

# FORMATION OF SCENARIOS FOR A MACHINE-BUILDING ENTERPRISE DEVELOPMENT WITHIN THE FRAMEWORK OF ADAPTIVE INVESTMENT PORTFOLIO MANAGEMENT

10.5281/zenodo.3870873

**OLGA MASLAK, NATALYA GRISHKO, MARIYA MASLAK**

**Abstract.** The article proposes an approach to the formation of a portfolio of a machine-building enterprise investment projects, which will focus on the selection of activity areas, the changes to which will have the greatest effect in the future development of the business entity. In accordance with the author's approach, the directions of modeling methods development in the system for assessing the risk level of investment activity of a machine-building enterprise are highlighted; an informational and analytical base has been formed for analyzing and evaluating the effectiveness of managing the research object's level of riskiness during investment activity; a multivariate regression model was built based on the level of return on investment; Based on the results of the analysis, the directions for the development of methods for assessing the investment activity risk level of PJSC "Kryukovsky Railway Car Building Works" were formed, and steps were proposed in regards to the selection of investment projects while forming an investment portfolio within the framework of scenarios of innovation-oriented development of a machine-building enterprise.

**Keywords:** investment, innovation, risk, portfolio of investment projects, innovative potential, adaptive management, development scenario, model.

## **Introduction**

The process of forming managerial decisions related to the implementation of investments or the process of their attraction encourages to consider the existing riskiness of the investment activity. A mistake in identifying these risks and their faulty assessment leads to a low level of measure effectiveness aimed at preventing and reducing the riskiness of investment activity, which is associated with the introduction of innovations. Nowadays, there is not a single scientifically-based theoretical and methodological basis for risk management of investment activities. Existing approaches are fragmented, which complicates the process of forming managerial decisions that are relevant to attracting and using investment resources.

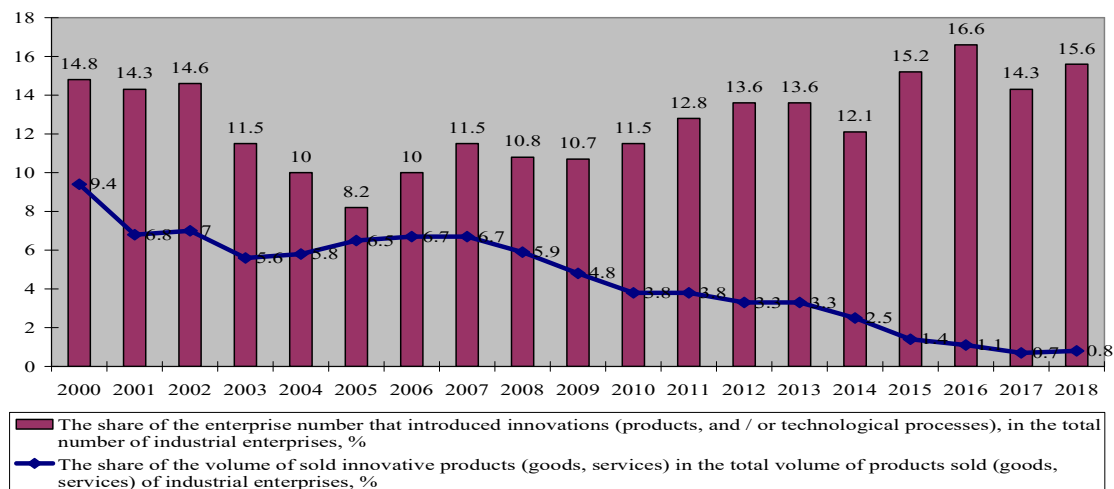
Significant attention is paid to the investment activity issues, investment portfolio management, investment risks by domestic and foreign scientists, namely: Blank I.O. [1], Bondar M.I. [2], Voynarenko M.P. [3], Ephifanova I.Yu., Moyseenko I.P. [4], Plaksin V.I. [5], Smalyuk G.F. [6], Zervanev D. M. [7], Lintner J. and others. As a result of familiarization with their works, it was identified that issues related to the theoretical aspects of the study of market forms and mechanisms for carrying out investment activities are

relevant. Despite the number of scientific papers in this area, a part of the issues, that are debatable and require new approaches and solutions, still remains. These include a system of indicators of the level of investment activity's riskiness, determination of the risk management's effectiveness, research of investment risk management models, as well as adaptive investment portfolio management and etc. As to machine-building enterprises, this topic is almost unexplored, so the goal of the work is to study methods and indicators for assessment of the machine-building enterprises investment activity's risk level in an investment portfolio.

