The empiric methodology of evaluating and managing the aggregate risk at implementing large complex building and investment projects abroad

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Abstract. The article considers the practical methodology of the efficient managing the aggregate risk at implementing the abroad large and complex investment and construction projects by Russian building companies with account of the peculiarities of world market conjuncture. Method of determining the acceptable level of risk is presented, recommendations and activities directed at reducing risk to an acceptable level in the process of enterprise strategy are given, typical sequence of steps in the procedure analysis of the factors and assessing the level of overall risk strategies is shown.

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Introduction

Investment and construction project (ICP), implemented abroad, is evaluated, in the first place, from the perspective of its economic efficiency, technical feasibility and environmental safety. The technical feasibility of ICP requires carrying out an expert examination of the chosen technologies, analyzing the expenses of construction operations, calculating time, required for the configuration of machines, equipment etc. [1].

The aggregate risk of implementing a large abroad complex ICP is a probability of occurrence, connected with the digression from a stated strategic goal of a developer (losses, costs, damages) in the process of implementing large complex investment and construction projects, having priority importance both for getting the positive result by the subject of construction business activity, and for improving the economic potential of the country and the country's image. Risk has a twofold property – probability of occurrence of a certain economic damage, known as pure risk, and another property of economic risk – the possibility of obtaining significant income at the acceptable boundary value and, as a result, providing the financial stability of the business entity [2].

The methodology of managing the aggregate risk implies special methods, including those using the toolkit of state and private partnership, which helps taking into account the uncertainty factor at all the building stages of ICP. The function of managing aggregate risk includes analysis, assessment and prevention of the risk occurrence, as well as taking measures to reduce its negative level and to distribute the possible damage from it among all the participants of project implementation [3].

As an object, at which the suggested project is oriented, there are used statistic data about nuclear power stations (NPS), built by the Russian Federation abroad and a unique special-purpose complex in Venezuela (Latin America).

The economic substance of the category "aggregate risk" allows the authors singling out the following three groups of factors and uses them to develop a hierarchical classification of risks relating to macro, - meso- and microlevels [4].

The first group includes the factors, the susceptibility to which is rooted in the structure of the foreign real estate complex, and which action is continuous and loss-making [5].

The second group is comprised by discrete emergency factors, depending on the state of biological environment, in which the object is implemented, and it is impossible to influence the probability of these risks occurrence, but there is possibility of lessening their impact on the object [6].

The third group includes the factors of efficient management of foreign projects with the purpose of counteracting the factors of the first two groups. Such measures are connected with financing R&D and introducing new innovation and technological solutions, insuring the construction business by a large foreign insurance company, using consulting and advertising services of international consulting firms etc. [7, 8].

In the methodology there is developed a hierarchical classification of risks by ICP managing levels with singling out the areas of risk occurrence, classification features and the assessment level.

Depending on complexity and deadlines of implementing an abroad ICP the structure of risks varies. The presented classifier of risks allows evaluating the aggregate risk and identifying the factors, which can have either negative or positive influence on its value. The stabilizing factors of the 3-rd group are aimed at the reduction of impact of the destructive factors of the 1-st and 2-nd groups and altering the probability of their occurrence.

The stabilizing factors can be aimed at the general reduction of impact of the destructive factors, or at lowering the probability of their action [4].

The expert analysis of the ICP aggregate risk with account of the sector and regional state is considered by the authors as the additive weighted convolution of their appraisal by points:

$$P = \sum_{i=1}^{N} A_j \cdot P_j \; ; \; P_i = \frac{1}{M} \sum_{i=1}^{n_i} a_{ij} \cdot P_{ij} \, , \quad (1)$$

where P_{ij} — scoring of i-th factor in the j-th kind of risk;
a_{ij} — weight of i-th factor in the j-th kind of risk;
n_i — number of the accounted factor characteristics in the j-th kind of risk;
M — the rating scale bound (from 1 to 10 points);
A_j — weight of the j-th kind of risk;
P_j — assessment of the j-th kind of risk;
P — the overall index of the aggregate risk.

The assessment of the ICP aggregate risk is carried out at the following limitations:

– assessment of the each factor is done within the developed scale depending on the level of influence of this factor on the ICP degree of risk at its ranging from 0 (no risk) to M (very high risk)

– the weight of each factor within the corresponding kind of risk and the weight of each kind of risk is determined within the interval (0÷1) at its normalization for the condition:

$$\sum_{i=1}^{n_i} a_{ij} = 1; \; \sum_{j=1}^{N} A_j = 1. \quad (2)$$

The coefficients of risks by its types from the suggested classifier and the overall index of the aggregate risk take values from the interval $0 < P_j < 1$ and $0 < P < 1$.

