MATHEMATICAL MODELS FOR DECISION-MAKING ON STRATEGIC MANAGEMENT OF INDUSTRIAL ENTERPRISE IN CONDITIONS OF INSTABILITY

Loginovskiy O.V.[1[0000-0003-3582-2795]], Dranko O.I.[2[0000-0002-4664-1335]], Hollay A.V.[1[0000-0002-5070-6779]]

[1] South Ural State University, Chelyabinsk, Russia
[2] Moscow Institute of Physics and Technology, Moscow, Russia
loginovskiyo@mail.ru

Abstract. The management of an industrial enterprise is complicated by the high degree of instability in the world economic system at present. Therefore, it is necessary to develop new methods and approaches to making strategic decisions that allow for effective management in industry.
In this article, we propose two mathematical models of decision-making for the strategic management of an industrial enterprise, which take into account the conditions of instability. The first model is based on the ranking of decision criteria, taking into account resource constraints. The second model is a mathematical model of an integrated assessment of the activity of an industrial enterprise, which is considered as a procedure for conducting expert modelling of hard-to-formalize fragments of a description of a problem. The procedure is based on standard reporting and the use of formal methods to streamline expert assessments for constructing a mathematical model of multi-criteria choice by computerizing a well-known convolution principle, adapted to the number and qualifications of experts, the degree of homogeneity and non-statistical uncertainty of expert estimates. Обе модели могут быть использованы при принятии стратегических решений по управлению промышленным предприятием.

Keywords: math modeling, industry, making decisions, strategic management, expert assessment; Integral estimation; huperfuzzy estimation; Fishburne scale.

1 MANAGEMENT OF INDUSTRIAL ENTERPRISE IN CONDITIONS OF INSTABILITY

Problems related to the management of industry and the economy have changed significantly at present [38,39]. This requires their rethinking, in the new realities of the modern world, and, most importantly, the search for new ways, methods, models and management technologies [17,23,28] that will ensure the effective operation of large industrial enterprises and corporations [31,32].

In recent years, the world economy has become instable [26]. The reason for this became interethnic and interreligious conflicts, local wars, various kinds of sanctions [37,9], etc. As a consequence, the conditions for doing business have deteriorated significantly [11,21,24].

Studying scientific works devoted to the improvement of the management processes of industrial enterprises [47,20,8,34,36,16], it can be stated that the vast majority of the conclusions, recommendations and proposals contained in these scientific papers are applicable in the conditions of stable development of the world economy.

However, in conditions of global instability [22], these approaches and methods become insufficiently effective [40] and do not allow to formulate strategic decisions for managing the development of industrial enterprises that are adequate to the circumstances [35]. As known [4,5,46,44], among the most important problems of industrial enterprises management, the following are traditionally distinguished:

1. Formation of a rational organizational structure of industrial enterprises and corporations [6].
2. Creation of an effective system of labor resources management, recruitment and training of managerial and production staff [7].
3. The organization of material flows at the enterprise on the basis of the logistic approach (optimization of cargo transportation, raw materials stock and commodity stocks, sales of finished products on the basis of marketing analysis, etc.) [43].
4. Support the management system of an industrial enterprise on the basis of various automated control systems for technological processes, transportation, accounting and control of material resources, equipment maintenance and repair, etc. [25].

However, it is important to realize that in today's conditions of global military and political, financial and economic, social instability in the world, as well as sharp drop in incomes of manufacturing companies in international markets and low customer purchasing power, industrial enterprises and corporations [27] can no longer receive the same income as in previous years from the sale of their products [18]. Survival considerations come to the forefront [1]. In this regard, the main shareholders of large industrial enterprises and corporations are forced to look for ways to ensure profitability and maintain the status of their companies in difficult business conditions [2,10].

As a result of all this, the emphasis in the management of industrial enterprises shifts towards financial and economic analysis [3, 12, 13], operational and strategic forecasting of companies' position [41]. Enterprises are looking for ways to reduce spending by simplifying the organizational structure, reducing management staff, both in production and other divisions [45,29].

