to reduction or exhaustion. Oppositely, the arisen intellectual resource quickly becomes a property of a wide circle of specialists. That is why the main task in the progress of construction operation is an introduction of latest technologies to construction organization, due to its’ promotion to creation of high quality construction documentation and new methods of construction management.

Negative influences’ quantitative evaluation is a fairly complex problem. It is possible to offer the following evaluation of negative influences’ force in points by using the resource approach. Precondition is an absence resources procurement in days. For convenience, the lead time can be equated as a common logarithm of the resource absence time. So, 1 point corresponds to 10 days, 2 points - 100 days. In addition, this a probabilistic value, because resource absence time is not exactly known. It is also possible to evaluate a negative impact in a form of financial losses due to resources procurement absence, inefficient managerial decisions, errors in technical documentation, etc.

Stability is another resistance property. In modern literature researches use this term for any kind of organization’s successful operation conditions [12]. There are financial and technical stability. To introduce the uniqueness of this concept we shall return to informational approach for that competitive advantage. External environmental parameters that surround the system are not constant. They vary both in value, what we talked about above, and in rate of their change. Comparing the change rate of environmental parameters to the reaction rate of the system to this influence, we conclude that system should be able to respond quickly to a changing external environmental factor. So, system change rate \( \frac{d\Phi}{dt} \) should be higher than parameter change rate \( \frac{d\Psi}{dt} \), i.e.

\[
\frac{d\Phi}{dt} \frac{d\Psi}{dt}\]

(2)

This formula is a condition of the system’s stability. As we can see, system’s stability is its ability to respond appropriately to external environmental parameters’ change rate. Otherwise, system is not able to realize its main function.

We remind that modern construction projects are complex systems that consist of large amount of elements, which compile to a specific organizational structure, comply with certain management laws and by through cooperation deliver on the project’s goals. Construction project organizational structure is a dynamic system. It transforms in accordance with project’s life cycle and takes the optimal form that most fully correspond with features of the current project phase. This task is achieved using management system that based on construction documentation in reliance on the current state of external and internal environment. Environmental disturbances are realized by their impact to system’s elements and links. The entire system functionality is directly depends on their operation under negative impact.

The elements’ links reaction can be excluded from consideration if production is localized in a single territorial complex, because as interoperational transitions that belong to system elements are included in some parts of technological process. Otherwise, system links should be considered as specific elements of construction project.

3. Results
Considering different types of influences on system element, we can select their simultaneous effect, whereby the corresponding level of reliability, durability and stability ensures function implementation of a system element. We write down the condition for the guaranteed functioning system’s element with a complex destructive impact on it.
\[ \rho \zeta \]  

Where: \( \rho \) - system element resistance; \( \zeta \) - destructive impact ability on a system element.

Integral resistance index \( \rho \) is the summation of element properties: reliability, durability and stability. We consider geometric mean of corresponding coefficients as:

\[ \rho = \sqrt[3]{\varepsilon \ast \upsilon \ast \omega} \]  

Where: \( \rho \) - element resistance; \( \varepsilon \) - coefficient of element reliability; \( \upsilon \) - coefficient of element durability; \( \omega \) - coefficient of element stability.

Numerical value calculation of \( \varepsilon, \upsilon, \omega \) coefficients is not difficult, especially since the topic of reliability determination is very relevant and at present various methods are presented [13-15], which can be used to implement our task.

One of the most important characteristic of resistance is a structural stability of organizational system. We consider different resistance types of system elements, but structural stability of organizational system is the new system concept. Structural stability of organizational system is an emergent property and does not resolves into resistance of a system element or group of elements. System structural stability is determined not only by elements resistance properties, but mainly by topology of elements’ connections, the loading point of destructive forces towards organizational structure. Mathematical model of structural stability should take into account all aspects of impacts on the system and its elements features. Unlike the purely mechanical components of technical devices system, the structural elements of production organizations are personnel with their inherent social characteristics. Therefore, it is very difficult to formalize a non-deterministic reaction of personnel to current events. In this regard, it is necessary to use the assumption definition, which will not affect the qualitative valuation of current processes. These assumptions and limitations include the following:

- company organizational structure perceives the environment external impact through only one system element;
- disturbance propagation is conveyed through organizational structure elements with a decrease in their functionality or durability;
- destructive ability of an impact does not change when passing through system elements;
- system element deranges when durability level decreases lower than the set value.

4. Discussion

Of course, the proposed methodology for resistance qualities increasee of a construction project’s organizational structure is schematic and requires serious study of issues that were outlined in this paper. Relevance of solving these problems is in no doubt, practical application will help to avoid possible risks and guarantee a rhythmic and high-quality project activities.

5. Conclusions

To determine element’s reliability we should consider as many factors of system’s reliability as possible, such as organizational, financial, economical, technological and social factors. An important place is taken by the justification of the indicator system that characterizes quantitative and qualitative levels of factors, which impact on element reliability. To determine element’s reliability level, a comparison of numerical with reference values of studied company’s indicators should take place.

Element durability is a relatively new concept in system engineering, where generally accepted methods of this indicator’s numerical calculation are not established. The previous suggestion about measuring durability by the element’s operation time in the context of a resource absence is an objective one with an easily determined value. We cannot discount the impact of macro and microenvironment on the system element.
Taking into account all considerations about element’s stability from above, we can affirm that the coefficient that characterizes stability may take only two values: 1 – in a context of element’s reaction rate exceeding the change rate of a disturbance, and 0 – when element reaction rate is less than disturbance rate. Indeed, if an element does not have time to adapt to changing operation conditions, then there is no question of its operation in general. Considering element’s operation condition in changing environmental parameters, it is necessary to be able to assess the destructive ability level of a complex disturbances influence.

Mathematical model of organizational system’s structure stability allows predicting possible negative consequences of destructive ability, as well as providing necessary measures of a structural stability increase in advance. Such as, for example, system elements duplication, creation of inter-operational departments, increase of logistical support level for a construction project, insurance financial functions, etc.

Considering the whole complex of external environment’s negative factors we can conclude that the set of various negative influences on a system or its elements has only two universal attributes that are inherent in all influences without distinction – an impact force and a change rate of this force, and the result of a negative impact is reduction or redistribution of system resources. The study of system reaction to disturbances gives an opportunity to accurately predict system behavior in order to arrange preventive measures ensuring its operation.

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