

# Algorithm for Assessing the Risks of Small Business Project Financing

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**Abstract**— The article examines the algorithm for estimation of the risks of small business financing, based on the method of median distributions in the formation of the enterprise's investment strategy with subsequent vector optimization of local evaluation criteria.

The choice of the optimal method for estimation of the risks of small businesses financing is characterized by the complexity and high degree of various factors and conditions interdependence, and also by the need of taking into account all possible parameters of the economic system.

While carrying out information training, there is a need to identify first all the constraints that are imposed on the use of resources necessary to achieve the strategic objectives of financing, as well as to determine the most beneficial alternative to which these resources need to be invested.

The list of risks inherent in entrepreneurship is extremely wide. The choice of a method for assessing the risk of financing is objectively one of the most important stages of investment planning, and its purpose is to identify the extent of the possible consequences of the risk.

Therefore, when considering each particular type of risk, as a criterion for accepting or not accepting an investment project, it becomes necessary to apply multi-criteria analysis methods in order to choose the best alternative.

The authors suggest the algorithm for estimation of the risks of small businesses financing.

In the course of the research conducted in the article, it is convincingly proved that the suggested algorithm provides an objective estimation of the options for small businesses financing, encompassing a list of possible heterogeneous risks that may arise during the implementation of the investment project, while revealing the most effective project for implementation in the first place. The received preference vector for the group of risk factors determines the top-priority objects for investments in the small business sector.

**Keywords**— risk, financing risks, risks of small business, algorithm for risk assessment

## I. INTRODUCTION

Each enterprise carries out investment activities in one way or another. This is due to the fact that for its development the enterprise must constantly invest in the acquisition of new fixed assets and the renovation of existing ones, in the expansion of business, in its diversification, in securities, etc. The success of investment depends on the soundness of the company's investment strategy, namely:

- approach to the formation of the investment portfolio of the enterprise;
- the right choice of investment projects;
- demand for investment projects;
- achievability of investment project results;
- timeliness of investments;
- budget, which the enterprise has to implement investment projects;
- level of costs of investment projects and the likelihood of their increase in the investment process;
- the level of professionalism and competence of specialists involved in investment projects, etc.

## II. RELEVANCE AND SCIENTIFIC SIGNIFICANCE OF THE ISSUE

Despite the fact that every enterprise must carefully develop an investment strategy, special attention to its reasoning should be paid by small businesses. This is due to the limited resources of small businesses, the lack of a financial cushion of security, the inability to broadly diversify projects, which is why the failure of even one investment project can seriously shake the financial stability of a small enterprise and worsen its position on the market.

It should be noted that any investment project is risky, because any of the above factors can have negative manifestations, that, taken together, would make the investment project unprofitable for the enterprise. In addition,

any project is influenced by the external environment, the effects of which can negate all carefully selected factors of the internal environment, if the enterprise does not monitor such opportunities.

## II. FORMULATION OF THE PROBLEM

Thus, the relevance of the study is to develop an algorithm for assessing the overall risk of small business project finance, the use of which will allow small enterprises to comprehensively assess the enterprise's risks when financing investment projects and choose the best alternatives.

## III. PRACTICAL SIGNIFICANCE, PROPOSALS AND RESULTS OF IMPLEMENTATION

Let us choose certain factors that characterize the riskiness of alternatives to investment projects in terms of the possibility of not receiving the required level of income, or non-receipt of profits. The risk assessment of project financing can be carried out in various ways and methods, including the classical method of measuring the risk of investments through covariance, as well as alternative approaches.

An analysis of the existing literature on the problem of financing small business investment projects allows suggesting that it is most effective to estimate the overall risk of an investment project in a complex.

The most significant types of risk are presented below:

- risk of loss of profits;
- risk of change in the estimated cost of an object;
- inflation risk;
- currency exchange risk;
- market risk;
- risk of ineffective project management;
- transport risks;
- branch risk;
- innovation risk;
- risks of administrative management;
- force majeure risks.

The construction of an algorithm for the selection and evaluation of the aggregate risk of project financing for small business is based on the use of the method of median distributions in the formation of the investment strategy of the enterprise, in particular Kemeny's median method.

The algorithm of the developed valuation model is presented below:

1. Assignment by the expert group of the influence level of the types of risk identified in the process of small business project financing to its final result  $q_n$  in the range from 0 to 1.  $Q_j$ ,  $j=1,q$ ; (where  $q$  is the number of risk types considered in the assessment) for each project alternative  $A_i$ ,  $i=1,n$ , (where  $n$  is the number of assessed projects)

2. The construction of a matrix of values of risk assessment factors for each of the proposed alternative small business projects  $Q=\{Q_{ji}\}$ .

3. Determination of the optimization directions (max/min) for the rows of the matrix, on the basis of which the vectors of

advantageous alternatives are formed in the following kind:  $\alpha_j = (\alpha_{j1}, \alpha_{j2}, \alpha_{j3}, \dots, \alpha_{jn})$ . Since we are talking about the level of the negative impact of risk on the result of project financing, and the goal of planning project alternatives is to reduce it to a minimum, all rows of the matrix will be optimized in the minimum direction.

4. The construction according to each of the vectors of advantageous alternatives  $\alpha_j$  of the preference vector  $P_j = (P_{j1}, P_{j2}, P_{j3}, \dots, P_{jk})$ ,  $j=1,k$ ;  $P_{jn}$  is ordinal number of the project occupying the  $i$ -th place in the ranking of projects for the  $j$ -th type of the estimated risk.