Among the main problems can be identified:

- Lack of investment.
- Lack of working capital.
- Depreciation of fixed capital, a large proportion of old equipment.
- Insufficient introduction of new technologies.
- High expenses.
- Low turnover.
- High tariffs, low solvency of customers.

- Low qualification of staff, aging of staff.
- Ineffective management system.

There are many indicators characterizing the industrial activity of the enterprise. A set of indicators of the financial condition of the enterprise (see Table 1).

Table 1. Set of indicators of a financial condition of the enterprise.

Property Valuation Unit	Liquidity Assessment Unit	The Financial Stability Assessment Unit	Business Evaluation Unit	Profitability Assessment Unit
a) the share of fixed assets in assets b) the share of the active part of fixed assets c) coefficient of depreciation of fixed assets d) coefficient of depreciation of the active part of fixed assets e) coefficient of renewal of fixed assets f) the asset retirement ratio	a) maneuverability of own circulating assets b) total liquidity ratio c) current ratio d) critical liquidity ratio e) coefficient of absolute liquidity (solvency) f) the share of current assets in assets g) the share of own circulating assets in current assets h) the share of own circulating assets in their total amount i) the share of inventories in current assets j) share of cash and cash equivalents in current assets k) share of own circulating assets in coverage of inventories l) stock coverage ratio m) a parity «a debt receivable - accounts payable»	a) coefficient of concentration of equity capital b) coefficient of maneuverability of equity capital c) structure coefficient of long-term investments d) coefficient of long-term borrowing (ratio "long-term borrowed capital - permanent capital") e) debt capital structure ratio f) loan to equity ratio g) the ratio of own funds h) I degree cover i) II degree cover	a) the turnover of funds in the calculations (in terms of turnover) b) inventory turnover (in turnover) c)turnover of accounts payable (in days) d) duration of the operating cycle e) duration of the financial cycle f) the rate of repayment of receivables g) turnover of own capital h) turnover of total capital i) the coefficient of stability of economic growth	a) product profitability b) profitability of core activities c) return on total capital d) return on equity e) profitability of current assets

In this article, two mathematical models for decision-making on the strategic management of an industrial enterprise in conditions of instability are proposed:

1. Model based on the ranking of decision criteria;
2. Model based on the construction of an integral indicator.

Both models can be used for making strategic decisions on the management of an industrial enterprise.

2 MODEL BASED ON THE RANKING CRITERIAS FOR DECISION-MAKING WITH RESTRICTIONS

The task of maximizing the target criterion can be written in the form [42]:

$$G = \sum_i m_i \cdot x_i \to max, \quad (1)$$

where G - the target criterion, m - the contribution to the achievement of the target criterion, x - scalability of the project, i – project index.

The main question: how to take into account the limitations on various resources. The problem of linear programming is widely known:

$$\sum_j a_{ij} \cdot x_i \le B_j \ . \quad (2)$$

where x - scalability of the project in continuous form, j - resource index, a_{ij} - the rate of consumption of the j-th resource on the i-th product, B_j - availability of j-th resource.

In practice, the application of the linear programming is difficult due to the need to accurately calculate the specific consumption rates of all resources The solution can be greatly simplified if the most important restriction can be determined.

The method of one-source, one-resource optimization "Cost-effectiveness" [43] ensures the selection of priority directions according to the criterion:

$$\alpha_i = m_i \ / a_{ik} \to max, \quad (3)$$

where k - the number of the scarce resource.

If the limitation is financial resources, the criterion for selecting priority measure will be:

$$\alpha_i^{\Phi} = m_i \ / I_i \to max, \quad (4)$$

where I - the amount of investment in the measure. Note that α_i^{Φ} is similar to the profitability index that is used to evaluate investment projects [15].

