©2020 International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

PAPER ID: 11A02L

METHOD DEVELOPMENT TO SUPPORT THE ENTERPRISE ECONOMIC SECURITY BY USING MATHEMATICAL MODELING TOOLS

Eduard Korovin [a*], Irina Smirnova [a], Milana Sultygova [a], Alim Mazhazhikhov [b], Eldar Miskhozhev [b]

[a] *Department of Economics and Law, Saint-Petersburg University of State Fire Service of EMERCOM of Russia, RUSSIA.*

[b] *Department of Management and Economics, Saint-Petersburg University of State Fire Service of EMERCOM of Russia, RUSSIA.*

ARTICLEINFO

Article history:
Received 03 May 2019
Received in revised form 21 October 2019
Accepted 05 November 2019
Available online 15 November 2019

Keywords:
Project risk threshold; Risk assessment; Acceptable risks; Economic performance; Uncertainty management; Project risk monitoring.

ABSTRACT

For any type of entrepreneurial activity, a characteristic feature is a decision-making in conditions of uncertainty or incompleteness of information. The solution to this scientific problem is concretized in the form of a set of interrelated goals. Development of the structure of the information base and organizational support necessary for the implementation of investment analysis. Development and adaptation of methods and algorithms for finding rational solutions to specific problems to improve the economic security of the enterprise. The rationale and systematization of the applied mathematical methods for the qualitative and quantitative assessment of risk, profitability and economic stability of an enterprise operating in conditions of uncertainty. The study of the impact of real-life risks on the economic performance of the enterprise: costs, profits, economic security. Development of a comprehensive risk assessment methodology with the determination of areas of acceptable risk values with appropriate indicators of profitability and economic stability. Building a system of models for assessing the economic reliability of a textile enterprise taking into account risk. Development of a risk management model taking into account economic reliability and testing of risk management techniques in a market economy for real textile production, as well as testing its performance and assessing the degree of its reliability in a production environment.

Disciplinary: Economic & Management Sciences.

©2020 INT TRANS J ENG MANAG SCI TECH.

1. INTRODUCTION

The task of economic revival of the industrial potential of Russia makes very stringent requirements for the organization of enterprises, the direction and speed of their structural and

*Corresponding author (Eduard Korovin). Tel: +7-911-8379688. Email: korovin@mail.ru

institutional transformations; improving the accounting system and minimizing risks to improve the economic security of industrial and commercial activities.

As a result, the whole range of issues related to the organization of economically safe management of industrial enterprises becomes vital for them, since it is precisely such a strategic approach that allows enterprises to solve the main problem of survival at this stage of economic development.

The solution of strategic and investment problems is largely difficult due to the uncertainty of the conditions for the functioning of the enterprise. Uncertainty is an integral part of the processes of making organizational and managerial decisions and has its expression in the concept of risk. Moreover, the importance of taking into account risk factors is directly proportional to the level of decisions made.

As a theoretical basis and practical decision-making tools in such situations, economic-mathematical models and the predictive calculations performed on them are used. The main difficulty in the application of rich scientific experience lies in the fact that in real business conditions, situations with the same internal and external parameters are extremely rare. Therefore, difficulties mainly arise when modeling a situation adequate to the real one, which is possible only if there is a large amount of statistical data.

The solution to investment problems depends on the degree of uncertainty of the conditions of the enterprise. Uncertainty is an integral part of organizational and managerial decision-making processes and has its expression in the concept of risk, therefore risk assessment and accounting become necessary elements of general economic research and practical activities of an enterprise.

In numerous scientific papers, as a rule, the practical basis of the system of quantitative assessments of entrepreneurial risk was not considered. The main reason for this may be that general methodological approaches to the quantitative assessment of risk and, in particular, the solution of problems of a comparative assessment and the final choice of solutions are associated with the use of a complex mathematical apparatus. At the same time, the need for practical use of the accumulated scientific experience in this area is very relevant in the process of forming a market economy.