To plot the curve of the risk and determine the level of losses there is introduced the concept of risk areas in the developer's activity.

The risk area of ICP, implemented by a developer, is a certain area of its total losses at the foreign building market, within which the losses don't exceed the limit value of the set risk level [9].

There are 5 main limit values of risk of the developer's activity at the main stages of ICP implementation: minimum risk area; average risk area; elevated risk area; critical risk area; unacceptable (catastrophe) risk area. As a basis for setting the areas there were taken the requirements of the Central bank of Russian Federation for the level of an economic entity's overall liquidity.

The organizational and economic sustainability of a developer consists of productive-economic and financial-economic sustainability of the enterprise and is one of the ratios of risk assessment of a state contract executor with the involvement of SPP mechanism and is evaluated by the following formula:

$$E_s = 1 - \frac{\sum_{i=1}^{n} m_i}{n(n-1)} = 1 - \frac{M(R,N)}{n(n-1)} \, , \quad (3)$$

where E_s —assessment of organizational and economic sustainability of a developer;
n —number of indices in the dynamical model of sustainability (normative model);
m_i —number of inversions in the real order for the index, having the i-th rank (taking the i-th place) in the dynamical model;
$M(R,N)$ — sum of inversions in the real order of indices (R) relatively to normative order (N), set in the dynamical model.

Inversion in the presented assessment is represented by the ratio of the value $M(R,N)$ to $n(n–1)$. It characterizes the measure of the developer's aggregate risk and shows the deviation of the actual condition of the developer's functioning from the normal condition.

As an example of implementing a developer's strategy there is considered a process of implementation of an ICP of a unique special-purpose complex in Venezuela (Latin America) (fig. 1). The purpose of building a mathematical economic model of forecasting and monitoring is providing the organizational and economic sustainability of a developer for the period of strategic outlook. There is selected a strategic function S_k ($k = \overline{1;k_1}$, where k_1 — the total number of strategic functions of the considered enterprise). As it was mentioned before, the strategy formulates the main goals and objectives to be achieved, and the developer obtains a unified course of development. In this case the strategy is considered as a complex of strategic decisions, namely:

– implementing in future large complex ICPs and preparing the basis for taking decisions at the operative and tactical management levels;

– specific implementation time limits $T_{\max}$ and $T_{\min}$;

– considerable uncertainties, connected with uncontrolled external factors;

– involving large material, technical and financial resources, which can have long-range consequences for a developer [10].

Implementation of strategy S_k goes in several stages (fig. 1). At each stage the monitoring and control of risk level of the strategy is performed, and at the appearance of negative risks — managerial decision U_{mng} is developed.

T_1 — 1-st stage of control and management at implementing the strategy;

$(S_{k0}\ (t_0)$ — time from the beginning of implementation of strategy to the completion of 1-st control cycle):

$$\Delta_{10} + t_{10} = \Delta_{20} + t_{20}; \qquad (4)$$

In the block at the 1-st stage there takes place the process of transforming the complex of strategic decisions to the objectives of operative and tactical decisions, i.e. respectively $\{T_{k0}\}$ and $\{S_{k0}\}$;

t_{10} — moment of beginning the implementing of operative decisions complex $\{O_{k0}\}$ in the operative management subsystem;

t_{20} — moment of beginning the implementing of tactical decisions complex $\{T_{k0}\}$ in the tactical management subsystem;

Δ_{10}, Δ_{20} — period of time, after which the control of risk level of the implemented strategy for the operative and tactical management systems is required;

t_{10}, t_{20} are selected from the condition:

$$T_1 = T_{exp0} + T_{imp0} + T_{con0} + T_{mng0}. \qquad (5)$$

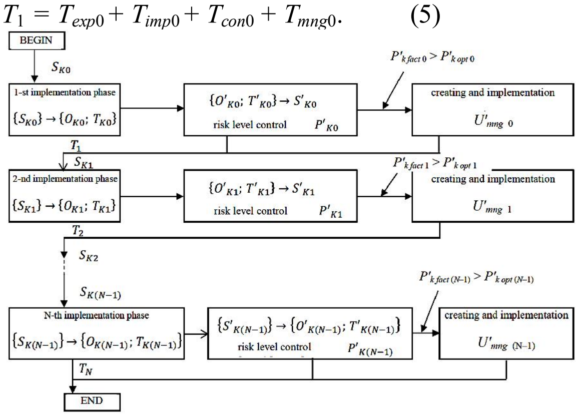

Fig. 1. Developer's strategy implementation process

In fig. 2 there is shown the 1st stage of implementing strategy S_k.

