ATLANTIS PRESS
Advances in Economics, Business and Management Research, volume 139
International Conference on Economics, Management and Technologies 2020 (ICEMT 2020)

Assessment of the Risk-Benefit Ratio of an Investment Project Based on the Volatility Rate and Integrated Indicator of the Environment Dynamics

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ABSTRACT
In this paper it is proposed to use calculations of the coefficient of unpredictability and an integrated indicator of the environment dynamics to evaluate the numerical values of the risk-benefit coefficient of an investment project. The investment project is divided into 10 stages. The external environment of the investment project is decomposed into two spheres: micro-environment and macro-environment. Micro- and macro-environment factors are presented in the form of five groups. Microenvironment factors (denoted by a, b, c, d, e) gradually develop into macroenvironment factors (denoted as A, B, C, D, E). Assessment of the coefficient of the unpredictability of the medium flow of the investment project was carried out by the methods of expert evaluation. The experts (for whom the questionnaire had been developed) evaluated the work at the microenvironment level and at the project stages, i.e. at the macroenvironment level. Experts were asked to rank the impact of each of the 5 factors on the work in such a way that all factors received ranks (numbers) from 1 to 5 units. The resulting point indicator is proposed to be called an indicator of the environment dynamics. An integrated indicator of the dynamic environment is calculated. The final risk coefficient is calculated on the basis of the environment unpredictability coefficient.
Keywords: *risk-benefit ratio, the environment volatility rate, an integrated indicator of the environment dynamics, macro-environment, micro-environment*

1. INTRODUCTION

A great number of foreign and national scientists were involved in the analysis and risk-benefit ratio assessment of an investment project. The optimum ratio of profitability of investment projects is analyzed in the papers by F. Knight [1], H. Markovitz [2], W. F. Sharpe, G. Alexander, J. Bailey [3]. Problems of riskology are covered by V. Vitlinsky [4], A. Mertens [5], and A. Yastremsky [6]. The problems of minimizing the risks of an investment project are discussed in the works by V. Shevchuk, P. Rogozhin [7], A. Goiko [8], S. Shumilin [9].

Among known methods for evaluating the effectiveness of investment projects, we can focus on the Little-Mirrlis method, i.e. calculating goods and services in international prices (Dosuzheva) [10]. It has certain disadvantages (Novikova) [11]. The "cost-benefit" method was developed mainly in the United States (Kalinovskaya) [12]. The disadvantage of this method is inaccuracy of treatment of benefits over the long term. The cost-benefit method is the basis for the UNIDO methodology, which is an alternative to the Little-Mirrlees methodology. The "guide to the preparation of industrial feasibility studies" is the keystone of the UNIDO approach, based on the methodology of the World Bank. Appraisal objects are the main distinguishing feature of the approach (Vilensky, Livshits, Smolyak, Shakhnazarov) [13].

A comparative analysis of current methods for assessing the environment and the risk of capital investment in the project has shown that the common disadvantages are:

- complete or partial absence of accounting for the uncertainty factor of the environment (the probability factor of the investment process);
- weak formalization;
- lack of a comprehensive methodology for assessing risk impacts at all stages of the project;
- insufficient use of the mathematical statistics apparatus, due to the lack of objective statistical material related to the implementation of projects.

This article is intended, in part, to solve these problems in determining the risk-benefit ratio of an investment project based on the coefficient of unpredictability and the integrated indicator of the dynamic environment.

The purpose of the study was to provide investors with practical tools for assessing the numerical values of the risk-benefit ratio of an investment project based on the calculation of the volatility rate and the integrated indicator of the environment dynamics.

The study uses a unique set of calculated values and contributes to the knowledge of investment management in terms of decision-making by an investor.

As a result, on the basis of the methodology, an investor is offered a model procedure for determining the risk-benefit ratio of the investment project on the basis of the volatility rate and the integrated indicator of the environment dynamics, which is advisable to use in determining the costs of investing in projects.

1.1. Methodology for determining the risk-benefit ratio

This article provides further consideration of the problem of identifying risk impacts on the investment project in major construction in Vladimir. See previous works by M. N. Doroshenko [14], [15].

For the convenience of research the investment project is decomposed into 10 stages:

1. Collection of initial data.
2. Development of a preliminary project.
3. Approval of the location of the object.
4. Permission for the land clearing.
5. Development, approval and critical review of the project.
6. Development of tender and tendering.
7. Allocation of a land plot.
8. Obtaining a construction permit.
9. Construction.
10. Commissioning of the facility.

The environment of the investment project is not directly included in it, although, of course, all the concepts that belong to the environment can to some extent be its constituent elements. An investment project is a part of an environment whose elements interact in a certain order. The environment and an investment project are in constant interaction.

An axiom which needs no proof is the statement that the investment environment is the main integrated factor and source that determines the degree of risk of an investment project. Then an investment project can be considered as an order of resources movement in a certain investment environment, where an investor may or may not lose some resources, and this is his risk.