**I. A study of the prerequisites for investment and innovative development of machine-building enterprises in Ukraine: an orientation toward accounting for the level of the investment risk.**

The industrial enterprises development of Ukraine on an innovative basis is a priority and a necessity in the context of the deployment of European integration processes and the need to increase their competitiveness. The solution to the given problem requires substantial investment resources, which means that the realization of innovative potential is in close direct dependence on its investment support, which is actualized with a shift in emphasis towards self-financing of technological and product innovations by domestic enterprises.

An understanding of the need to intensify investment processes was obtained during the global crisis, as a result of which there was a sharp decline in sales volumes of enterprises' products in the machine-building industry of Ukraine and the investment activity's riskiness as a whole, increased objectively. At the same time, against the background of an increase in the number of enterprises that introduced innovations, their low productivity should be noted, which affects the continuous reduction in the share of sold innovative products (Fig. 1).

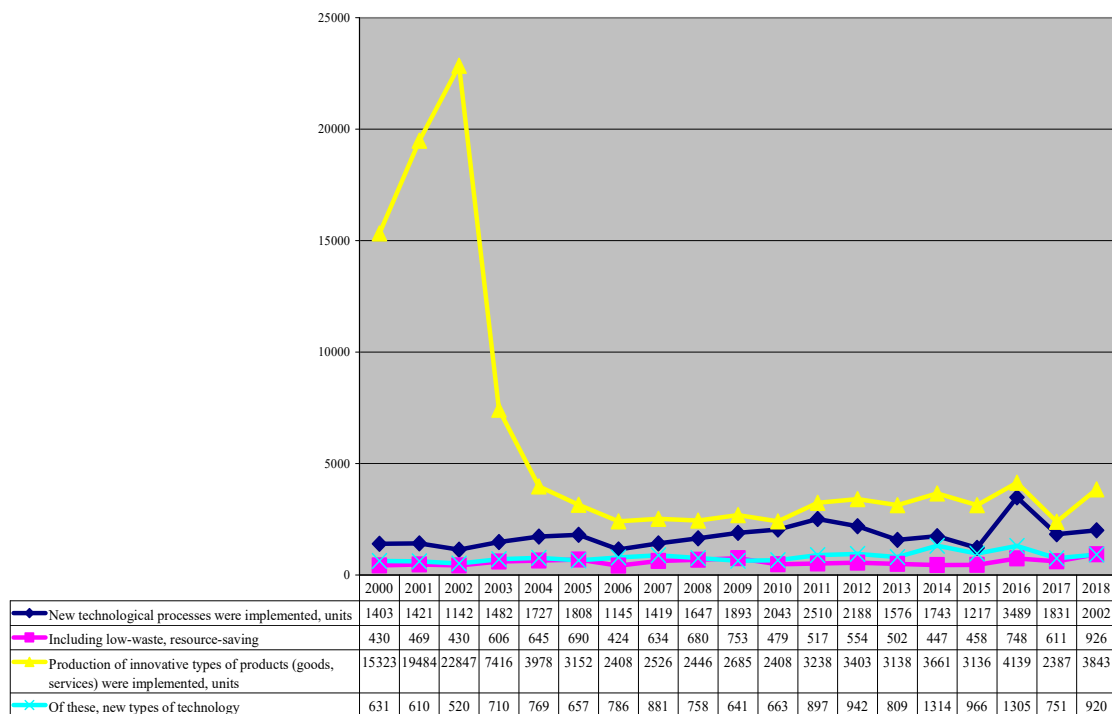


**Figure 1 - The ratio of the share of innovatively active industrial enterprises of Ukraine**

## and the share of sales of innovative industrial products

Source: formed on the basis of [12]

The difficult financial situation at industrial enterprises significantly slows down the technological update and innovative development of the national economy of Ukraine as a whole. Dynamics and correlation of new technological processes in areas during 2000-2018 are illustrated in Fig. 2.