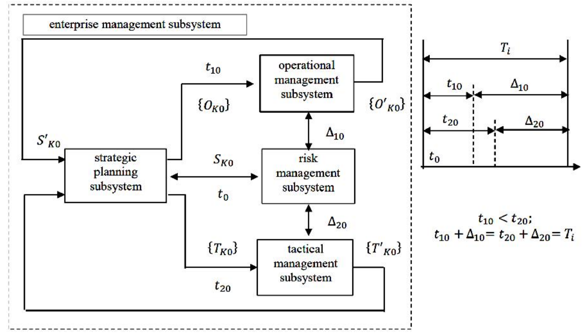

Fig. 2. Structure of implementing strategy S_k at the1 stage

At this there were used the following designations:

t_0 — moment of starting the implementation of strategy S_k;

T_{exp0} — expectations at the 1-st stage of implementation of the strategy (period from moment t_0 to the moment of strategy implementation);

T_{imp0} — period of time in subsystems of operating and tactical control in the implementation of the strategy at the 1-st stage;

T_{con0} — period of time, necessary for controlling the level of risk;

T_{mng0} — period of time, necessary to develop and implement the managerial decision.

Then

$$\{O'_{k0}; T'_{ki'}\} \rightarrow \{S'_{k0}\}, \quad (6)$$

where O'_{k0} — complex of operative decisions after finishing period of time Δ_{10};

T'_{k0} — complex of tactical decisions after the finishing of period of time Δ_{20};

S'_{k0} — complex of strategic decisions, after finishing the implementation phase at the 1-st stage.

The risk analysis of strategy S'_{k0} ends with the assessment of the integrated aggregate risk of strategy P'_{k0}.

If $P'_{k\,fact0} > P'_{k\,opt0}$, there is developed the strategy of controlling action, the aim of which is to lower the risk level to the acceptable value. In case, if $P'_{k\,fact0} \le P'_{k\,opt0}$, the strategy goes to the 2-nd stage of its implementation, omitting the control procedure.

After the time T_1 begins the 2-nd stage of implementing strategy S_k and the strategy looks as follows (fig. 3).

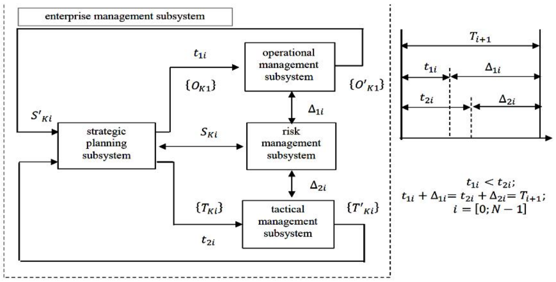

Fig. 3. Structure of implementing strategy S_{ki} at the stage (i+1)

To stage (i+1) goes strategy in form
S_{k1} (i = 0; $N-1$),
where N — the total number of stages.

Time (i+1)-the stage of the cycle of implementing, control and management can be defined as:

$T_{i+1} = T_{exp\,i} + T_{imp\,i} + T_{con\,i} + T_{mng\,i}$, (7)

where $T_{exp\,i}$ — period, necessary for waiting at the (i+1)-th stage, connected with the confirmation of strategy S_{ki} to the beginning of complexes of tactical and operative actions:

$T_{exp\,i} = \max\{t_{1i}; t_{2i}\}$, (8)

where t_{1i}—period from the beginning of accepting strategy S_{ki} to the beginning of actions, connected with operative decisions $\{O_{ki}\}$ at the (i+1)-th stage;
t_{2i}—period from the beginning of accepting strategy S_{ki} to the beginning of actions, connected with tactical decisions $\{T_{ki}\}$ at the (i+1)-th stage;
$T_{imp\,i}$ — period of implementing the strategy at the (i+1)-th stage of tactical and operative management.

