Efficiency of Organizational Development of the Construction Complex

V Gerasimov ¹⁺, E Ulitko ¹ and N Svetoshev ¹

¹Novosibirsk State University of Architecture and Civil Engineering (Sibstrin), 113, Leningradskaya str., 630008, Novosibirsk, Russia
E-mail: v.gerasimov@sibstrin.ru

Abstract. The goal of this research work is to improve organizational methodology and technological reliability of construction, developed in 1970 on a new-market basis, which determines the need to take into account uncertainty factors in the 'construction activities' results at all life cycle stages of creating objects. The topic’ relevance is determined by the insufficient level of the regulatory and methodological base of organizational and technological design and an objects’ construction planning, taking under consideration the risk of their implementation. These decisions are made during the development of organizational and economic documents - FIS, feasibility study, business plans, plans, forecasts, etc. The implementation of an investment and construction project is associated with great risks due to the uncertainty of decisions and influence of the external environment, which manifests itself in changing the conditions of the legal, economic, social, environmental and other spheres, which the investment and construction project is being implemented with.

1. Introduction
Market conditions’ analysis shows that, the project management is becoming an urgent methodology, since it allows ensuring in the long term management of construction and installation organizations activities to manage risks at all stages of an objects’ life cycle.

Theoretical - methodological problems of the organizational development effectiveness were solved by foreign scientists: Meyer E., Fatrell R.T., Shafer D.F., Royce U. and domestic scientists: Gusakov A.A., Bagrinovsky K.A., Nanasova P S., Andreychikova Yu.Yu., Sapozhnikov V.N., Zhukov L.M., Ustimenko V.V., Kachanova T.L., Lapidus A., Saati T.L. and etc.

The issues of organizing risk management are widely covered in foreign and domestic literature. Among the most significant works are Shevchenko S.Yu., Balabanov I.T., Birman G, Berstein L, Gracheva M.V., Kachalov M., Kleiner G.B., Tokarenko G.S., Koshechkin S.A. The works of: Moskvina V.A., Pervozvanskii A.A., Lipsitsa I.V., Shapiro V.D., Kovaleva V.V., Filina S.A., Kirsanova K are devoted to the influence of investment activity risks on investment mechanisms. A.A., Chetyrkina E.M., Lukasevich I.Ya., Buyanova V.P. and others.

Theoretical, methodological issues of reliability were discussed by foreign scientists: Meyer, Fatrell R.T., Royce U. and by domestic scientists: Gusakov A.A., Bagrinovsky K.A., Nanasova P.S., Sapozhnikov V.N., Zhukov L. M., Ustimenko V.V., et al.

This work contains the main approaches to improving activities efficiency at the stages of design, planning and risk management, determined by internal factors - features of objects’ architecture and external ones - random deviations of the project parameters. The main approach is focused on the use
of situational management methodology and includes developments for the normalization, optimization and updating of complex parameters.

The study purpose is to determine the standards for the reliability of organizational development forms, to develop methodological approaches and to manage the effectiveness of construction complex development in risk conditions.

Systemic methods, design and situational approaches, statistical and technical and economic analysis were used in the work.

The result was obtained in the form of standards for reliability and risk and development schemes, methodological tools for design, planning, management of the construction complex in market conditions in the development process.

The work significance lies in the possibility of using methodology for the risks’ related areas development: technological, economic and financial and creation on this basis of a digital automated system for managing of the construction complex reliability.

The organizational forms reproduction of the construction complex development includes two groups of objects: forms of new construction and forms of an objects development. The second ones have the greatest risks due to the need to perform work in special conditions. In practice, expert assessment methods are used, which have limited use due to the insufficient reliability and the lack of methods for determining the risk, [1,2].