Currently, more and more attention of practitioners on the issues of sustainability of the enterprise from the perspective of risks having different nature of the occurrence. From the above arguments, it follows that there are a number of practically significant and insufficiently developed problems that we present as the goals and objectives of this study.

Consequently, in the course of managing targeted processes, an inevitable collision occurs with one degree or another of uncertainty, i.e. with scientific, technical, and production and technological risks that affect business risks (Zubova, et al, 2018).

Risks are an inevitable reality and an immanent sign of the process of formation, functioning, and development of enterprises, however, there is still no unambiguous understanding of the economic nature of this category (Kolesnik, et al, 2018). The reason for this is the complex nature of risk, as a result of which there are various definitions of the concept under study (Kuzmin, et al, 2018). In many cases, the nature of the risk is not determined directly, but indirectly, for example, through its consequences (loss, threat, damage, etc.) or probability, which is the degree to which a particular event can occur in specific conditions, and not actually risk.

In conditions of scientific uncertainty (the unknown is the result of the consequences of scientific

processes), there are risks of not achieving the required quality of scientific products or achieving them with a given level of quality, but with an excess of time costs (Batkovskiy, et al, 2015).

Under conditions of production uncertainty (the unknown is the result of the consequences of production processes), there are risks of not achieving the required quality or achieving it with a given level of quality, but with an excess of time costs (Vikulov, 2004). To date, there is no sufficiently adapted and to some extent universal method for assessing economic risks (Gagiyan, et al, 2016). The absence of such a method does not allow determining the stability of enterprises in the face of economic risks.

2. MATERIALS AND METHODS

A method to help identify the effect of exogenous variables on results is sensitivity analysis. Sensitivity analysis refers to a combination of quite different approaches and possibilities for the practical application of methods. The most commonly used sensitivity analysis in three forms. The first of them consists of determining the stability (reliability) of the solution used at the enterprise's investment planning model, that is, the analysis establishes how much one or several initial values can be changed, provided that the resulting solution remains unchanged. A much larger amount of risk information is represented by the second form of sensitivity analysis, which is based on the establishment of critical value. The result of the analysis is the identification of acceptable sizes for varying the values of one or many variables, provided that the result does not exceed the established critical value. The third form, in which sensitivity analysis is applied in practice, provides information on how the value of the result will change if one or many of the initial variables change by a given value.

Using sensitivity analysis, you can determine the deviation limits of any indicator of the project from the initial value, within which the investor's attitude to the project does not change. Computer programs allow you to simulate the results, changing the values of variables within certain limits and determining the impact of these changes on the project. When analyzing sensitivity, it is also possible to establish a critical point for each factor, going beyond which can change the decision to accept or reject the project. The relative deviation of the calculated indicator from its initial value gives an idea of the "safety limit" for this indicator.

In the process of project implementation, almost all initial values of indicators can deviate from their forecast values. Defining critical values that vanish. The calculation results give a criterion for assessing sensitivity. The value of each factor is found by solving the equation. The safety limit is the percentage deviation of the obtained value of each factor from its actual value, therefore, the greater the value of the calculated safety limit, the greater the deviation of this factor from its actual value. A slightly different approach is used in calculating risk indicators. Based on linear interpolation, the discount rate is determined.

There proposed a method for monitoring the risks of space projects by creating an information base consisting of five stages of data shown in Figure 1.

*Corresponding author (Eduard Korovin). Tel: +7-911-8379688. Email: korovin@mail.ru ©2020 International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies. Volume 10 No.11 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A02LA http://TUENGR.COM/V10A/11A02L.pdf DOI: 10.14456/ITJEMAST.2020.32