**Figure 2 - Dynamics and correlation of new technological processes in areas during 2000-2018, units**

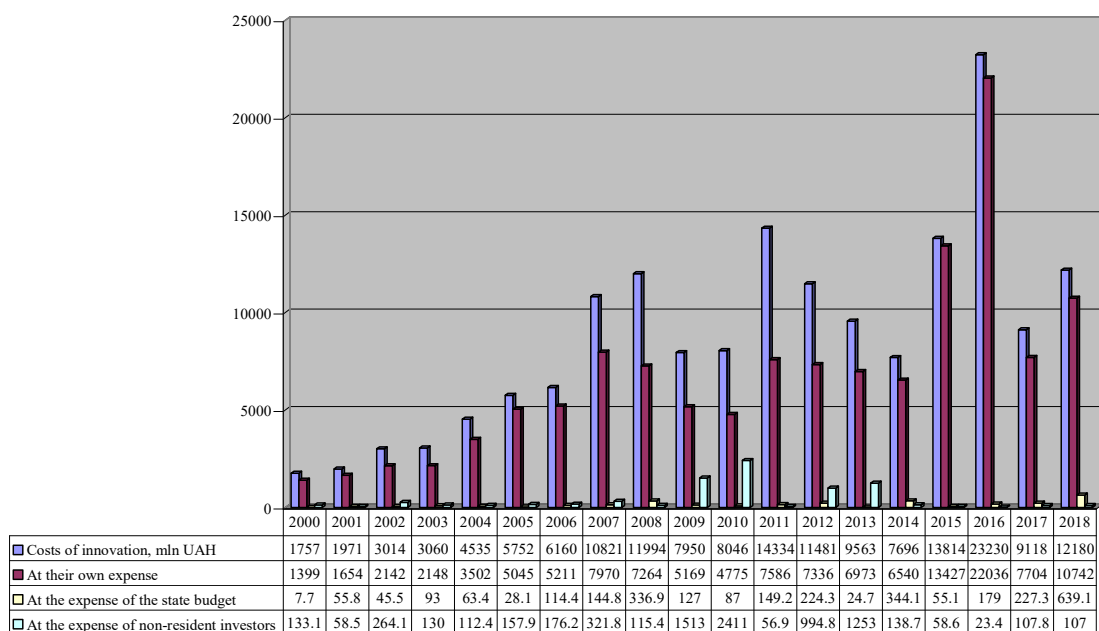
Source: calculated by the authors according to [12]

It should be noted that the development of industries - drivers of technological and innovative changes, which include production with high added value, primarily engineering, produces positive changes in other sectors of the national economy. In particular, the urgent need for industrialization of the country, support for the development of high-tech industries, actualizes the issue of acceleration in the medium-high-tech and high-tech sectors, is problematic for the Ukrainian industry.

The own funds remain as the main source of financing the innovation activity of industrial enterprises of Ukraine during 2000-2018. (Fig. 3).

A negative phenomenon is also a significant decrease in the total amount of financing of innovative activities: its value at the end of 2017 is only 39% of the previous 2016. The

proportion of foreign investment remains at only 0.88% at the end of 2018. Financing of innovative activities at the expense of the state budget was executed only in the range of 5.25% of the total volume of 2018.



**Figure 3 - Dynamics and correlation of sources of financing innovative activities of industrial enterprises of Ukraine during 2000-2018**

*Source:* calculated by the authors according to [12]

So, the intensification of the development of the industrial sector of the national economy of Ukraine on an innovative basis is possible only if the investment processes are more effective, primarily due to the preventive management of its risk.

## **II. Assessment of the level of effectiveness and riskiness of investment projects of PJSC “KRCBW”**

We will illustrate the risk assessment and the level of the effect obtained from investment projects according to the data of the engineering company PJSC “Kryukovsky Railway Car Building Works”, which specializes in the production of freight and passenger cars, as well as components for this type of transport, the manufacture of escalators, etc. The enterprise PJSC “KRCBW” has an innovation-oriented direction of development during 2014-2018. used different sources to finance their investment activities. The main sources of financing investment activities for the study period are depreciation and long-term liabilities.

We can conclude that the company is not able to carry out investment activities at the expense of net profit, because it received a net loss in 2014-2016, and in 2017-2018. the amount was insufficient to cover expenses.

The enterprise uses a standard approach to determine the effectiveness of investments. Risk assessment of the implemented investment projects of PJSC “KRCBW” was carried out on the basis of calculations, which are summarized in table 1.