Development can occur in four main directions: organization - structuring of objects, technology - regulation of processes, economy - material consumption, and finance - organization of cash flows. The solution of organizational problems is the most urgent for three reasons: possibility of large dimension objects studying, possibility of obtaining complex assessments, formation of an effect, not due to additional investments, but to a combination of organizational solutions’ options - forms and development schemes.

The target tasks solution of organizational development is due to the need to determine the objects structure within the framework of development organizational forms: restructuring, reorganization, reconstruction, renovation; standards determination of reliability and risk; distribution of risk by organizational forms and development schemes of objects by construction process functions, design, planning and management

2. Materials and methods
Methodology formation for the effective organizational forms and schemes for the construction complex development has been developed in accordance with the theoretical principles of systems engineering, project management and situational management.

Structuring is based on a modular approach. Organizational development is represented by structuring options variety for primary modules - various types and types of residential buildings, specialized modules - a set of primary modules, complex modules - a set of specialized modules. The complete structure is a technical and economic model of the object and possible strategies for changing the construction complex development.

Development safety is represented by the assessments variety of organizational forms effectiveness and schemes by forming local and integrated assessments.

The study was carried out according to a special technique and included the formation of a parametric basis for a building complex [3]:

1. The object’s structure. The development included: the goal was to classify the work structure’s elements by stages of the object life cycle, the task was parameterization of structural elements; the result was the object modules formation.
2. The organizational forms’ structure of the object development included following schemes: restructuring - by types of horizontal, vertical, mixed integration; reorganization - by types of products, resources, potential; reconstruction - by types of extension, superstructure, external
reconstruction, internal reconstruction; repair - by type of major repairs, current repairs, and restoration.

3. The development included: the goal was to classify the work structure’s elements and organization schemes of the object; the task was parameterization of forms’ structural elements and organization schemes of an object; the result was the formation of modules and object organization schemes.

4. The structure of resources included material, cost, and monetary resources. The development included: the goal was the classification of the object structure resources, the task was the parameterization of the resources’ structural elements, and the result was the formation of objects’ resource modules.

5. The structure of performance evaluations. The development included: the goal was the estimates’ classification of the object structure’s elements, the task was the parameterization of the structural elements’ estimates, and the result was the formation of the objects’ integrated estimates.

6. Development of a safety technique. The development included: the goal was models of objects’ forms and organization schemes and algorithms for their implementation; task was grades classification; result was organizational security areas of the facility.

The interrelation of the objects system’s elements according to the organization forms of the object development is given in Table 1.

**Table 1.** Functional model of the structural modules relationship of the organizational forms’ system of object development.

| № | Parameters and ratings | Orf |
|---|------------------------|-----|
|   | rs | re | rk | rn |
| obj | Vrs | Vre | Vrk | Vrn |
| r-ty | frrs* | frr* | frk* | frrn* |
| r | frrr | frr | frrk | frrn |
| ee | frrs | frr | frrk | frrn |
| ie | fee | fee(orf) |

The research task of determining the reliability standards is given in [4-14]. Ob-object; r-ty-reliability; r-risk; ee-economic efficiency; ie-integrated efficiency; V-volume of work in the object; rs - restructuring; re-reorganization; rk-reconstruction; rn-renovation; Or.f-organizational forms of development; f (rs) -function of restructuring; f rr r - function of restructuring reliability; f (rs) - function of restructuring risk; f (Or.f) - function of organizational forms of development.

Analysis of the matrix showed the following:

1. The volume of an object-complex includes many volumes in terms of development forms, which predetermines the need to study the reliability of both local and whole object.
2. Each form and scheme must have an assessment of the reliability standard.
3. The complex resources by the forms should be determined, taking into account reliability and risks.
4. Risk and efficiency assessments should be determined by an integrated assessment, since they characterize different areas of efficiency - the risk of the results loss and profitability of activities, and in general, the level of business efficiency.
5. The complex state can be determined by three zones with efficiency (E): safe - at -E> 1, dangerous zone - E = 1, crisis zone - E <1.