5. Finding of the averaged group ranking by calculating Kemeny's median

The average group ranking is evaluated to reflect the best results of preferences for each factor of the investment risk type by calculating the Kemeny's median as the distance between two rankings:

$$\bar{\alpha} = \min \sum_{j=1}^q \sum_{i=1}^n |\alpha_i - \alpha_i^j|, \quad (1)$$

### 5.1. Arraying of a loss matrix $L=\{l_{ms}\}$

The loss matrix  $L=\{l_{ms}\}$  is arrayed by modifying the vectors of advantageous alternatives of project financing of small business  $\alpha_j = (\alpha_{j1}, \alpha_{j2}, \alpha_{j3}, \dots, \alpha_{jn})$  with the location of each of them  $i(i=1,n)$  sequentially from the 1st place of preference to the  $n$ -th place. Total losses in the aggregate of complex indicators  $k$   $l_{ms}$  are calculated by the formula:

$$l_{ms} = \sum_{s=1}^k |\alpha_m - \alpha_m^s| \quad (2)$$

where  $m$ -th project stands in place  $s$  according to preference ( $\alpha_m^s = s-1$ ).

5.2. Reduction of the evaluation algorithm to the solution of the assignment problem using the following constraints:

5.2.1. The constraints of the first group ensure the uniqueness of each selected variant of project financing. A two-dimensional array  $X=\{x_{ms}\}$  is constructed. The purpose is an acceptable solution. It is searched for by selecting a single value in each row and each column of the  $X=\{x_{ms}\}$ . For a given value of  $n$ , there exist  $n^*$  admissible solutions.

$X_{ms} = 1$ , if  $A_m$  (variant of project financing) is on the  $s$ -th place according to the preference;

$X_{ms} = 0$ , if  $A_m$  (variant of project financing) isn't on the  $s$ -th place according to the preference.

5.2.2. The constraints of the second group ensure that each project alternative will be assigned one place of preference in the vector of advantageous alternatives.

$$F(X) = \sum_{m=1}^n \sum_{s=1}^n l_{ms} \cdot x_{ms} \rightarrow \min \sum_{m=1}^n x_{ms} = 1, m = 1, \dots, n;$$

$$\sum_{s=1}^n x_{ms} = 1, s = 1, \dots, n;$$

$$x_{ms} \in 0, 1.$$

When the constraints of the second group are fulfilled, the matrix  $X=\{x_{ms}\}$  acquires the form  $X_{opt}=\{x_{optms}\}$ .

6. Restoring of the vector of preferences for a group of risk types of small business projects: if  $x_{opt\ ms}=1$ , then in the vector  $P_{jint\ pjintl}=m$ .

The investment alternative, which ranks first in the vector of risk preferences for a small business project, is the most effective for implementation in terms of minimizing the risk that are possible at any stage of the project.

#### IV. CONCLUSION

Accordingly, the algorithm developed by the authors of the article for assessing the risk of small business project financing allows for a detailed and objective analysis of the effectiveness of investment in a small business project solution in terms of minimizing the negative impact of the risk factors inherent in small business.

The practical application of the algorithm is carried out in the following sequence:

- A table of values and directions of optimization of the indicators for evaluation of the impact of risk factors on the result of project financing of small businesses for enterprise projects is plotted (table 1).

Table 1. Expert evaluation of the influence of the risk factor on the result of project financing of the small business project

Risk factors	Project 1	Project 2	Project 3	Direction of optimization
Risk of loss of profits	60	45	61	min
Risk of change in the estimated cost of an object	10	30	25	min
Inflation risk	30	25	34	min
Currency exchange risk	20	30	40	min
Market risk	17	50	15	min
Risk of ineffective project management	12	36	17	min
Transport risks	25	10	10	min
Branch risk	7	9	25	min
Innovation risk	12	16	20	min
Risks of administrative management	2	4	18	min
Force majeure risks	40	35	20	min

- Vectors of advantageous alternatives are formed for 11 risk factors.

- Preference vectors  $P_j$  are set according to each of the vectors  $o_j$ .

- The loss matrix  $L = \{l_{ms}\}$  is constructed by performing the modification of the vectors of advantageous alternatives  $o_j$  with sequential arrangement of each  $i$ -th project from the first to the last place of preference according to the formula (2):

$$L = \begin{bmatrix} 7 & 8 & 15 \\ 13 & 7 & 10 \\ 14 & 9 & 8 \end{bmatrix}$$

- The Kemeny's median is found by solving the assignment problem.

- The minimal elements are subtracted by rows in the matrix and a new table is plotted:

- An optimal matrix of assignments is constructed, which in this case are admissible solutions  $X_{opt}=\{x_{optms}\}$ :

$$X_{opt} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

The preference vector for the group of indicators of risk assessment  $R_i$  is restored by means of matrix analysis by rows.  $x_{11}=1; x_{22}=1; x_{33}=1$ , therefore, the preference vector for the group of complex indicators will look like this:

$$P(R_n) = (1,2,3).$$

Accordingly, the project financing option No. 1 for the risk factor assessment group is the most preferable.

In the course of the study, it was convincingly shown that the authors' algorithm provides an objective assessment of the options for project financing from the point of view of the risk component. The received preference vector determines the priority objects for investments in the small business sector in terms of reducing the negative impact on the economic outcome of the project. The objectivity of the data obtained is confirmed by the findings of a number of small enterprises in Saratov. Estimates are given in the example.

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