The overall period of strategy implementation, consisting of N stages for the (i+1)-th stage

$$T^* = \sum\left(\max\{t_{1i};t_{2i}\} + \min\{\Delta_{1i};\Delta_{2i}\} + T_{coni} + T_{mngi}\right) \quad (9)$$

where Δ_{1i}— time for implementing the complex of operative decisions $\{O_{ki}\}$;
Δ_{2i} — time for implementing the complex of tactical decisions $\{T_{ki}\}$;
$T_{con\,i}$ — time of monitoring and control of the level of aggregate risk of strategy S'_{ki};
$T_{mng\,i}$ — time, required for developing measures for lowering the risk level to the acceptable value (in case, when $P'_{k\,fact0} > P'_{k\,opt0}$).

In case, when $\sum_{i=0}^{N-1} T_{mng\,i}$ = 0, we have the period of time of strategy implementation (fig. 4).

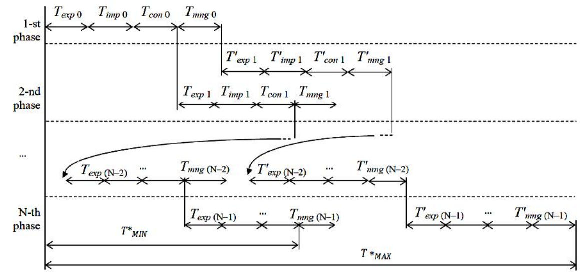

Fig. 4. Determination of time periods $T_{\min}$ and $T_{\max}$ of implementing the strategy of the developer

At the time limits of implementing $T_{\min}$ and $T_{\max}$ it's necessary to observe the terms

$$T^* \in [T_{\min}, T_{\max}]. \quad (10)$$

Let for the i-th optional stage in the block there is cumulated If in case of developer obtaining stochastic or expert information of the averages of random parameters: $T_{exp\,avg}$; $T_{imp\,avg}$; $T_{con\,avg}$; $T_{mng\,avg}$, so for N stages we have:

$$T^*_{\min avg} = N\left(T_{exp\,avg} + T_{imp\,avg} + T_{con\,avg}\right);$$
$$T^*_{\max avg} = N\left(T_{exp\,avg} + T_{imp\,avg} + T_{con\,avg} + T_{mng\,avg}\right). \quad (11)$$

With account of the previous formula, financial restrictions and external conditions N we obtain:

$$N \geq \frac{T_{\min}}{T_{exp\,avg} + T_{imp\,avg} + T_{con\,avg}};$$
$$N \leq \frac{T_{\min}}{T_{exp\,avg} + T_{imp\,avg} + T_{con\,avg} + T_{mng\,avg}}. \quad (12)$$

The process of monitoring the control of a strategy's aggregate risk level in a certain period of time can be presented as follows.

$P'_{k\,fact\,i} \leq P'_{k\,opt\,i}$. (13)

Monitoring and control of the aggregate strategy risk level includes the following stages:

– **stage I** — qualitative evaluation of risk with forming the factor space and model of the objective empirical area of strategy S_k risk without specific numerical values of probability parameters. At stage I there is carried out the necessary information collection about the structure subdivisions of a developer and contractor organizations, doing building works at the critical path.

The importance of this qualitative evaluation should be accentuated. The competitiveness of organizational and economic sustainability of a developer, its organizational structure should be such that the work of its structure subdivisions and the main contractor organizations at implementing and abroad ICP were concentrated on activities, connected with the set time-limit of performing the main building works. That is why at the differentiation of information collection function, its maximal adequacy and reliability are ensured.

At the **stage II** in the organizational structure subdivisions, determined at the first stage, the quantitative characteristics of risks are calculated: $P(A_{ij}$, $EMV(A_{jj})$ at $i = \overline{\overline{1;p}}$, $j = \overline{\overline{1;q}}$,

where q_i — the quantative value of the recorded causes of an event occurrence A_{ij}.

Time, necessary for the calculation of parameters data, is determined from the equation:

$$t_{calc} = \max\{t(A_{ij})\}. \quad (14)$$

III, IV and V stages are connected with selecting the index of the aggregate risk of the strategy, determining the risk area and calculating the integral value of risk [11]. The aggregate time of assessment of strategy risk t_{ast};

$$t_{ast} = t_{qlt} + t_{qnt} + t_{rcr} + t_{rar} + t_{val}, \quad (15)$$

where t_{qlt} — qualitative assessment;
t_{qnt} — quantitative assessment;
t_{rcr} — selecting the risk criteria;
t_{rar} — selecting the risk area;
t_{val} — determining the risk cumulative value of the strategy.