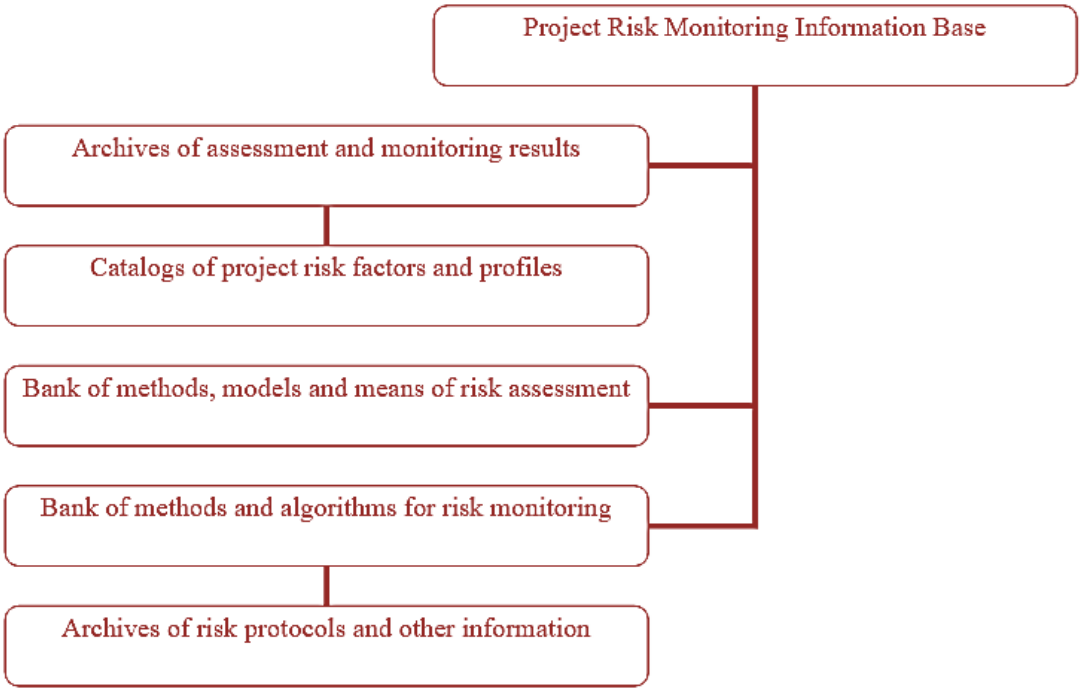

Figure 1: Information base for monitoring project risks title.

In general, the need has arisen for posing key problematic issues, the solution of which will allow us to form the preferred ways to comprehensively optimize the use of funds allocated to improve the economic security of enterprises based on the levels of risk tolerance of economic entities.

The concept of assessing economic risks should be carried out in order to determine the threshold values of the economic security of economic entities.

3. RESULT AND DISCUSSION

The proposed methodology for determining the maximum allowable risk cost, risk tolerance indicator and risk indicator of a specific organization, respectively (See Table I).

Table 1: New classification of risk tolerance states taking into account temporal and spatial coordinates.

Spheres of space	Decision Life Cycle Stages		
	Past	Present	Future
Objectively Existing Reality (OCP)	(Rust.experience OSR)	(Rust.fact OSR)	(Rust.planOSR)
Information-driven reality (IOR)	(Rust.experience IOR)	(Rust.fact IOR)	(Rust.planIOR)

The final expert assessment of the probability of occurrence of risk at the macro level was 0.424; at industry level 0.548. According to the conditions of the adopted calculation algorithm, the risk indicator ranges from 0 to 1.

Analyzing the data obtained, it should be noted that the trend in the development of macroeconomic factors in the industry is such that the most significant of them is government regulation of monetary policy and the economy as a whole.

Another risk - the economic activity of enterprises was considered as complex, the constituent elements of which are financial and commercial risks. The generalized indicator for these positions is 0.333, which indicates an average level of risk. This level of the indicator is confirmed by the fact that in the context of financial-industrial groups, enterprises have great potential for using the reserves of

cooperation. Also, the possibilities of self-financing of private entrepreneurs are expanding due to increased capacity utilization, working capital savings, and consolidation of participants' assets.

The results of the expert assessment are the first assessment stage of the IP and provide an opportunity to analyze the implementation of the innovation program and predict risk management measures.

Implanting all forms of innovations as entrepreneurs, business, technological or technical solutions, financing in various forms and terms, we set ourselves the task of developing an algorithm for calculating quantitative and qualitative indicators, the totality of which corresponds to the decision of the concept of making a managerial decision: “Given the pace set by the competitive environment growth, the effectiveness of capital investments must match their risk”.