If the limitation is human resources, the criterion for choosing priority measure will be::

$$\alpha_i^{L} = m_i \ / L_i \to max, \quad (5)$$

where L - the amount of labor (staff) resources in the measure. Note that α_i^{L} is a characteristic of labor productivity in achieving the target criterion.

3 THE MATHEMATICAL MODEL OF INTEGRATED EVALUATION OF ACTIVITY OF INDUSTRIAL ENTERPRISE

The comprehensive automated information system of an industrial enterprise that ensures the unification of all information systems within the company as a whole, without fail, should include an information system for an integrated assessment of the activities of this enterprise [28].

The mathematical model of an integrated assessment of the activity of an industrial enterprise can be based on such an information system.

An integral evaluation is the calculation as a single indicator, which unambiguously reflects the generalized, total financial and economic state of the organization at a given moment in time. Comparing its value for any period (five years, a year or a quarter), you can see how the state of the enterprise changes. And having analysed the appropriate dynamics, it is possible to assess the work of the enterprise for the relevant period and on this basis to formulate proposals for improving the management of the financial and economic activities of an industrial enterprise.

To a large extent, such assessments can be carried out by ranking enterprises according to known international methods (for example, by investment attractiveness, solvency, creditworthiness) adapted to the peculiarities of the national economy and the goals of stakeholders (investors, shareholders, creditors).

These methods suggest the calculation of some aggregated indicator (for example, the Altman Z-indicator), comparing it with similar indicators of other enterprises and then comparing them with the table values for their joint interpretation (for example, referring to a group of financially stable enterprises for Z> 2.99).

The process of assessing the financial and economic state of an enterprise is considered as a procedure for conducting expert modelling of hard-to- formalize fragments of the description of a problem situation based on standard reporting data and applying formal methods for ordering expert assessments for constructing a mathematical model of multi-criteria selection by computerizing a known convolution principle adapted to the number and the quality of experts, degree of homogeneity and non-statistical uncertainty of expert assessments.

3.1 Selecting metrics

The choice of indicators (Table 1) by which the integral assessment of the financial condition of an enterprise will be calculated depending on the goals of the rating. By their semantic purpose, the indicators are divided into several groups that will determine the structure of the aggregated estimate. When selecting indicators, the necessary condition is not to use interdependent indicators. If this condition is not satisfied, the construction of the rating by the rule of additive convolution will give an incorrect result.

3.2 Calculation and normalisation of indicators

The procedure for expert evaluation of the financial and economic state of the enterprise is multi-level and involves several stages: the formulation of the decision-maker (DM), the objectives of the expert survey; DM's selection of the expert working group (EWG); EWG's the development of a detailed scenario for collecting and analyzing expert opinions (assessments), a specific type of expert information (words, conditional grades, numbers, rankings, breakdowns or other types of objects of non-numerical nature), the way of its formalization and methods of its analysis; selection of experts in accordance with their competence and the formation of an expert commission (EC); collection of expert information; processing of the results of the examination, including determining the consistency of expert opinions and determining the maximum allowable, minimum acceptable and optimal values of financial indicators of the enterprise; summarizing and interpreting the results obtained and preparing an official conclusion for the decision maker.

Solving the problems of modelling and optimization is always connected with the presence of uncertainties. Expert assessments of different specialists can vary significantly depending on their experience, qualifications and intuition. A certain objectification of the process of forming the desirability function can be achieved in various ways. One of the most common is the method of aggregating the views of a group of experts. In this technique, consideration of non-statistical uncertainty is proposed to be performed on the basis of the apparatus of the theory of fuzzy sets. When assessing indicators, experts set the lower ones - "pessimistic assessments", the upper ones - "optimistic estimates" and the intervals of the most expected (possible) values of the investigated parameters. Then, to perform operations related to the determination of the generalized opinion of experts, procedures are used to construct particular quality criteria based on hyperfuzzy functions.

Hyper-fuzzy sets are called fuzzy sets characterized by functions of trapezoidal form (fuzzy intervals), the support points of which in turn are themselves indistinct intervals of the trapezoidal shape.

