Methodological Approach to Assessing Performance of the Organization Projects

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Abstract

Objectives: This article develops a methodological approach to assessing performance of the organization investment projects with an allowance for an integrated risk factor. Methods: The integrated value of risks was determined by multivariate statistical analysis. The taxonomic analysis method was used as a variation of the multivariate statistical analysis. To determine the optimal portfolio of the organization's investment, the projects were diversified by the degree of profitability and level of risk. The differentiation was carried out using Kohonen neural networks by allocating clusters of input vectors, having common properties. Findings: Quantitative characteristics of investment project risk factors specified by the conditions of uncertainty of its implementation have been determined within the scope of research. An integrated index of risk factors of the organization investment project has been calculated by taxonomic analysis. This index takes into account multidimensionality of impact exerted by the destructive factors on implementation of the organization project. Discriminant functions have been developed which allow classifying economic feasibility of the investment project with regard to comparison of rate of return and integrated level of the investment project risk. The proposed methodological approach is a versatile tool of project performance diagnostics enabling to consider the diversity of risk factors of its implementation. It is not limited by the terms and variability of investment projects. Application/Improvements: This approach allows optimizing the process of project portfolio formation.

Keywords: Financial Rate of Investment Project Return, Integrated Risk Factor, Organization Investment Project, Performance Assessment

1. Introduction

Investment project activity is one of the most important aspects of functioning of any organization. Reasons determining the necessity of investment activity are renovation of the existing material and technical basis, expanding the production capacity, entering new business areas, etc. Meanwhile in the modern investment practice, as demonstrated by the statistical observations of Standish Group Chaos, of all projects implemented in the organizations only 32% were successful, 44% were challenged (having cost overrun, budget deficit and other drawbacks), and 24% were failed projects.

The causal factors of this situation include inefficiency of the approaches to the assessment of economic feasibility of the investment projects and project risk management in the organizations, to the problem of selecting tools and approaches of their detection and elimination. Planning and implementation of projects in any organization occurs in the conditions of uncertainty, which is generated by changes in the internal and external environment. This implies absence of complete and reliable information about the conditions of the project implementation.

Uncertainty, relating to the possibility of creating unfavorable situations and consequences in the course of the project implementation, is connected with risk. In the market economy project risk is an integral feature of economy management in any organization, and uncertainty results in the fact that it becomes impossible to avoid risk event. Timely identification and neutralization of external and internal hazards in the development and implementation of projects, reliable monitoring of their economic feasibility may decrease considerably the extent of the organization’s financial losses and ensure safety in imple-
2. Literature Review

Development and implementation of various projects is an integral part of efficient functioning of any organization in the context of increasingly growing market competition. In this connection assessment of their performance, analysis and management of project risks as a threat to the economic usefulness of the organization's project becomes a generally recognized methodology of quality and feasibility assessment of the organization's projects.

Understanding of the essence of investment project performance and risk is a theoretical basis of these scientific issues under investigation. Whereas understanding of the essence of investment project performance is characterized by a relative agreement of the scientists' viewpoints implying compliance of the investment project costs and results with the interests and purposes of all its participants, striking discrepancy occurs with regard to the conceptual interpretation of risk. This is explained by the fact that risk is a complex multi-faceted phenomenon having multiple various actual foundations. Determination of possible risk consequences is a key statement in the discussion of the scientists. Most scientists understand risk as a probability that the return on the investment made will differ from the expected one. Thus, risk includes not only unfavorable (rate of return being below the expected one), but also favorable (rate of return being above the expected one). In our opinion, this view is incorrect. Since referring to this conceptual position it can be assumed that for the positive cash flows economic risk is that they may be less than predictable cash flows, and for the negative cash flows it implies that their values can exceed the predicted. The possibility for the positive cash flows to be above the predicted ones and for the negative cash flows to be below the predicted ones is not an economic risk at all. In this connection, based on the position of Damodaran, within the scope of the study risk is determined primarily by the terms having a negative connotation, i.e. as a probability of arising unfavorable financial consequences in the form of loss of all or a part of the expected investment return due to implementation of a definite investment project in the situation of uncertainty of conditions for its implementation.

In modern literature the methodological basis for assessing performance of the organization's investment projects is characterized by diversity of approaches and variability of their application. Thus, the most widespread approaches to project assessment include adjusting discount rates and validation of equivalents, analysis of perceived relevance of project performance indicators. These approaches are based on definition of the economic feasibility in terms of relative and absolute indicators of the project rate of return. The shortcoming of this approach is a project performance assessment with regard to risk-free discount rate. In the conditions of the project uncertainty this fails to reflect reliably the impact of destructive factors on the possible financial loss of the organization in the course of project activity implementation. Moreover, these methods preclude assessing project performance in the longer term, for example, projects exceeding 10 years.

The methods of scenarios and game theory refer to more improved approaches to assessing organization's project performance. They allow forming project implementation scenarios depending on the changing factors of its external and internal environment.