Therefore, the following indicators were considered in the work:

• the net present value of the innovation program (NTS);

• payback period of the project with and without discounting cash flows;

• a simple rate of return (NDP), calculated as the ratio of net profit to total cost during the forecast interval, that is, the period when the planned capacity has already been reached, the repayment of external debt continues;

• internal rate of return (VNR);

• return on investment (RI).

The first calculation option for the case when financing is carried out at the expense of equity capital and part of the redistributed profit is very rare in the practice of enterprises and is theoretical. Financing using borrowed capital due to tax protection creates the effect of financial leverage, increasing the return on equity to the enterprise.

The calculation of the TTS, taking into account inflation and risk components, is currently the most developed, since the calculation of the discount rate R takes into account all the effects of borrowed capital. The next most important indicator, taking into account the risks of inflow and outflow of capital investments in their monetary form, is Hungary. The semantic value of this indicator lies in the fact that, at the calculated rate of VNR, the sum of the discounted outflows of finance is equal to the sum of the discounted outflows of finance.

The interpretation meaning of VNR can be represented by the following options:

• the value of VNR determines the maximum rate of payment for credit resources, at which the IP remains break-even;

• the value of VNR is the lower limit on the profitability of investment;

• the discount rate is proportional to the risks taken into account when analyzing the IP, but VNR does not have to be negative.

Given the existing difference between the rates of attraction and placement of funds, we can conclude that:

1. With BHP, the placement rate is lower, taking into account the existing risk, it is unprofitable to invest in the project, as you can simply put them in the bank.

2. When VNR is higher than the placement rate but lower than the current rate of attracting loans, the project can be carried out but provided that the cost of ownership or the weighted value of all the already raised funds of the enterprise is less than VNR. That is, this project should focus only on the resources of the enterprise.

*Corresponding author (Eduard Korovin). Tel: +7-911-8379688. Email: korovin@mail.ru ©2020 International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies. Volume 10 No.11 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A02LA http://TUENGR.COM/V10A/11A02L.pdf DOI: 10.14456/ITJEMAST.2020.32

3. When VNR has a higher interest rate, it makes sense to use borrowed funds to finance the project, if the company does not have cheaper own funds.

Two methods for calculating MB HP:

1. discounting cash outflows at a risk-free rate;

2. compounding inflows at a real reinvestment rate.

The rate of VNR does not limit the cost of attracted financial resources and does not take into account the discount rate of risk factors. For it cannot be argued that the cost of loans is limited to 0.3 since the TTS is again positive and at a cost of more than 0.74, at the same time, TTS <0 when the cost of resources is up to 0.01.

It is these shortcomings that are eliminated when using the indicators of the MVNR and SDPM and the corresponding modifications of the formulas for calculating the NWT.

One of the main factors determining the value of the project's NTS is the scale of activity, which is manifested in the "physical" volumes of investments, production or sales. This implies a natural restriction on the use of this method for comparing projects that differ in this characteristic: a higher value of the NWT will not always correspond to a more effective investment option.

In such cases, it is recommended to use the return on investment (RI) indicator, also called the net present value coefficient or profitability index. This indicator is the ratio of the net present value of the project to the discounted value of all costs of its implementation.

It is advisable to evaluate risk tolerance taking into account changes in not only temporal but also spatial coordinates to objectively existing and information-driven reality (See Table II).

The transition from one risk tolerance (Rust) to another risk tolerance (Rust1) is the movement of the subject in conditions of uncertainty over time, that is, risk. Whether the subject will achieve the desired result (set goal or task) is the conditions of uncertainty, pushing the subject to a new risk, motivating (or forced as no alternative) to a new goal in the form of a new state of risk tolerance for achieving a new level of quality of this or that matter.