The data of architectural and construction projects with the materials of the SFD and PIC of residential objects were taken as the initial research materials.
The study of reliability standards included experimental simulation of structural forms and schemes with the probability function determination, depending on the cost deviation options with obtaining numerical values of reliability for the structural forms’ options and development schemes. As a result, the numerical values of organizational reliability have been determined according to the options "form-diagram-trend" of development. The experimental values of reliability by the development forms were: for restructuring was 0.88, reorganization was 0.77, reconstruction was 0.68, and repair was 0.65. Reliability values were given as average values for the schemes variants in the composition of development forms.

The calculations established the following assessments and areas of organizational security for the example of the housing construction complex (HCC) in Novosibirsk, 2018 (Table 2).

Table 2. Assessment of the HCC state in the determination variant and after safety assessment optimization.

| ObjCa | Orf |     |
|-------|-----|-----|
|       | rs  | re  | rk  | rn  | Total |
| ObjCd,% | 24  | 28  | 23  | 25  | 100   |
| Cr    | 12  | 23  | 32  | 35  | 28    |
| R,%   | 12  | 23  | 32  | 35  | 28    |
| E     | 0.87| 0.76| 0.64| 0.63| 0.84  |
| Ia    | 4.2 | 8.7 | 12.5| 10.3| 9.2   |
| Coi   | 3   | 5   | 7   | 9   | 6     |
| R,%   | 3*  | 5   | 7   | 9   | 6     |
| E     | 0.96| 0.89| 0.91| 0.83| 0.92  |
| Ia    | 1.5 | 1.6 | 1.5 | 1.7 | 1.8   |

ObjC-cost of the object; ObjV - the object volume by the development forms; ObjCd - the object cost is deterministic; Coi - cost is optimized through insurance; Cr - cost of risk; R - risk; E - efficiency; Ia - integrated assessment; 3 * - risk values are taken on the basis of an expert assessment of insurance equal effectiveness to 0.25.

The model block of the computational complex of estimates is given:

\[
\text{ObjCd} = \sum \text{ObjCd}_i, n(1)
\]

\[
\text{Rel}^* = f(P, \beta)(2)
\]

\[
\text{R}^* = f(\text{Rel})(3)
\]

\[
\text{E} = (C + \text{P} \text{Rel})/3(4)
\]

\[
\text{Ia} = \text{R} \times \mu + \text{E} \times \alpha, \mu + \alpha = 1(5)
\]

where i - index of the i-th local value of the object; Rel * - reliability, determined according to the research results [15]; P - probability; \(\beta\) - index of changes (deviations); R * - cumulative risk, taking into account the growth of the calculated risk due to the summation of the structural elements’ risks; C - costs; P - profit; \(\mu\) - importance of risk in the integrated assessment equal to 0.3; \(\alpha\) - importance of effectiveness in the integrated assessment equal to 0.7.

The functional purpose of the design and assessment model equations is as follows: the formation of the object value by structural elements (1), the development of standards for the forms reliability (2), the risk calculation of the development forms (3), the determination of the development forms effectiveness (4), the integrated assessment calculation of the object (five) development forms.

From the data analysis:

The functional purpose of the design and assessment model equations is as follows: the formation of the object value by structural elements (1), the development of standards for the reliability of development forms (2), the risk calculation of the development forms (3), the determination of the development forms effectiveness (4), the calculation of the integrated assessment of the development forms of the object (five).
1. Deterministic assessment of the decision object does not take into account the probable risk cost of reduced efficiency up to 12-35%, which is reflected in the cost of losses.
2. Optimization to minimize risk on the basis of insurance allows you to reduce risk, increase efficiency and generally improve the integrated assessment of the forms’ safety of objects complex development.
3. The efficiency of the forms’ structure development can be adjusted not only by local estimates, but also by the business dynamics.
4. The integrated assessment can be used to solve the problems of designing strategies for the development of business organizational forms in the building complex.