The modern investment practice is represented by an escalation of applying mathematical modeling in the process of development and diagnosis of the organization's projects. This trend is caused by the possibility of a mathematical apparatus to transform qualitative criteria of the investment project into the quantitative ones – more accurate data for its regulative assessment. The capital asset pricing model, Capital Asset Pricing Model (CAPM), and its derivative forms, the model of the formation and evaluation of investment portfolios by Tobin and Markowitz seem to be the most interesting in terms of a set of techniques and methods. The fuzzy-set theory occupies a special place in the methodological toolkit for project assessment.

It should be noted that the above methodological approaches to assessing the organization's project performances have many advantages and disadvantages of their own, analysis and presentation of which are dealt in a lot of scientific papers. In this study, the emphasis is made on the problems of allowance for risk when assessing the investment project performance.
Net Present Value (NPV) of the project is fundamental for any approach to assessing the organization’s investment project performance\textsuperscript{25-27}. Calculation of the organization’s project NPV is based on determination of the discount rate. This indicator makes it possible to evaluate the excess of total cash receipts over the total cost for a specific project with regard to the disparity of costs and results, formed at different times\textsuperscript{28}. Despite the advantages of determining the net present value in the process of assessing the organization’s project performance\textsuperscript{5,11}, this method has significant drawbacks. Performance of investment projects is determined using the above methods with allowance for risk-free discount rate, i.e. when the second coordinate of the ‘vector’– risk – is equal to zero.

But the estimated cash flows of the organization’s projects relate to the future periods and are of predictive nature, determination of the project performance factor is accompanied by the impact of multiple factors of its internal and external environment. Uncertainty of the predicted results leads to a risk that the expected project objectives may not be achieved in whole or in part.

An attempt to quantify risks in assessing the rate of return of the organization’s investment projects in contemporary literature is reflected in such approaches as the Monte Carlo method\textsuperscript{29,30}, allowance for economic risks based on indicators of variation or expert evaluations\textsuperscript{31}. The disadvantage of these approaches is an allowance for risks as an alternative economic result of project implementation, including consideration of a positive economic result. In addition, these methodological approaches are a special case in the framework of the choice theory in risk assessment, not enabling to take into account the multidimensional nature of the conditions of project implementation uncertainty. They are also characterized by inflexibility of the methodological toolkit, that is, the absence of the ability to apply the full-fledged analysis of scenarios, actually existing in the formation and implementation of the portfolio of the organization’s investment projects.

Referring to the shortcomings of the conceptual approaches to resolving problems of this scientific field, the aim of the study was to develop a methodical approach to assessing performance investment projects of the organization by taking into account diversity of risk factors of its implementation, and to form such methods for economic feasibility diagnostics of the organization’s project, which would be characterized by its a simplicity and operational versatility and consider the variability investment projects and destructive factors of their implementation.

3. Research Methodology

3.1. Sample and Data Collection

The basis of the scientific research was a sample of 25 typical projects implemented in the appropriate year, as exemplified by the Russian project organization Invest project LLC over the period from 2011 through 7 months of 2015. In 2011 the organization implemented the following group of projects: “Flora Ru”; “Solar Batteries”; “Production of Phospholipid Preparations”; “Efficient Location of Production, Storage and Primary Processing of Potato and Vegetables” and “Logistics Center”. In 2012 the following projects were carried out: “Bread Factory”; “XXX” Trading Network; “Brewery”; “Plastic Packaging” and “Roofing”. The group of 2013 investment projects included: “Cheese Production”, “Instant Photo Booth Nework”; “Reinforced Concrete Products” and “Mini-Brewery”. In the next 2014 the following projects were executed: “Logistics Company”; “Extreme Park” “Wood Shop”; “Log Hut Manufacture” and “Glass Packaging”. Project activity of organization over 7 months of 2015 was characterized by such projects as: “Specialized Fleet”; “Eco technologies”; “Gelion” and “3D Production Studio”\textsuperscript{31}.

Project implementation, as a probabilistic event, is accompanied by a high degree of uncertainty in such elements as purposes and technologies to achieve them\textsuperscript{25}. This necessitates their most comprehensive quantitative and qualitative determination and consideration of the impact on the project performance factor of the organization’s project. Identification of implementation risks of the organization’s projects is based on determining the risk system of the internal and external environment of projects. On the basis of generalizations supported by research of the leading scientists in this field\textsuperscript{11,17,32}. The fundamental risks were highlighted, affecting financial rate of return of the organization’s project. Since the formed risk system reflects the qualitative values, this study determined the key indicators enabling to characterize their quantitative level (Table 1).

Despite the projects are long-term plans of economic activity of organization, a coefficient of depreciation is used as a quantitative criterion of production and technological risk. This position is explained by the fact that the situation is possible to arise when in the process of the
project implementation the organization takes on lease worn-out fixed assets.

On the basis of the reliable data of Invest project LLC\textsuperscript{31}, the Federal State Statistics Service of the Russian Federation\textsuperscript{33}, WGI\textsuperscript{34}, a statistical sample of quantitative risk criteria was formed for each project of the study group of the organization’s investment projects (Annex 1, Table A1).