Developing a business plan in the areas of technical, technological and organizational-economic efficiency, a game theory model was used to solve the problem of choosing forms of a cooperation agreement with suppliers of raw materials and consumers of finished products. By concluding contractual agreements for a certain period, none of the participants is immune from market uncertainties and the behavior of colleagues under the agreement. A game matrix is compiled, with the help of which you can analyze the issue of decisions taken by each side, where j is the index of the participant in the contract agreement. There are two "players" in this matrix. The first is the analyzed enterprise, the second player is the remaining enterprises entering into contractual relations.

This system has certain reliability and should to some extent protect itself from possible violations of contracts. These opportunities are partially or fully reflected in the "gains", that is, in the values of those profits and losses that are recorded in the squares of the income and risk matrices. All the "gains" Wj 'should be considered as the value of the additional costs.

If we accept the condition that wages are a fixed amount, determined by the normative labor costs and its price, then Wj 'can be exactly correlated with the profit indicator CC. Obviously, with this formation of the contract or collective transaction, the value of Wj 'is distributed over all production units. The question arises of how to find the best solution for the behavior of participants in a collective agreement, obliged to coordinate actions in a conflict of interest.

Based on the uncertain behavior of counterparties, we also set the game matrix in the form of a risk matrix or a matrix of missed opportunities due to the lack of information about the state of the market, since the risk is the difference. The selection of the best enterprise strategy was carried out using the following criteria: Maximax, Wald, Savage, and Hurwitz. The use of each of them is determined both by the character of the "player" and by the situation on the market.

Table 2: Algorithm for determining the marginal cost of risk and marginal risk tolerance and marginal risk level of an economic entity.

Name of indicator	Calculation * (Source of information)	Formula
Extreme Risk Resistance Condition	$line8 = \frac{line6}{line7} = 1$	$P_{ust\ pred} = \frac{CK_{dop}}{CP_{pred}} = 1$
Risk Limit Condition	$line9 = \frac{line6}{line7} = 1$	$Y_{r\ pred} = \frac{CP_{pred}}{CK_{dop}} = 1 (or\ 100\%)$
Risk tolerance indicator (as the ratio of equity to cost of risk) and the condition for equality or excess marginal risk tolerance	$line11 = \frac{line6}{line10} \geq 1$	$P_{ust} = \frac{CK_{dop}}{CP} = \frac{CK_{dop}}{CP + I_r} \geq 1$
Risk level indicator (as the ratio of risk cost to equity) and the condition for not exceeding the maximum risk level	$line12 = \frac{line10}{line6} \leq 1$	$Y_p = \frac{CP}{CK_{dop}} = \frac{CP + I_r}{CK_{dop}} \leq 1$

The next step is to use the apparatus of variation statistics for calculating the risk of commercial offers for two payment options for the processing of tolling raw materials.

Then we applied the sensitivity analysis of the investment project for the implementation of several exogenous factors. The essence of this examination is to determine how much you can change one or more of the studied factors so that the resulting optimal solution remains unchanged. Or it is possible to identify the limiting sizes of variation of the values of variables when the result does not go beyond the critical parameters. Using computer programs for EXCEL simulation of the result, we obtained the point where the TTS turned to zero when the initial technical, technological or economic parameters reached the safety limit threshold.

If the analyst believes that all factors are within acceptable safety limits, then this project is considered economically safe. Sensitivity analysis allows you to determine the risk content of each business project when implementing various innovations. Each of the analyzed technological chains changes the indicators of material costs, the price of the product, the volume of planned sales, the salary of workers. Having estimated the mathematical expectation (MOj) of each project, the margin of its stability (Znpi) by the ith factor variable, the risk factor of investments (B) and the risk parameter (R) were determined, through which the risk tolerance of the projects (RS) was calculated and the most stable negative impacts.

The effect of operating leverage is an indicator of profit growth for each percentage increase in sales revenue. Its relationship with fixed costs is directly proportional, and when "passing" through the threshold of profitability, the impact of the operating lever falls. Characterizing the threshold of profitability, it should be noted that the higher it is, the more difficult it is to "step over" it and vice versa. A decrease in the value of the indicator is achieved either by increasing the gross margin by increasing the price of goods, or by reducing variable costs, or by increasing the physical volume of sales. In a competitive environment, raising prices for goods sold is always acceptable, therefore, the best way out is to establish links between the producer of products and trade organizations.