**Table 1 - Risk assessment of investment projects of PJSC “KRCBW”**

| №3/п | Project   | Actual values, NPV, thousand UAH | Expected value, $r_0$ | Standard deviation, $\alpha$ | The coefficient of variation, $k$ | Interval of Expected Values |             |
|------|---|----------------------------------|-----------------------|------------------------------|-----------------------------------|-----------------------------|-------------|
|      |   |                                  |                       |                              |                                   | Pessi-mistic                | Opti-mistic |
| 1    | The introduction of carriages (trolley) model 68-7115   | 146795                           | 117902,5              | 73836                        | 0,626                             | 10550                       | 206700      |
| 2    | The introduction of carriages(trolley) model 68-7115-01   | 763400                           | 693400                | 155241,7                     | 0,224                             | 463400                      | 863400      |
| 3    | Production of mobile heating points   | 67840                            | 63340                 | 8261,356                     | 0,130                             | 50840                       | 70840       |
| 4    | Mastering the production of metal constructions for FERREXPO POLTAVA MINING (210 tons)  | 65432                            | 57932                 | 18874,59                     | 0,326                             | 30432                       | 80432       |
| 5    | The development of a new product type: wagon-type tank bunker model 19-7126 for the transportation of pulverized coal injection | 12348                            | 11848                 | 5220,153                     | 0,441                             | 5348                        | 20348       |
| 6    | Implementation of prototypes: vacuum sweeper  | 7651                             | 7425,5                | 1918,554                     | 0,258                             | 5000                        | 10500       |
| 7    | Implementation of prototypes: regimental earth-digging machine PZM-03-01  | 76060                            | 55660                 | 35253,94                     | 0,633                             | 2060                        | 85060       |

As for the risks of investment activities of PJSC “KRCBW”, the analysis made it possible to conclude that the assessment of risks associated with domestic real investments at the research object is carried out using analytical and heuristic methods, in particular, a method for determining the level of expected losses from investment activities. At the same time, it is advisable to evaluate and monitor the financial component of the development of the innovative potential of the enterprise, evaluate the deviations of the investment costs of the enterprise from the planned values, and also adjust the investment budget when changing strategic guidelines under the influence of external factors.

Consequently, the formation of the investment portfolio of machine-building

enterprises on the basis of optimizing the ratio of profitability and risk will make it possible to use the reserves of revenue growth and expansion of domestic investment resources, to establish a connection between investment decisions and the development strategy of the enterprise. This will allow us to move away from the inflexible traditional organizational scheme for coordinating “bottom-up” investment decisions currently used at the enterprise.

The proposed approach is based on the hypothesis that there is a relationship between the effectiveness of the investment activity of the enterprise, which characterizes the ability of the enterprise to effectively use and increase the efficiency of use of financial resources involved in the development of the enterprise and the processes of maintaining sufficient liquidity of the investment portfolio; minimization of investment risks; acceleration of income growth rates, capital profitability growth rates. As a result of the application of regulatory decisions aimed at increasing the level of investment performance of PJSC “KRCBW”, positive or negative changes may occur in indicators characterizing the object of management. The presence of these changes indicates the establishment of links between regulatory decisions and the management object and determines the appropriateness of the preventive measures application in the framework of increasing the effectiveness of managing the profitability and investment risks of a machine-building enterprise. The alternative of these goals and the dual relationship of riskiness and the investment portfolio liquidity requires the use of certain methodological tools that will allow us to establish the nature of the dependencies and, based on a retrospective input base, to make a forecast of changes in the effective indicator. In our opinion, the most correct for the implementation of this task is the use of statistical methods, namely, correlation and regression analysis when building a multiple dependence of return on investment. The developed model will look like this:

$$R_{inv} = f(X_1; X_2; X_3; X_4; X_5; X_6; X_7), \quad (1)$$

where  $R_{inv}$ - Return on investment is (Y);  $X_1$  - the share of highly liquid investment projects;  $X_2$  - return on assets;  $X_3$ - the share of costs for technological innovation;  $X_4$ - a dynamic criterion for the innovation of the enterprise;  $X_5$ - coefficient of financial dependence;  $X_6$ - absolute liquidity ratio;  $X_7$ - return on equity.

The obtained regression dependence  $Y = -0,750 + 0,567X_1 + 0,573X_2 - 1,605X_3 + 0,388X_4 + 0,238X_5 + 0,257X_6 + 0,091X_7$  is the basis for the formation of development scenarios as part of adaptive investment portfolio management of a machine-building enterprise (tested according to PJSC “KRCBW”).

### **III The formation of the investment portfolio of the enterprise based on the optimization of the ratio of profitability and risk**

The effectiveness of the functioning of the mechanism for ensuring the implementation of the investment potential of PJSC “KRCBW” as a system is an indicator characterizing the change in its state in dynamics provided that an effective development direction is chosen between existing strategic alternatives. As a tool for choosing the optimal direction of development, we used the method of hierarchies’ analysis as a step-by-step process of setting priorities: the best ways to compare and evaluate elements, the way to make decisions when selecting alternative enterprise reactions.