A key feature of economic feasibility of the project is considered to be a relative value of its rate of return, definable in the practice of the organization’s project management as a cost-adjusted NPV. The calculation of rate of return of the organization’s project involves consideration of the monetary risk value\textsuperscript{27}. This type of risk was not taken into account when calculating the taxonomic risk indicator of the organization’s investment projects. Such an approach is justified by the task of neutralizing of their impact duplication in two key indicators for assessing the feasibility of investment project.

Using content characteristics of inflation, inflation rate, currency devaluation and refinancing rate are adopted as components of a monetary risk of the organization’s project profitability. Their statistical base has been formed according to the data of the Federal State Statistics Service of the Russian Federation\textsuperscript{33} and the Central Bank of the Russian Federation\textsuperscript{35} by year of implementation of the projects under study (Table 2).

### Table 1. Systematization of the organization’s project implementation risks

| External risks              | Economic | Political | Social | Environmental | Regulatory |
|-----------------------------|----------|-----------|--------|---------------|------------|
| Rate of GDP drawdown        |          |           |        |               |            |
| Political instability       |          |           |        |               |            |
| **Indicator**               |          |           |        |               |            |
| The proportion of population with incomes below the subsistence minimum |          |           |        |               |            |
| The increase in emissions of air pollutants |          |           |        |               |            |
| Absence of supremacy of statute law |          |           |        |               |            |

| Internal risks              | Manufacturing and technological risk | Marketing risk | Risk of decrease in financial stability of organization | Project underfunding risk | Structural operational risk |
|-----------------------------|-------------------------------------|----------------|----------------------------------------------------------|---------------------------|---------------------------|
| Indicator                   | Manufacturing and technological risk | Marketing risk | Risk of decrease in financial stability of organization | Project underfunding risk | Structural operational risk |
| Depreciation coefficient    | Level of revenue volatility         | Leverage ratio  | Weighted average capital cost                            | Percentage of fixed costs in the total amount |

3.2 Research Methods

Since the formed research hypothesis assumes the most complete account of all the risks in each of the identified investment projects, it is advisable to determine the integrated value of risks by multivariate statistical analysis. The taxonomic analysis method was used in the study as a variation of the multivariate statistical analysis. This approach, based on the statements\textsuperscript{36,37}, makes it possible by means of standardization of the dimensions of the employed indicators and their aggregation to form a synthetic value – the integrated indicator of risk. Technology for defining risk development benchmark of the organization’s projects involves the distribution of features on the incentives and disincentives. Since risk acts as a vector-standard and all the indicators are risk characteristics, the study identified only indicators-incentives which exert directly proportional impact on the performance indicator.

To determine the optimal portfolio of the organization’s investment, they are diversified projects in the study by the degree of profitability and level of risk. The differentiation is carried out using Kohonen neural networks by allocating clusters of input vectors, which have common properties. The advantage of this approach in the study is the possibility to use variables not characterized by the laws of Gauss and the accuracy of the performance indicator, expressed in minimum statistical error, the value of which should approach to zero\textsuperscript{38}.

Financial rate of return and risk level of the investment project subjected to clustering are input vector of

### Table 2. Indicators of the monetary risk factors of the organization projects

| Risk factor                     | 2011 | 2012 | 2013 | 2014 | 2015* |
|---------------------------------|------|------|------|------|-------|
| Inflation rate, %               | 6.10 | 6.60 | 6.50 | 11.40| 16.20 |
| Currency devaluation, %         | 5.64 | -5.66| 7.76 | 71.89| 16.73 |
| Refinancing rate, %             | 8.13 | 8.08 | 8.25 | 8.25 | 8.25  |

* Figures for 2015 are projections with regard to 7 months of 2015 based on the assessments of the RF Central Bank
Kohonen networks. Linear weighted combiners were used as Kohonen network neurons. Each $j$-th neuron is described by weight vector $w_j = (w_{j1}, w_{j2}, \ldots, w_{jm})$, where $m$ is a number of components of input vectors. The input vector takes the form $x_i = (x_{i1}, x_{i2}, \ldots, x_{im})$.

In Kohonen networks to obtain reliable results learning through competition mechanisms (..) was applied. When applied to the network input of vector $x$ the neuron wins whose weight vector differs from the input vector least of all. For the winning neuron of the following relation is fulfilled:

$$d(x, w_j) = \min_{1 \leq i \leq n} d(x, w_i),$$

where $n$ – quantity of neurons,

$j$ – the winning neuron index,

d $(x, w_j)$ – distance (in terms of the selected metric between vectors $x$ and $w$).

Euclidean measure was used as a measure of distance in the study:

$$d(x, w_j) = \|x - w_j\| = \sqrt{\sum_{j=1}^{m} (x_j - w_{ij})^2}$$

(2)

A surrounding environment consisting of the neurons with similar properties is formed around the winning neuron. This results in formation of clusters of investment projects based on cumulative criterion of risk level and rate of return.

To create a toolkit for assessing economic performance of the project in the study by the discriminant analysis the functions were formed for the classification of the organization’s investment projects, taking into account the level of comparability of the integrated risk factor and the rate of return.

The discriminant analysis is aimed at classifying an object based on measurement I various characteristics (features), i.e. refer it to one of several pre-set groups (classes) by some optimal method.