*Corresponding author (Eduard Korovin). Tel: +7-911-8379688. Email: korovin@mail.ru ©2020 International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies. Volume 10 No.11 ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8 Paper ID:11A02LA http://TUENGR.COM/V10A/11A02L.pdf DOI: 10.14456/ITJEMAST.2020.32

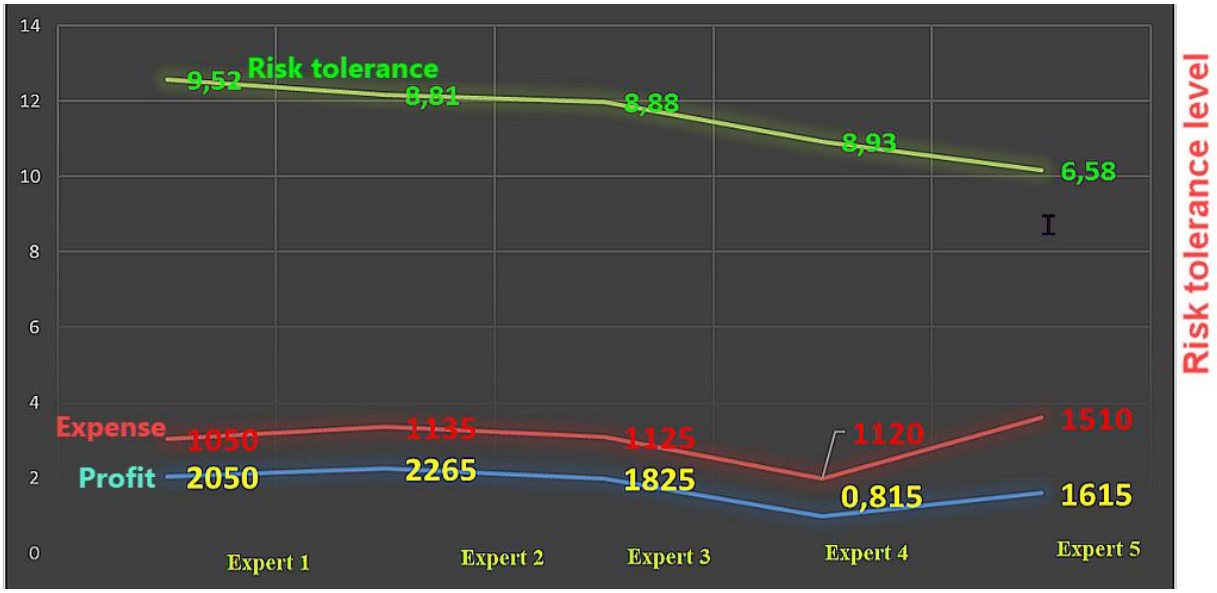

Figure 2: The results of assessing the enterprise risk tolerance with different alternatives in conjunction with a possible profit

Using the algorithms from Table 2, determined the risk tolerance zones of enterprise in targeted processes. The results of assessing the risk tolerance by five expert alternatives are presented in Figure 2, where experts offered their alternatives taking into account the criterion of maximum possible risk tolerance, trying not to fall into the zone of maximum permissible risk tolerance, which is characterized by greater uncertainty and high risks and requiring determination of the corresponding value level of probability of their suppression.

4. CONCLUSION

The results obtained made it possible to form a mechanism for methodological support of economic security for the development and functioning of enterprises of various ownership forms taking into account risk, as well as to develop appropriate measures and recommendations for ensuring economic reliability, and through it, the prerequisites for economic growth

Based on market principles, a risk classifier has been developed. Hierarchies, groups, subgroups are identified for each level and type of risk, which allows to unify management tasks and identify areas of risk influence by the main parameters: economic activity of the enterprise profitability, economic security, and business activity

The conditions for the occurrence of risks in investment projects (innovations) implemented by industrial enterprises are identified and determined. The boundary conditions for the minimum risks of a business entity are established taking into account the internal structure of a textile enterprise. The zones of the probability of bankruptcy of a manufacturing and commercial textile company during the implementation of the project are established. The dependence of the nominal rate of return on the real rate of return, risk, and inflation, taking into account the discount rate, is determined.