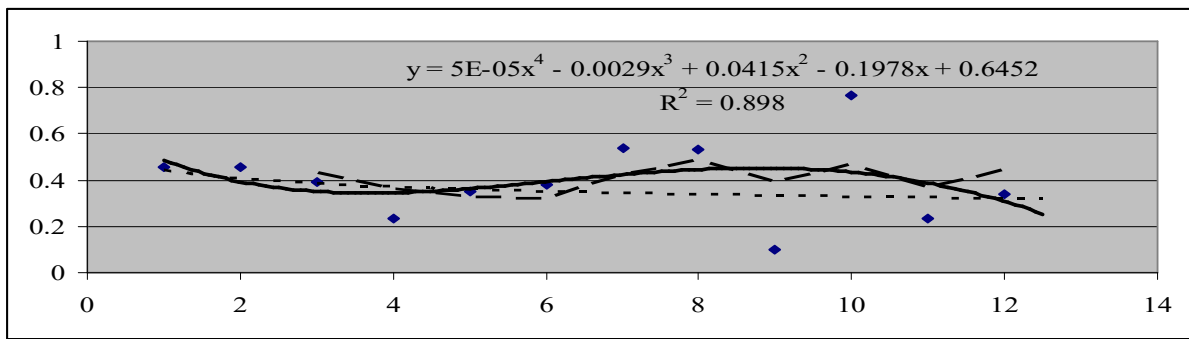
Given that the enterprise is a complex open system, the relationships, the criteria and development factors of which are constantly changing, there is a need to develop and implement such a mechanism to ensure the implementation of the investment potential of PJSC “KRCBW”, which would allow the system to transform itself depending on changes in the external and internal environment. Such an adaptive mechanism for managing the investment portfolio will allow not only to formulate priorities of activities, but also to change the state of the management object, providing the possibility of a proactive response to external and internal threats.

The implementation of adaptive management of the investment portfolio of PJSC “KRCBW” in practical activities should be carried out in three stages:

- 1) the organization of continuous monitoring of the estimated parameters of the investment potential of a machine-building enterprise;
- 2) analysis of internal capabilities and external threats;
- 3) the use of adaptive management of investment potential of PJSC " KRCBW " based on the formation of development scenarios.

The investment portfolio management system of PJSC “KRCBW” should coordinate the process of information flow, which is the basis for selecting scenarios of innovation-oriented enterprise development. A dedicated system should serve as a filter, a store of information about the state of changes in the production, financial, personnel, marketing, scientific, technical and organizational components of innovative potential, that is, a kind of intermediary between all elements of the external and internal environment of the enterprise. In this case, it is possible to implement management of the investment portfolio of PJSC “KRCBW” on the principles of preventive regulation.

The task of optimizing the process of activity in general terms can be formulated as follows: maximize the objective function of the mathematical model of an object (process) considering restrictions (Fig. 4).