In general case the discrimination problem is formulated as follows. Let construction of $m$-dimensional random vector $X = X_1, X_2, \ldots, X_m$ be a result of observation over an object, where $X_1, X_2, \ldots, X_m$ are features of the object. It is required to establish a rule (to construct a discriminant function), according to which by the values of coordinates of vector $X$ the object shall be referred to one of possible $\pi_i$, $i = 1, 2, \ldots, n$.

Discriminant functions are written as follows:

$$f_{i,m} = u_0 + u_1X_{1,m} + u_2X_{2,m} + \cdots + u_pX_{p,m}$$

(3)

where $X_{i,m}$ is a value of the discriminant variable $X$ for $th$ object in group $i$;

$u_i$ – coefficient providing fulfillment of the required conditions.

Coefficient $u_i$ of the discrimination function is determined so as its average values for various classes would differ from each other as much as possible.

4. Results

The basic criterion for assessing the effectiveness and feasibility of the company investment project, as already noted, is its level of profitability. However, since the implementation of any project is accompanied by uncertainty, risks of internal and external environment exert a significant impact on the net present value of the project. The investor will always have a choice, because the project activity is connected with the law of investment “the higher profitability of the project organization, the higher the level of risk is, and vice versa.” In the framework of the study the level of profitability of company projects under consideration for years of their implementation and the taxonomic indicator of risk of a certain project (Table 3) are calculated. Taxonomic rate in the framework of the study is a quantitative characteristic of the synthetic indicator of the risk level of the company project. Integral risk level gives a possibility to quantify the importance of the risk with taking into account internal and external risk groups, which have a direct impact on the efficiency of the investment project.

Quantitative values of the level of profitability and integrated risk factor for the company investment projects give a possibility of systematizing the classes of economic efficiency of the organization project. Arrangement of the company projects through their cauterization using Kohonen neural network is presented in Table 4.

Errors values of training and testing samples, the value of which is close to zero, show the adequacy and accuracy of simulation results.

Following the results of the simulation using the application software Deductor Studio Academic – version 5.3, the error value of training is 0.000076 and of the test is 0.0061, the percentage of correct cauterization is estimated at the level of 99.8%.

Visualization of clustering results of the company investment projects is represented in the form of Kohonen maps in Figure 1.
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5. Discussion

Three portfolios of economic effectiveness considering criteria of profitability and integral risk are formed based on the results of clustering (Table 5).

The 0-th cluster includes projects with a high level of profitability, but also with the highest level of integrated risk factor. Such company project portfolio is not economically viable, since under the level of profitability is 136% -206%, the level of loss is 35-50%. This level of integrated risk in international practice is considered more than high.

The second cluster includes the company investment projects with the lowest level of the integrated risk, within

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**Table 3.** Calculated value of the integral indicator of the level of risk and return for each of the company investment projects, (coefficients)

| Year of implementation | Project                                      | The risk level of the investment project | The yield on the investment project |
|------------------------|----------------------------------------------|------------------------------------------|-------------------------------------|
| 2011                   | “Flora Ru”                                   | 0.15                                     | 0.97                                |
| 2011                   | “Solar panels”                               | 0.07                                     | 0.17                                |
| 2011                   | “Production of Phospholipid Preparations”    | 0.07                                     | 0.14                                |
| 2011                   | “Efficient Location of Production, Storage and Primary Processing of Potato and Vegetables” | 0.30                                     | 1.40                                |
| 2011                   | “Logistics Center”                           | 0.22                                     | 1.27                                |
| 2012                   | “Bread Factory”                              | 0.08                                     | 0.55                                |
| 2012                   | “XXX” Trading Network”                       | 0.08                                     | 0.22                                |
| 2012                   | “Brewery”                                    | 0.23                                     | 1.29                                |
| 2012                   | “Plastic Packaging”                          | 0.12                                     | 0.32                                |
| 2012                   | “Roofing”                                    | 0.06                                     | 0.10                                |
| 2013                   | “Methanol Production”                        | 0.24                                     | 1.37                                |
| 2013                   | “Cheese Production”                          | 0.35                                     | 1.36                                |
| 2013                   | “Instant Photo Booths Network”               | 0.19                                     | 1.18                                |
| 2013                   | “Reinforced Concrete Products”               | 0.27                                     | 1.23                                |
| 2013                   | “Mini-Brewery”                               | 0.50                                     | 2.06                                |
| 2014                   | “Logistics Company”                          | 0.20                                     | 1.16                                |
| 2014                   | “Extreme Park”                               | 0.23                                     | 1.31                                |
| 2014                   | “Wood Shop”                                  | 0.40                                     | 1.93                                |
| 2014                   | “Log Hut Manufacture”                        | 0.29                                     | 1.38                                |
| 2014                   | “Glass Packaging”                            | 0.28                                     | 1.32                                |
| 2015                   | “Fuji-Smile”                                 | 0.23                                     | 1.24                                |
| 2015                   | “Specialized Fleet”                          | 0.16                                     | 0.94                                |
| 2015                   | “Eco Technologies”                           | 0.25                                     | 1.14                                |
| 2015                   | “Gelion”                                     | 0.24                                     | 1.65                                |
| 2015                   | “3D Production Studio”                       | 0.19                                     | 1.11                                |