An economic and mathematical model for assessing the risk of a project has been developed with the establishment of acceptable boundary values for the degree of risk, obtaining a threshold level of profitability and the necessary degree of economic stability (the boundary risk conditions range from 0.25 to 0.50% of the total risk indicator).

5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

6. REFERENCES

Batkovskiy A. M., Semenova E. G., Trofimets E. N., Trofimets V. Ya., Fomina A. V. (2017). Modified method for sensitivity analysis of investment projects efficiency criteria. *Journal of Applied Economic Sciences*. XII, 4(50), 116-1131.

Batkovskiy, A. M., Konovalova, A. V., Semenova, E. G., Trofimets, V. Ya., Fomina, A. V. (2015). Risks of Development and Implementation of Innovative Projects. *Mediterranean Journal of Social Sciences*. 6(4-4), 243-253

Gagiyan, M. G., Saprunov, G. S., Frantsev, R. K. (2016). Aspects of R&D management in the rocket and space industry. *Innovative Economics and Management*. 255-256.

Kolesnik, A. V., Zubova, L. V., Nikolaev, S. P. (2018). Features of Scientific and Technical Risks in the Development of Rocket and Space Technology. *Science and Society*. 2, 37-45.

Korovin, E. V., Zubova, L. V. (2019). Ways to increase the economic security of the state by reducing the risk level of business entities in the conditions of functioning of the global navigation satellite system GLONASS. *Strategies and tools for managing the economy: sectoral and regional aspects*. 137-144.

Kuzmin, V. N., Sherstyuk, A. V., Zubova, L. V. (2018). Model Of Administration Managerial Decisions Based On Estimation Of Risk-Stability Of Enterprises. *8th The International Conference "Social Science and Humanity"*. London. 29-36.

Medvedchikov, D. A. (1999). Development of organizational and economic methods for managing the risks of space activities based on insurance coverage for projects of enterprises in the rocket and space industry. 270-274.

Vikulov, S. F. (2004). The development of military-economic practice and science at the present stage. *Bulletin of VFEU*. 75-86.

Zubova, L. V., Gotskaya, N. R., Davydyants, D. E., Karlik, A. E., Petrov, D. M. (2018). Comprehensive Value Of Enterprise Solutions And Algorithm Of Risk Level Assessment. *Technical Sciences*. 3, 111-121.

Dr.Eduard Korovin is an Associated Professor at Saint-Petersburg University of State Fire Service of EMERCOM of Russia. He earned his Doctor of Economic Sciences. His research focuses on Solutions of Investment Problems Depends on the Degree of Uncertainty of the Conditions of the Enterprise.

Professor Dr.Irina Smirnova is Professor at Saint-Petersburg University of State Fire Service of EMERCOM of Russia. She got a Doctor of Economic Sciences. Her research focuses on Solutions of Investment Problems Depends on the Degree of Uncertainty of the Conditions of the Enterprise.

Milana Sultygova is an Associate Professor at Saint-Petersburg University of State Fire Service of EMERCOM of Russia. She is a Candidate of Economics Sciences Her research focuses on Solution of Investment Problems Depends on the Degree of Uncertainty of the Conditions of the Enterprise.

Alim Mazhazhikhov is an Associate Professor, Saint-Petersburg University of State Fire Service of EMERCOM of Russia. He is a Candidate of Economics Sciences, His research focuses on Solutions of Investment Problems depends on the Degree of Uncertainty of the Conditions of the Enterprise.

Dr.Eldar Miskhozhev is an Associate Professor at Saint-Petersburg University of State Fire Service of EMERCOM of Russia. He has a Doctor of Economic Sciences degree. His research focuses on Solutions of Investment Problems Depends on the Degree of Uncertainty of the Conditions of the Enterprise.