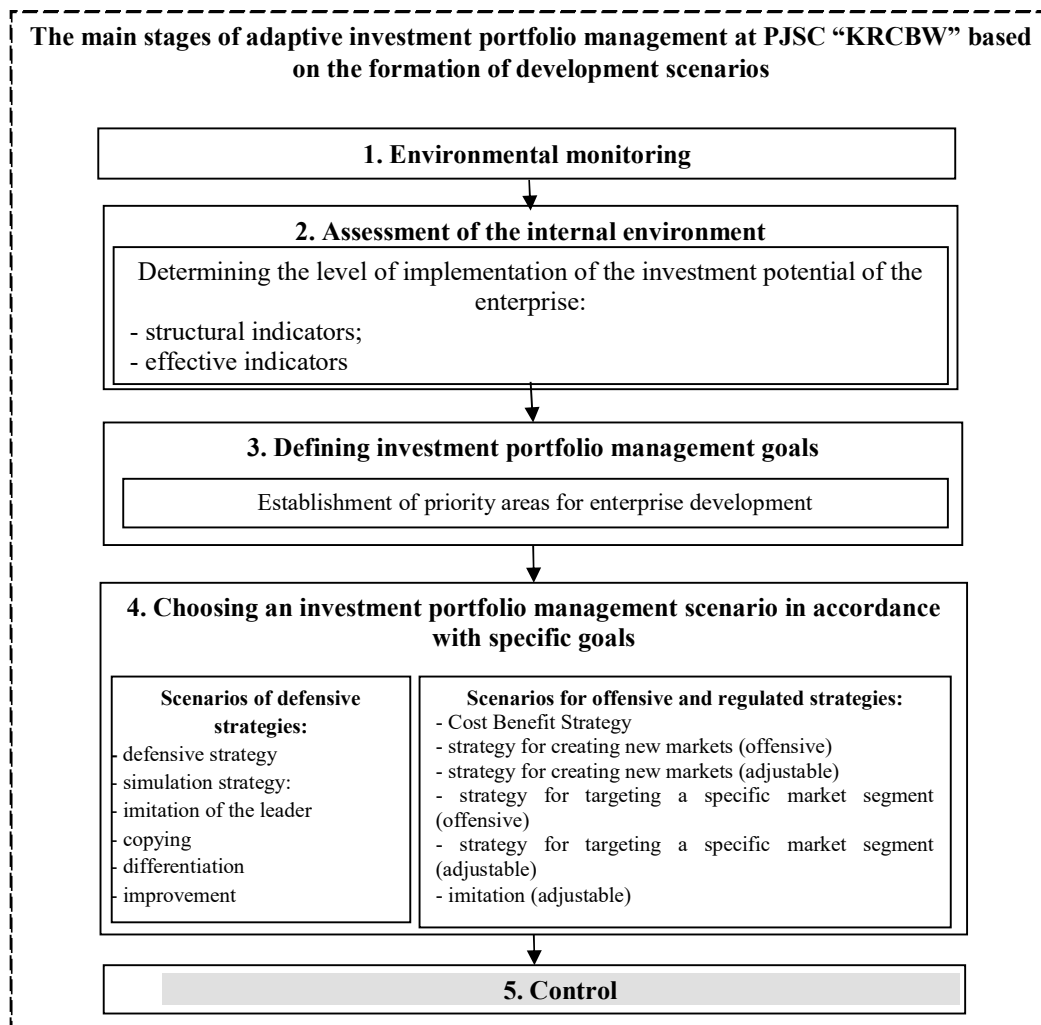
**Figure 4 - Prediction of the investment potential development of PJSC "KRCBW" (extrapolation beyond the trend line: optimistic and pessimistic scenario)**

*Source:* calculated by the authors based on [12]

Considering that the enterprise is in constant exchange with the external environment, which provides it with the opportunity to carry out operational, financial and investment activities, the state of the enterprise depends on the frequency of unforeseen events and the stability of the external environment. In this regard, methods are needed that require the use of specific models for the adoption and implementation of strategic decisions, and consider realistic, optimistic and pessimistic scenarios.

In order to compare the complex of local solutions by the criterion of efficiency and the degree of resistance to directed and non-directional actions of environmental threats, the analysis of all x0 should be carried out considering the realistic, optimistic and pessimistic scenario of the development of events, based on the following main stages of investment portfolio management. (Fig. 5).





**Figure 5 - The main stages of adaptive investment portfolio management at PJSC “KRCBW” based on the formation of development scenarios**