Consider the situation when experts are asked to quantify the values of the reference points of the trapezoidal desirability function. It is clear that in the general case, for each of the reference points, the experts will give differing estimates. The simplest way to construct on their basis the function of desirability is to average the opinions of experts. However, a significant part of the information is lost. For its preservation and use on the basis of a set of expert estimates, we construct the membership functions for each of the reference points.

Further, on the basis of the membership functions of the obtained fuzzy intervals describing [48,19] the reference points, we construct the desired desirability function for the quality criterion. Most often, by an indistinct interval we mean a trapezoidal form of fuzzy value, and by an indistinct number - a triangular shape.

Fig. 2 graphically illustrates the structure of a hyper-fuzzy number on a plane. The darker areas correspond to the greatest unanimity among experts regarding the value of the reference points, the lighter ones to the scatter in their representations. The most desirable value of the quality index corresponds to the maximum value of the desirability function equal to 1, the least desirable value is the minimum value equal to 0.

To operate with hyper-fuzzy numbers (intervals), a technique has been developed.

Practice shows that trapezoidal forms are an ample level of abstraction for formalizing uncertainties in most real situations.

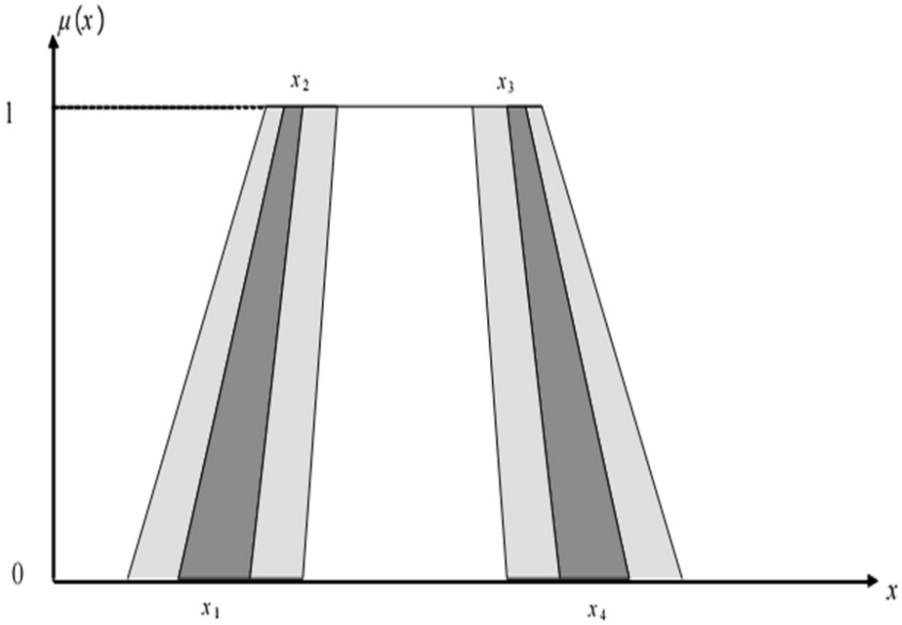

Fig. 1. Representation of a hyperfuzzy number on the plane

Let us further assume that there is some particular criterion described by the desirability function represented by the hyperfuzzy number GX (Fig. 2). Let further $x^* \in X_{GX}$ - some non-fuzzy number, corresponding to certain specific value of the analyzed indicator. Then, within the framework of the formulated definitions, the value of the hyperfuzzy function (describing the hyperfuzzy number GX) for the fixed argument x^* is the usual trapezoidal fuzzy number $G\left(x^*\right)$:

$$G\left(x^*\right)=\left\{\left(g_1\left(x^*\right),g_2\left(x^*\right),g_3\left(x^*\right),g_4\left(x^*\right)\right),x^* \in X_{GX}\right\} \tag{6}$$

The last statement for the left front of the hyperfuzzy interval is illustrated graphically in Fig. 2., which clearly shows that the result is also a fuzzy interval $G=\{g_1,g_2,g_3,g_4\}$. The interpretation of the result should be as follows: the most possible values f the evaluation of the quality criterion lie in the interval $[g_2,g_3]$, and the entire range of possible values of the criterion evaluation is $[g_1,g_4]$.