Source: Own research

**Table 4.** Results of clustering the company projects in terms of profitability and integrated risk

| Project                                          | Project                                      | Project                                      |
|--------------------------------------------------|----------------------------------------------|----------------------------------------------|
| “Cheese Production”                              | Mini Brewery                                 | 0                                            |
| “Wood Shop”                                      | “Flora Ru”                                   | “Efficient Location of Production, Storage and Primary Processing of Potato and Vegetables” |
| “Brewery”                                        | “Logistics Center”                           | “Methanol Production”                        |
| “Log Hut Manufacture”                            | “Glass Packaging”                            | “Instant Photo Booths Network”               |
| “Fusi-Smile”                                     | “Specialized Fleet”                          | “Eco Technology”                             |
| “Gelion”                                         | “3D Production Studio”                       | “Plastic Packaging”                          |
| “Solar Panels”                                   | “Production of Phospholipid Preparations”    | “Roofing”                                    |

Source: Own research

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The second cluster includes the company investment projects with the lowest level of the integrated risk, within
This investment portfolio also has no economic feasibility, because a minimum level of profitability of the project not exceeding 55% is characterized by the lowest level of risk.

The most optimal for investment are the company projects from the first cluster. Such portfolio is characterized by an average level of profitability, which in exceptional cases even exceeds the minimum rate of return of zero portfolio. Such projects in this study, which should be regarded as an exceptional investment cases where a high level of profitability is accompanied by an average level of risk include:

- “Helion” project: the rate of return of 165%, the risk level of 24%;
- “Efficient Location of Production, Storage and Primary Processing of Potato and Vegetables” project: the rate of return of 140%, the risk level of 30%;
- “Log Hut Manufacture” project: the rate of return of 138%, the risk level of 29%;
- “Methanol Production” project: the rate of return of 137%, the risk level of 24%.

At that the level of integrated risk factor of this company portfolio fluctuates within 15-30% which is significantly lower than the level of zero risk of the company investment portfolio.

Thus, the highest level of profitability of the company project does not guarantee the maximum efficiency of the project. So to determine the feasibility of the investment project it is necessary to specify the level of its profitability and the integrated risk indicator. Depending on the interests and the strategy pursued by the investor the company portfolio or feasibility of a separate project will be determined.

On the basis of the formed company portfolios it seems possible to define the functions of the classification of the investment attractiveness of projects. Using discriminant analysis based on criteria of profitability and integrated projects risk brought the decremental power of the variables is used in the research that indicate the significance of the calculations (Table 6).

The statistical significance of variables to assess the economic efficiency of the company projects is supported by: F-criterion, the actual value of which for the two variables is above the critical level of 8.5; p-level whose value is close to 0, and the tolerance level, the limit value of which is above 0.01.

The significance of the variables in the discriminant model is characterized by disparity, since the value of Wilks-λ rate of return on the investment project is greater than the integral risk. But significant to the model is the level of integrated risk. At that, based on the performance level of profitability and integrated risk, it is possible to build classification of functions of the company projects in terms of their investment attractiveness (efficiency) (Table 7).

The system of functions of economic performance classification of the organization’s projects is represented by a system of equations:

\[
\begin{align*}
\text{Risk level of the investment project} & \quad \text{The yield on the investment project} \\
& \quad \text{Clusters}
\end{align*}
\]
Table 6. Characteristics of the adequacy of the discriminant analysis of the company projects in terms of profitability and integrated risk

| Variable                                      | Wilkes λ  | Private F-Exception | p-level | Tolerance | 1-Tolerance |
|-----------------------------------------------|-----------|---------------------|---------|-----------|-------------|
| The level of the investment project risk      | 0.123933  | 0.486739            | 11.07215| 0.000521  | 0.497130    | 0.502870    |
| The rate of return on the investment project  | 0.153537  | 0.392888            | 16.22520| 0.000055  | 0.497130    | 0.502870    |

* The variables in the model: 2; Grouped: cluster: (3 group) Wilks Lambda: .06032 approx. F (4.42) = 32,251 p < .0000

Source: Own research

Table 7. Classification functions of investment attractiveness of the company project portfolio

| Variable                                      | The portfolio of high risk projects (0-cluster) | The portfolio of moderate risk projects (1st cluster) | The portfolio of low yield projects (2nd cluster) |
|-----------------------------------------------|-------------------------------------------------|------------------------------------------------------|--------------------------------------------------|
| The risk level of the investment project      | 140.3770                                         | 33.6303                                              | 42.12688                                         |
| Financial rate of return of the investment project | 23.5570                                         | 26.6768                                              | -0.24307                                         |
| Constant                                      | -52.3704                                         | -20.9429                                             | -3.08181                                         |

Source: Own research

\[
\begin{align*}
L_0 &= 140.3770 \cdot R + 23.5570 \cdot FRR - 52.3704 \\
L_1 &= 33.6303 \cdot R + 26.6768 \cdot FRR - 20.9429 \\
L_2 &= 42.12688 \cdot R - 0.24307 \cdot FRR - 3.08181
\end{align*}
\]

\(L_0(R; FRR)\) – membership function of high integrated risk project class;

\(L_1(R; FRR)\) – membership function of effective project class (which are worth investing);

\(L_2(R; FRR)\) – membership function of low yield and low risk project class;

\(R\) – level of integrated risk factors of the investment project;

\(FRR\) – financial rate of return of the investment project.