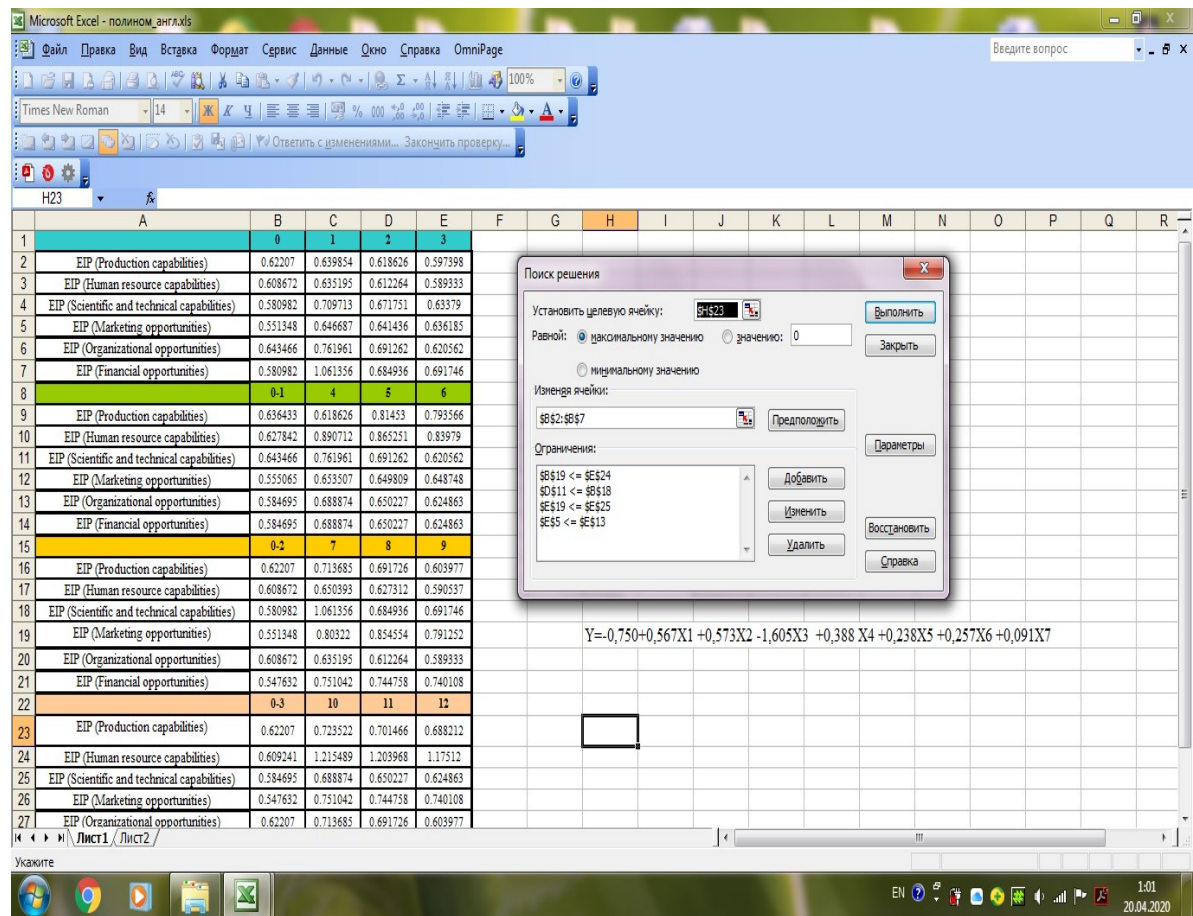
*Source:* developed by the authors

The adaptive nature of the investment portfolio management process makes it possible to select scenarios in accordance with changing environmental conditions, as well as the preventive nature of the information received, which allows you to timely respond to external challenges and deviations from the expected (desired) development path. So, the proposed mechanism considers the possibility of implementing the classical functions of the management process: planning (forecasting), organization, motivation (stimulation), analysis, control.

The results of an integrated assessment and forecast of the level of development of investment potential is the starting point for developing possible development scenarios and strategies for innovation-oriented development. Using the selected forecasting model, we obtained three options for predicting the level of investment potential: pessimistic, realistic

and optimistic, which, in turn, allowed us to develop three appropriate development scenarios considering the influence of external factors and assessing possible investment risks.

The simulation results for the generated scenarios for PJSC "KRCBW" are shown in Fig. 6. The add-on “Solution search” is used.



**Figure 6 - Using a decision-making mechanism based on the multicriteria optimization method (fragment)**

*Scenarios 1-3 “Simulation strategy (adjustable)”*, which is aimed at ensuring the liquidity of funds advanced into the activities of the enterprise (primarily associated with financial investments).

*Scenarios 4-6 “Simulation strategy”* in the conditions when optimizing the riskiness of the investment portfolio depends on the investor's perception of an acceptable level of risk in certain conditions (in this case, projects are selected according to the criterion of returning capital and obtaining planned income).

*Scenarios for offensive and regulated strategies:*

*Scenarios 7–9 “The Strategy for Achieving Cost Benefits”* are guided by the maximum values of those control factors that determine the cash flow values. The increase in investor’s

income is possible both due to profits from the implementation of investment projects adopted for implementation, and due to an increase in the assets' value.

*Scenarios 10-12 "Strategy for the creation of new markets"* should consider the comparison of the change rate in the size of the results of the enterprise, presented in the corresponding model through innovative changes in its activities. The strategy of creating new markets for the expansion of markets through the release of new types of innovative products. The strategy of targeting a specific market segment is generally accepted for enterprises producing a specific innovative product for a specific group of consumers or industry.

It should be emphasized the alternative investment objectives and, accordingly, the formed scenarios for the development of the enterprise.

### **Conclusions**

Summarizing the mentioned above facts, we can draw the following conclusions.

1. The intensification of the industrial sector development of the national economy of Ukraine on an innovative basis is possible only if the investment processes are more effective, primarily due to the preventive management of its risk.