To study the influence of the environment that causes the occurrence of risk situations during the implementation of an investment project, it makes sense to decompose the entire investment environment into two areas – the microenvironment and the macroenvironment.

Microenvironment is a concept that covers the phenomena, factors, under the influence or under the conditions of which elementary work takes place.

Macroenvironment is a concept that covers the phenomena and factors that have impact on the phase, stage, or the entire investment process development.

Thus, an investment project can be represented as a flow of time and capital, or the capital over the time, influenced by an elementary (micro) environment and a large, comprehensive macro environment. Studies of environmental influences are conducted at the project level.

Now it is necessary to introduce the concept of a hierarchy of micro- and macro-environment factors. These factors should be presented in five groups. Microenvironment factors (denoted by *a, b, c, d, e*) – gradually develop into macroenvironment factors (denoted as A, B, C, D, E) (table 1).

Table 1 Grouping of micro-and macro-environment factors of an investment project

Factors	
Macroenvironment	**Microenvironments**
A – legislative and legal factor	a – factor of legal regulation of the work performed
B – factor of availability of the system of state and administrative-economic apparatus	b – spatial factor
C – factor of banking and financial institutions system availability	c – factor of the main aspect of initial cost formation
D – factor of availability of scientific and technical, production potential of the state, availability of infrastructure, communications	d – factor of the physical form of the work carrier

Source: compiled by the author

To explore risk business influences on the investment project the author proposes to use the approach of determining risk-benefit ratio based on the volatility rate and an integrated indicator of the environment dynamics.

Determination of the volatility rate of the investment project environment was carried out by expert evaluation methods. There are various mathematical and statistical methods of engineering forecasting and expert evaluation, which make up two groups. The first group includes methods of interviewing experts: Delphi, individual, group, face-to-face, phone. Common survey forms include questioning, interviewing, commission, and brainstorming.

The second group consists of methods of expert evaluation: ranking, paired comparisons, and direct assessment. Comparative analysis of these methods showed that to solve the problem good results are obtained by the method of direct evaluation based on an individual survey of experts in the form of a questionnaire followed by ranking factors by increasing values, which is carried out by the forecaster after receiving the survey data.

Experts (private and public investors, having at least five-year experience at the major construction investment market in Vladimir) conducted assessment of the work, i.e. at the level of the microenvironment and the stages of the project, i.e. at the level of the macroenvironment. It is extremely difficult to study the impact at the macro-environment level. Considering each work at the micro level as a separate simple procedure, it is possible to evaluate the result of interaction between the environment and the work in terms of predictability (as well as unpredictability) of the result.

Experts were asked to assess the impact of each of the 5 factors (*a*, *b*, *c*, *d*, *e*) on the work so that all factors got the ranks (numbers) from 1 to 5 units. The resulting score is proposed to be called an indicator of the environment dynamics. A predictable situation is estimated by a smaller number of points, a little predictable – by a large one. The average results of the ranking of investment project works for all 10 stages can be presented in the form of a table "Indicators of Dynamic Environment". Due to the limited scope of the article, the author considers it possible to give an example table for 1 work of the 1st stage of the investment project (table 2). Each work was evaluated for each of the five factors in the microenvironment. In addition, an integrated dynamics index is calculated (N). It is equal to the arithmetic average of each elementary indicator by factors (*a*, *b*, *c*, *d*, *e*)

$$N = \frac{a+b+c+d+e}{5} \quad (1)$$

Table 2 Rates of the Environment Dynamics

	Name (number) of the network schedule works	The elementary microenvironment factors										Integrated (total) rate of the environment dynamics $N == \frac{a+b+c+d+e}{5}$
		Legal regulation of works (a)		Spatial (b)		The main factor in the formation of the initial cost (c)		Physical form of the work carrier with the result (d)		Operators manipulating work (e)		
		Characteristic	Rate of dynamics	Characteristic	Rate of dynamics	Characteristic	Rate of dynamics	Characteristic	Rate of dynamics	Characteristic	Rate of dynamics	
STAGE 1												
1	1/1	Position	2	The office of the investor	1	Salary	3	Sheet of paper	1	Employee	5	2.4

Source: compiled by the author

Thus, we consider that the higher the rate of the environment dynamics, the greater the risk situation arises when performing this elementary work. The method of evaluating the work is quite time-consuming and bulky (due to their large number). Rather serious errors in averaging cannot be excluded. Therefore, the software for calculating of the risk-benefit ratio caused by the environment dynamics is based on the method of assessing the value characteristics of the project stages by the factors of the macroenvironment. A questionnaire for individual experts' survey was developed (table 3):

Table 3 Sample questionnaire for an individual expert survey

Macro environment factors	**Stages of the investment project**									
	I	II	III	IV	V	VI	VII	VIII	IX	X
A. Imperfection of the state legislation										
B. Imperfection of the management bodies structures										
C. Imperfection of the financial and banking system										
D. Lack of development of the industrial and manufacturing infrastructure										
E. Impact of the human factor, features of work style of officials on their psychology and moral principles										

Source: prepared by the author

Each of the ten stages was evaluated by 5 factors of the macroenvironment.