Functions formed by means of a discriminant analysis reflect a comparison of the level of profitability and integrated risk of the organization's project, enabling to specify the type of project and create an optimal portfolio of organization's investment projects. The class of the project is determined by calculating in terms of profitability and the level of integrated risk \(L_0, L_1, L_2\) of the project. The project should be ranged in such a class which has the maximum \(L\) value in the system of functions of the project investment attractiveness classification.

6. Conclusions

Thus, based on the understudied status of the problem of determining the investment attractiveness of projects, this research proposes a methodological approach to assessing the organization's project performance developed with allowance to the integrated risk index (Annex 2 and Figure A2).

In contrast to the approaches presented in theory, this technique is not limited to considering only monetary risk factors in the process of assessing the investment project performance, since the level of the project rate of return related to the major range of risks of its internal and external environment is calculated. The advantage of this approach is in evaluating the economic feasibility of the project comparing two key performance criteria: financial rate of return and integrated risk level. Based on the combination of these characteristics the developed classification functions enable to accurately diagnose a project class according to its economic feasibility, give an opportunity to define reasonably investment priorities and to develop an effective strategy of creating the investment project portfolio. The methodological approach designed in the study serves as a basis for the improvement of the theoretical foundations of project management and
optimization tool for investing activities of any organization. It is characterized by its simplicity and versatility, because it is not limited by the period of implementation of investment projects and their variability.

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8. References

1. Tikhomirova OG. Project management: an integrated approach and systems analysis. Moscow, Russia: SIC INFRA-M, 2014. (In Russian).
2. Knapp BW. Essential project management templates. The Project Management Excellence Centre Inc. 2010. http://glavnoe-hvost.ru/essential-project-management-templates-brent-w-knapp-pmp.pdf. Date accessed: 07/10/2015
3. Ciaramella A. Application of project risk management and performance indices in the construction sector: a case study. TECHNE - Journal of Technology for Architecture and Environment: 2013, 100-108. DOI: http://dx.doi.org/10.13128/Techno-13462
4. Dahlgren E, Leung T. An optimal multiple stopping approach to infrastructure investment decisions. Journal of Economic Dynamics and Control. 2015; 53:251–67.
5. Towler G, Sinnott R. Economic Evaluation of Projects. Chemical Engineering Design. 2013; 2:389–429.
6. Kenneth HR. Organizational Project Portfolio Management: A Practitioner’s Guide by Prasad S. Kodukula. Book Review Editor. Project Management Journal. 2015; 46(1):1–64.
7. Antonov VG, Maslennikov VV, Skamay LG, Vachegin AM. Risk management of priority investment projects: The concept and methodology. Moscow: Rusayns Publisher, 2014. (In Russian).
8. Buckley JJ. The fuzzy mathematics of finance. Fuzzy Sets and Systems. 1987; 21:257–73.
9. Kenneth HR. Project Quality Management: Why, What and How. USA: J Ross Publishing; 2006.
10. Guthrie G. Real options in theory and practice. United Kingdom: Oxford University Press; 2009.
11. Damodaran A. Strategic Risk Taking: A Framework for Risk Management. USA: Wharton School Publishing; 2007.
12. Hall E. Managing Risk. USA: Addison-Wesley Professional; 1998.
13. Lappe M, Spang K. Investments in project management are profitable: A case study-based analysis of the relationship between the costs and benefits of project management.