The process of risk management includes the following sequence:

1 stage — developing measures, aimed at lowering the risk level to the required value;

2 stage — the value appraisal of measures, aimed at lowering risk, is done in case of the adherence of inequation

$$C_{mng} \le C_{opt}, \quad (16)$$

where C_{opt} — optimal cost of implementing risk management procedures,

3 stage — implementation of the function of risk management.

If conditions of the inequation (16) are not fulfilled, it's necessary to develop measures of risk management, or reconsider the developer's strategy. After the introduction of alterations the strategy goes through all the stages again. This implies, that

$$t_{mng} = h\,(t_{creating} + t_{cost})\,t_{implementation}, \quad (17)$$

where h — the necessary quantity of developing the measures of risk management.

At this the function of risk management goes through all the cycles in the structural subdivisions of the developer.

Information reliability and marketing research are the necessary condition of economic sustainability of the developer, ensuring the relevant information analysis base for taking economic decisions [12].

Providing the economic sustainability of a developer is inseparably associated with managing the aggregate risk.

The actual integrated index of the economic sustainability (E_{sus}^{act}) is determined by using the methodology of Analytic Hierarchy Process by T. Saaty with account of the overall indices of the investment and entrepreneurial risks. Deviation E_{sus}^{act} from the admitted value E_{sus}^{adm} is the integrated specification of aggregate risk, reflecting the amount of possible losses (–) or gains (+) of random character [13].

The essence of methodology of functional and statistical modeling consists in the hierarchical structuring of the integrated index E_{sus}^{act}, its qualitative values at the each index of the corresponding level of productive-economic and financial-economic sustainability of a developer.

The hierarchical approach to developing and taking decisions in the system of functional and statistical modeling is of constant cyclical character and consists of the following basic stages:

– collecting the dynamics and analyzing information;

– forecasting the situation and developing measures for taking decisions;

– monitoring and controlling the decision implementing;

– evaluation of results with account of aggregate risk.

The assessment of risk of a developer's strategy is based on a comprehensive (science, technical, technological, marketing, sociological etc.) research of a construction company and its business environment as risk sources, analysis the external and internal risk factors, building a risk profile at the action of this or that risk factor, determination of indices of assessing the risk level, and on identifying mechanisms and models of the interrelation between indices and factors of risk [14].

Managing the risks of strategies (S_k) includes developing and implementing the economically feasible for the developer company recommendations and measures, aimed at lowering the initial risk level to the acceptable level [4].

The practical application of the acceptable risk methodology in the process of forming the enterprise's strategy allows:

— identify the possible situations, connected with the adverse development, which can result in not achieving the set goals;

— obtain the characteristics of the expected monetary value, connected with the adverse development;

— plan and implement in advance, if needed, the measures to lower risks to the acceptable level.

A certain procedure, connected with analyzing factors and assessing the level of aggregate risk of S_k strategies can vary, depending on a specific task, the actual situation of a developer, state of business environment and time of work performance, connected with the implementation of the abroad ICP. Though, in the opinion of the authors, we can single out a certain standard sequence of stages, namely:

– taking into account the international normative requirements and standards, as well as national peculiarities at the pre-investment phase and construction phase;

– qualitative evaluation of the strategy risk (analyzing information about structure subdivisions, contractor organization, forming the risk profile of the strategy);

– quantative evaluation of the aggregate strategy risk (selecting the mathematical model of quantative characteristics and risks);

– choosing the index of the aggregate strategy risk;

– selecting the scale of alteration of the aggregate strategy's risk level (nominal scale, order scale, ratio scale, absolute scale [0, 1];

– calculating the integrated index of the aggregate risk of the strategy $0 \leq R^k_{act.} \leq 1$ (by using method of functional and statistical modeling);

– developing measures and practical recommendations for lowering the strategy's risk level to its acceptable value.

The efficient management of the aggregate risk is impossible without special methods of analysis and control [15].

The developed methodology of managing aggregate risk at implementing abroad ICP is an available toolkit, allowing:

– carry out the operational and predictive analysis of the developer's activity with the account of external and internal risk factors;

– take into account different types of risk, influencing the aggregate level of risk of the project;

– detect the level of organizational and economic sustainability and, consequently, the risk level of a developer;

– plan and forecast the displaying of risks in the process of investing activities;

– develop measures of restoring the organizational and economic sustainability of a company within the acceptable level of risk.

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