3. Results
The main research results are in the field of design - standards for the reliability of forms and schemes for the objects complex development, planning - a distributed structure of standards for the reliability of many forms of the complex development, management - standards for updating changes and deviations in the parameters of the complex forms development.

The new knowledge, obtained the research result includes: regulatory framework for the reliability of development forms in design, the methods of standards distribution for the reliability of development forms in the objects’ space in planning, the methods for standards changing of the forms development reliability in the objects’ space of the construction complex in management.

4. Discussion
The research results make it possible to predict the hazards of activities at the three main stages of the design and construction process.

The research results in design provide for the possibility of standardizing the reliability and risk of organizational forms of a local building complex development. This solution provides mitigation of damage to activities during the security design stage.

Research findings in planning provide the possibility rationing the reliability and the risk of the organizational forms’ resources of objects development in construction complex. This solution provides mitigation of damage to operations during the security planning stage.

The research results in management provide for the possibility of standardizing the reliability and the risk of changes and deviations in the organizational forms parameters of the construction complex development. This solution helps to reduce the damage to activities at the stage of safety management.

References
[1] Gerasimov V V, Korobova O N, Schepotin G K 2014 The effectiveness of systems engineering of organizational and technological solutions for construction projects. News of Educational Institutions. Construction, 1, pp 49-56
[2] Magomedov A G, N.M. Hasanova N M, V.Yu. Kolyvanov V Yu, 2012 Problems of theory and practice of forming an effective management system for construction production on the basis of scientific and technical progress, M.: Economic newspaper,p 296
[3] Gerasimov V V, G.B. Safaryan G B, N.V. Svetyshev N V, 2016 Stochastic planning of the building complex of residential objects, News of Educational Institutions. Construction, 12, pp 55-64
[4] Gerasimov V V, Ikonnikova A V , Svetyshev N V , Isakov A K Research of planning technology for complex construction processes in conditions of uncertainty. - Izvestiya Vuzov. Construction. - No. 3. 2018. - p52-62
[5] Gerasimov V V, A.A. Chernichenko A A, E.V. Ulitko E V, 2019 Assessment of the risk of resource supply for a construction organization, National Science and Technology. Conferences, pp 251 – 257
[6] Chernichenko A A, V.V. Gerasimov V V, 2018 Risk Management of Reconstruction of Housing Construction Projects, NGASU, 1 (67), pp155-162
[7] Ulitko E V, Gerasimov V V, 2018 Planning with the risk of restructuring housing construction projects, NGASU, 1 (67), pp 155-162
[8] Baronin S, Organizational and economic mechanism for managing the process of reproduction of fixed assets in construction, Penza: PGUAS Publishing House, pp.24-28 (2014)
[9] Telichenko V I 2011 From ecological and "green" construction - to ecological safety of construction, Industrial and civil construction. 2, pp 47-51
[10] Osipova O V 2006 Features and prospects of the cluster model of economic development: author. dis. Cand. econ. Sciences / O. V. Osipova. - Chelyabinsk: RSL, 2006. -- 16 p.
[11] Lapaev D N 2015 Management of integration processes in the investment and construction sphere of the region, Nizhny Novgorod: Raster, p 159
[12] Gerasimov V V, Ulitko V V, 2018, Research of planning technology for complex construction processes in conditions of uncertainty, News of Educational Institutions Construction, 3, pp 52-62
[13] Strokin K B 2009 Management of the development process of a construction enterprise: theory and practice, St. Petersburg: SPbGUEF, p 158,
[14] Makarov E I 2015 Logistic business processes of an industrial cluster: methodology and optimization tools, Voronezh: Scientific book, p 177
[15] V.V. Gerasimov V V, E.V. Ulitko E V, 2020 Safety of transformation of the housing construction complex based on the engineering methodology, Proceedings of universities. Construction, 1, pp 82-93 (2020)