International Journal of Project Management. 2014; 32(4):603-12.
14. Bernardo M. Performance Indicators for Enhancing Governance of Projects. Procedia - Social and Behavioral Sciences. 2014; 119:55–64.
15. Bannerman PL. Risk and risk management in software projects: A reassessment. Journal of Systems and Software. 2008; 81(12):2118–33.
16. Irimia-Dieguez AI, Medina-Lopez C, Alfálla-Luque R. Financial Management of Large Projects: A Research Gap. Procedia Economics and Finance. 2015; 23:652–57.
17. Guo F, Chang-Richards Y, Wilkinson S, Cun Li T. Effects of project governance structures on the management of risks in major infrastructure projects: A comparative analysis. International Journal of Project Management, 2014; 32(5):815–26.
18. Sharpe F. Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. Journal of Finance. 1964; 19(3):425–42.
19. Tobin J. Liquidity Preference as Behavior toward Risk. Review of Economic Studies. 1958; 25(2):65–86.
20. Markowitz H. Portfolio Selection: Efficient Diversification of Investments. New York: John Wiley & Sons, Inc.; 1959.
21. Nedosekin AO. Fuzzy-multiple risk analysis of a stock investment. St. Petersburg: “Sesame” Printing House; 2002. [in Russian].
22. Chui YC, Chan SP. Fuzzy cash flow analysis using present worth criterion. Engineering Economist. 1994; 39:113–38.
23. Huang X. Optimal project selection with random fuzzy parameters. International Journal of Production Economics. 2007; 106:513–22.
24. Yaghootkar K, Gil N. The Effects of Schedule-Driven Project Management in Multi-Project Environments. International Journal of Project Management. 2012; 30(1):127–40.
25. Bas E. A robust approach to the decision rules of NPV and IRR for simple projects. Applied Mathematics and Computation. 2013; 219(11):5901–08.
26. Sundqvist E, Backlund F, Chronéer D. What is Project Efficiency and Effectiveness? Procedia - Social and Behavioral Sciences. 2014; 119:278–87.
27. Weber TA. On the (non-)equivalence of IRR and NPV Original. Journal of Mathematical Economics. 2014; 52:25–39.
28. Guidelines on the assessment of the investment project performance. Moscow; 2004. [in Russian].
29. Halawa W, Abdelalim A, Elrashed I. Financial evaluation program for construction projects at the pre-investment phase in developing countries: A case study. International Journal of Project Management. 2013; 31(6):912–23.
30. Chou J-S. Generalized linear model-based expert system for estimating the cost of transportation projects. Expert Systems with Applications. 2009; 36(3):4253–67.
31. LLC Invest project. 2015. http://www.btires.ru. Date accessed: 01/10/2015
32. Antonov VG, Maslennikov VV, Skamay LG, Vachegin AM. Risk management of priority investment projects. The concept and methodology. Monograph. Moscow: Rusays Publisher; 2014. [In Russian].
33. Federal State Statistics Service; 2015. http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/ [in Russian]. Date accessed: 01/10/2015
34. Worldwide Governance Indicators (WGI); 2015. http://info.worldbank.org/governance/wgi/index.aspx#reports. Date accessed: 01/10/2015
35. The Central Bank of the Russian Federation; 2015. http://www.cbr.ru/ [in Russian]. Date accessed: 01/10/2015
36. Saaty TL. Relative Measurement and its Generalization in Decision Making: Why Pairwise Comparisons are Central in Mathematics for the Measurement of Intangible Factors – The Analytic Hierarchy/Network Process. Review of the Royal Spanish Academy of Sciences. 2009; 102(2):251–318.
37. Plyuta V. Comparative multivariate analysis in economic research. Methods of taxonomy and factor analysis. Moscow: Statistics; 1980. [In Russian].
38. Kohonen T. Self-organizing Maps. Moscow: Binom. Laboratory of Knowledge; 2008. [in Russian].
39. Borovikov VP. Neural Networks. Statistics of Neural Networks. Methodology and Technology of Modern Data Analysis. Moscow: Hot Line – Telecom; 2008 [in Russian].
40. Kim J-O, Mueller CW, Klecka WR, Aldenderfer MS, Blashfield RK. Factor, discriminant and cluster analysis. Transl. from English. Moscow: Finansy i statistika Publ.; 1989. [in Russian]
41. Moseyko VO, Dudykina EN. Assessment and minimization of the innovation process risks. Russian Entrepreneurship. 2008; 10(2):66–70. [In Russian].
42. Eveleens JL, Verhoef Ch. The Rise and Fall of the Chaos Report Figures. IEEE Software, January/February; 2010. p. 30-36. http://www.cs.vu.nl/~x/the_rise_and_fall_of_the_chaos_report_figures.pdf Date accessed: 10/10/2015.
43. Copeland T, Koller T, Murrin J. Valuation: Measuring and managing the value of companies. McKinsey & Company Inc.; 1990.
44. Doroshenko YuA et al. Methodological Approaches to Investment Management at Small Businesses. IJST. 2016 June; 9:22.
45. Patrikeeva NV, Babeshko VN, Voyakin EA. Developing Methodological Fundamentals of Criterial and Diagnostic Assessment of Idea Management Efficiency at an Early Stage of Innovative Process and Innovation Development in Higher Education Institutions on the Base of Screening Models and Innovation. IJST. 2015 December; 8:36.