2. The adaptive nature of the investment portfolio management process makes it possible to select scenarios in accordance with changing environmental conditions, as well as the preventive nature of the information received, which allows timely response to external challenges and deviations from the expected (desired) development path. So, this allows you to consider the possibility of implementing the classical functions of the management process: planning (forecasting), organization, motivation (stimulation), analysis, control.

3. The approach of adaptive management of an enterprise's investment portfolio is based on the establishment of selection criteria for projects on the basis of their compliance with the strategic development guidelines of the enterprise.

### **References**

1. Blank, I. A. (1995), "Investment management", ITEM, pp. 448.
2. Bondar M.I. (2008) Investycyjna dijalnistj: metodyka ta orghanizacija obminu i kontrolju: monogr. [Investment behavior: methods and organization of control and control: monogr.]. K.: KNEU (in Ukrainian)
3. Voynarenko M.P., Yepifanova I.Yu. (2001) Upravlinnja investycyjnoju dijalnistju promyslovykh pidprijemstv: monografija [Management of investment activity of industrial enterprises: monograph]. Vinnitsa: VNTU. (in Ukrainian)

4. Moiseynko I. P. Formuvannya investment portfolio in market minds [Text] / I. P. Moiseynko // News of the National University "Lviv Politics": "Problematic Economy and Management". - 2003. - PROMETEUS 2013 No. 1 (40) 159 No. 484. - S. 133-138.
5. Plaksin V. I. Methodological basis of the system for managing the risk neutralization of the investment portfolio of an enterprise [Text] / V. I. Plaksin, E. A. Gorbacheva // News of SevNTU: zb. sciences. Seriya Ave.: Economy and Finance. - 2010. - No. 109/2010. - S. 123-127.
6. Smalyuk G.F. Methods of forming and reforming the portfolio // Science and Economics. - 2007. - No. 2. - S.18-24.
7. Zervanev D. M. (2003), "Management of investment activity of enterprise", Znanya-press, pp. 622.
8. Annual financial statements of enterprises, *Stock market infrastructure development agency of Ukraine (SMIDA)*, [access mode] : [http:// www.smida.gov.ua/](http://www.smida.gov.ua/).
9. L. Karpenko, S. Filyppova, "Strategic competitive analysis of innovative enterprises development: predictive validity". Actual Problems of Economics, 2016, vol. 6 (180), pp. 392–404.
10. Lutz Fridrich and Vera (1981), "The Theory of Investment of the firm", Lutz Fridrich and Vera. Princeton University Press, pp. 99.
11. Maslak O., Grishko N., Sokurenko P., Buriak Ie, Maslak M. Anti-crisis approach in the industrial enterprise management: methodological tools of preventive regulation/ SHS Web of Conferences. Innovative Economic Symposium 2019 Milestones and Trends of World Economy (IES2019). - <http://ies.vstecb.cz/>
12. The State Statistics Service of Ukraine (2019) [online]. Available at: [www.ukrstat.gov.ua/](http://www.ukrstat.gov.ua/)
13. Ukrainian Institute of Scientific and Technical Expertise and Information (2018), The state of innovation activities and activities in the field of technology transfer in Ukraine in 2017: analytical reference, Ukrainian Institute of Scientific and Technical Expertise and Information, Kyiv, 98 p.
14. Pererva P.G., Kocziszky G., Szakaly D., Somosi Veres M. Technology transfer. - Kharkiv-Miskolc: NTU «KhPI», 2012. - 668 p.
116. Pererva P.G., Kocziszky Gy., Somosi Veres M., Kobieliava T.A. Compliance program: [tutorial] / P.G.Pererva [et al.]; ed.: P.G.Pererva, G.Kocziszky, M. Veres Somosi. – Kharkov ; Miskolc : NTU "KhPI", 2019. – 689 p.

**Note about Authors:**

**Olga Maslak**, Doctor of Economics, Professor, Head of Economics Department, Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine, [oimaslak2017@gmail.com](mailto:oimaslak2017@gmail.com)

**Natalya Grishko**, Candidate of Economic Sciences, Associate Professor of Economics Department, Kremenchuk Mykhailo Ostrohradskyi National University, Kremenchuk, Ukraine, [2nata.grishko@gmail.com](mailto:2nata.grishko@gmail.com)

**Mariya Maslak**, Candidate of Economic Sciences, Senior Lecturer of the department of Innovative Entrepreneurship Management and International Economic Relations Department of the National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine, [mariya.maslak2016@gmail.com](mailto:mariya.maslak2016@gmail.com)