An example of the results of the survey of five experts to assess the values of the five factors of the investment project first stage of is given in table 4.

Table 4 Assessment of the values of the five factors of the first stage, according to a survey of experts

Experts	**Evaluation factors of the i stage, from i_1 to i_n n=5**				
m=5	i_1=B	i_2=A	i_3=C	i_4=D	i_5=E
1	1.2	1.8	3.75	4.14	4.5
2	1.14	1.6	3.7	4.2	4.6
3	1.12	1.9	3.8	4.5	4.7
4	1.14	1.8	3.95	4.14	4.9
5	1.1	1.9	3.7	3.72	4.8
$\overline{\varphi}(i)_{avg}$	1.14	1.8	3.78	4.14	4.7

Source: prepared by the author

where m is the number of experts surveyed; n is the number of factors assessed. The last line shows the average values of the factors $\overline{\varphi}(i_1) = 1{,}14,...\overline{\varphi}(i_5) = 4{,}7$. The arrangement of these values is a sufficient reason to rank the factors as shown in table 2. The need for the allocation of ranks actually disappears, since the location of the arithmetic averages indicates the distribution of ranks $(\overline{\varphi}(i_1) - rank1,...\overline{\varphi}(i_5) - rank5)$. However, figuring out the degree of expert opinions consistency within each factor and at the first stage as a whole is of real interest. To do this, it is necessary to evaluate statistical and heuristic indicators.
Due to the limited volume of the article, the author will not provide the reader with calculating statistical and heuristic indicators, but there is table 5 to show the results of calculating the environment dynamics at the stages of the investment project.

To maintain the experimental integrity, the environment dynamics (N) is calculated as the arithmetic average of both integrated indicators (directly on the stage and on the works of the stage). For this example $N = {(3{,}13 + 3{,}23)}/{2}$.

The final risk-benefit ratio, determined on the basis of the environment volatility rate $(K_{(N)})$, is calculated by the formula:

$$K_{(N)} = (K_{(R)} / 5) \bullet N \; ; \quad (2)$$

where $K_{(R)}$ is the maximum possible risk-benefit ratio accepted by the investor (reasonable risk) – equals 2 in this paper;
N is the volatility rate obtained as the arithmetic average as described above.

Table 5 Rates of the Environment Dynamics by stages of the investment project

Stage	Name	Rates of the Environment Dynamics by macro-environment factors					Integrated index (the average over the stage)
		A	B	C	D	E	
Stage I	Collection of initial data	1.80	1.14	3.78	4.14	4.70	3.13 \ 3.23
Stage II	Development of a preliminary project	2.97	1.16	4.34	3.82	4.60	3.38 \ 3.39
Stage III	Approval of the location of the object	1.17	1.13	5.00	4.43	4.52	3.25 \ 3.23
Stage IV	Permission for the land clearing	2.00	1.57	3.57	2.85	3.42	2.67 \ 2.60
Stage V	Project development approval and critical review	2.70	1.50	4.33	4.12	4.11	3.35 \ 3.41
Stage VI	Development of tender and tendering	1.00	1.03	3.90	2.32	2.74	2.20 \ 2.11
Stage VII	Allocation of a land plot	1.91	1.04	4.26	4.13	4.78	3.22 \ 3.13
Stage VIII	Obtaining a construction permit	2.00	1.00	3.39	2.52	3.85	2.55 \ 2.55
Stage IX	Construction	2.10	1.89	2.25	2.78	2	2.21 \ 2.21 2.24 2.24
			2.05	2.20	2.84	2	
Stage X	Commissioning of the facility	1.80	1.17	3.00	3.19	4.93	2.81 \ 2.74
Average by factors		1.95	1.33	3.64	3.38	3.79	2.80

Source: compiled by the author

2. CONCLUSION

The investment project is carried out in the external investment environment. The unpredictability of interaction between the environment and the project is a source of investor's risks. To identify it, the approach of determining the risk-benefit ratio through the volatility rate (dynamics) of the environment is proposed.

For the convenience of the study, the environment is decomposed into two spheres – macroenvironment and microenvironment, and further study of the project is carried out in parallel at two levels.

Uniformity of classification of risk factors of microenvironment (*a, b, c, d, e*) and macro environment *(A, B, C, D, E)* grouped in five groups provides possibility for application of methods of expert survey and estimation at levels of both spheres: for work – at micro level, and on stages – at the macro level. An opportunity to compare their average estimates increases the accuracy of the study.

The method of assessing the values of risk factors for each stage of the project is used. It allows the forecaster, according to the survey, to rank the risk factors by increasing values, as well as to evaluate statistical and heuristic indicators of the degree of consistency of experts' opinions.

This approach is important and interesting as it is instrumental in calculating the costs of the investment project implementation, taking into account the risk-benefit ratio. It is advisable to use it in determining running costs of investing in projects.

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