Annex 1

| Year of implementation | Project          | The rate of GDP decline (fraction) | The rate of GDP decline (fraction) | Political instability (points) | Fraction of population below the subsistence minimum, % | The increase in air pollution emission | Absence of supremacy of law (points) | Depreciation coefficient | Revenue variation level (points) | Leverage ratio | The weighted average cost of capital (points) | The proportion of fixed costs to total costs (points) |
|------------------------|------------------|-----------------------------------|-----------------------------------|-------------------------------|--------------------------------------------------------|---------------------------------------|------------------------------------|-----------------------------|----------------------------------|----------------|---------------------------------------------|-------------------------------|
| 2011                   | “Flora Ru”       | 0.91                              | 12.70                             | 0.96                          | 0.77                                                   | 0.23                                  | 0.16                               | 0.38                        | 0.18                             | 0.1600         | 0.1600                                      |
| 2011                   | “Solar Panels”   | 0.91                              | 12.70                             | 0.96                          | 0.77                                                   | 0.06                                  | 0.13                               | 0.75                        | 0.20                             | 0.3554         | (Continued)                                 |
| Year | Project Name                                      | Score | Popularity | Trustworthiness | Relevance | Accessibility | Originality | Quality | Efficiency | Effectiveness | Sustainability | Source |
|------|--------------------------------------------------|-------|------------|----------------|-----------|---------------|-------------|---------|------------|--------------|----------------|--------|
| 2011 | “Production of Phospholipid Preparations”        | -0.0426 | 0.91 | 12.70 | 0.96 | 0.77 | 0.16 | 0.09 | 0.21 | 0.13 | 0.4265 |        |
| 2011 | “Efficient Location of Production, Storage and Primary Processing of Potato and Vegetables” | -0.0426 | 0.91 | 12.70 | 0.96 | 0.77 | 0.37 | 0.10 | 4.28 | 0.32 | 0.2523 |        |
| 2011 | “Logistics Center”                                | -0.0426 | 0.91 | 12.70 | 0.96 | 0.77 | 0.11 | 0.26 | 5.23 | 0.47 | 0.0157 |        |
| 2012 | “Bread Factory”                                   | -0.0341 | 0.99 | 10.70 | 0.99 | 0.74 | 0.09 | 0.11 | 1.57 | 0.21 | 0.3563 |        |
| 2012 | “XXX” Trading Network                            | -0.0341 | 0.99 | 10.70 | 0.99 | 0.74 | 0.14 | 0.16 | 1.09 | 0.27 | 0.0037 |        |
| 2012 | Brewery                                           | -0.0341 | 0.99 | 10.70 | 0.99 | 0.74 | 0.17 | 0.13 | 2.43 | 0.36 | 0.3752 |        |
| 2012 | “Plastic Packaging”                               | -0.0341 | 0.99 | 10.70 | 0.99 | 0.74 | 0.12 | 0.20 | 0.57 | 0.17 | 0.4262 |        |
| 2012 | “Roofing”                                         | -0.0341 | 0.99 | 10.70 | 0.99 | 0.74 | 0.05 | 0.29 | 0.28 | 0.14 | 0.4632 |        |
| 2013 | “Methanol”                                        | -0.0134 | 0.83 | 10.80 | 1.01 | 0.82 | 0.09 | 0.12 | 1.98 | 0.29 | 0.4924 |        |
| 2013 | “Cheese Production”                               | -0.0134 | 0.83 | 10.80 | 1.01 | 0.82 | 0.06 | 0.27 | 4.20 | 0.40 | 0.3925 |        |
| 2013 | “Instant Photo Booths Network”                    | -0.0134 | 0.83 | 10.80 | 1.01 | 0.82 | 0.09 | 0.19 | 0.53 | 0.21 | 0.2742 |        |
| 2013 | “Reinforced Concrete Products”                    | -0.0134 | 0.83 | 10.80 | 1.01 | 0.82 | 0.10 | 0.15 | 1.66 | 0.32 | 0.5012 |        |
| 2013 | “Mini Brewery”                                    | -0.0134 | 0.83 | 10.80 | 1.01 | 0.82 | 0.25 | 0.17 | 5.21 | 0.49 | 0.3966 |        |
| 2014 | “Logistics Company”                               | -0.0064 | 0.75 | 11.20 | 1.00 | 0.78 | 0.06 | 0.21 | 3.78 | 0.42 | 0.0285 |        |
| 2014 | “Extreme Park”                                    | -0.0064 | 0.75 | 11.20 | 1.00 | 0.78 | 0.14 | 0.09 | 4.55 | 0.41 | 0.1423 |        |
| 2014 | “Wood Shop”                                       | -0.0064 | 0.75 | 11.20 | 1.00 | 0.78 | 0.18 | 0.26 | 2.63 | 0.39 | 0.3163 |        |
| 2014 | “Log Hut Manufacture”                             | -0.0064 | 0.75 | 11.20 | 1.00 | 0.78 | 0.10 | 0.23 | 1.72 | 0.35 | 0.3565 |        |
| 2014 | “Glass Packaging”                                 | -0.0064 | 0.75 | 11.20 | 1.00 | 0.78 | 0.17 | 0.17 | 1.03 | 0.28 | 0.4010 |        |
| 2015 | “Fuji-Smile”                                       | -0.0044 | 0.74 | 11.40 | 1.00 | 0.80 | 0.21 | 0.11 | 0.76 | 0.25 | 0.2167 |        |
| 2015 | “Specialized Fleet”                                | -0.0044 | 0.74 | 11.40 | 1.00 | 0.80 | 0.08 | 0.08 | 1.04 | 0.29 | 0.4005 |        |
| 2015 | “Eco Technology”                                  | -0.0044 | 0.74 | 11.40 | 1.00 | 0.80 | 0.17 | 0.18 | 0.86 | 0.18 | 0.3934 |        |
| 2015 | “Gelion”                                          | -0.0044 | 0.74 | 11.40 | 1.00 | 0.80 | 0.14 | 0.24 | 1.04 | 0.21 | 0.2055 |        |
| 2015 | “3D Production Studio”                            | -0.0044 | 0.74 | 11.40 | 1.00 | 0.80 | 0.04 | 0.16 | 0.96 | 0.31 | 0.3966 |        |

Source: Own research
Figure A2. The methodical approach to the evaluation of the organization investment project effectiveness with regard to the integrated risk factor
Source: Own research