The result of the calculation of the values of the hyperfuzzy function $G\left(x^*\right)$ is determined in the most general situation as follows:

$$\begin{aligned} g_4 &= \left(x^* - G1_1\right) / \left(G2_1 - G1_1\right) \\ g_3 &= \left(x^* - G1_2\right) / \left(G2_2 - G1_2\right) \\ g_2 &= \left(x^* - G1_3\right) / \left(G2_3 - G1_3\right) \\ g_1 &= \left(x^* - G1_4\right) / \left(G2_4 - G1_4\right) \end{aligned} \quad (7)$$

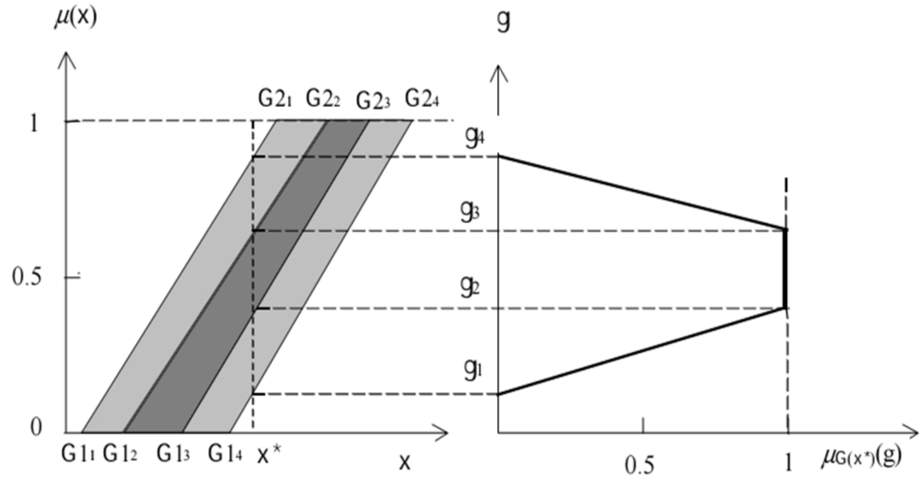

Fig. 2. Display a clear number x * on the left side of the trapezoidal hyper-fuzzy number

1. Determination of the weight coefficients of the indicators

Each indicator x_i is compared to an estimate of its significance. The balance system is designed in such a way that:

$$\sum_{i=1}^{n} a_i = 1 . \quad (8)$$

Where a_i is the weight of the *i*-th indicator; *n* - number of indicators; i - the number of the current indicator.

To compose a system of weights, each expert ranks the indicators in a descending order of importance:

$$x_1 \geq x_2 \geq ... x_i \geq ... \geq x_n , . \quad (9)$$

where x_i - the indicators of the state of the enterprise.

In this case, to determine the weights of the indicators, it is suggested to use the Fishburn scale [14], which corresponds to the maximum entropy of the available information uncertainty about the values of a_i :

$$a_i = \frac{2(n-i+1)}{n(n+1)}, \tag{10}$$

where a_i is the coefficient of significance of the *i*-th indicator; *i* - number of the current indicator; *n* - number of indicators. If the system of preferences is absent, then the indicators are equivalent:

$$a_i = \frac{1}{n}. \tag{11}$$

On the basis of individual rankings of experts it is necessary to construct a generalized ranking. This can be done by different methods. The most correct (but also the most time consuming) method is the "Kemeni median" method. To find the median, first of all, you need to specify how to determine the distance between the rankings, i.e. "Define the metric in the ranking space". After that, you need to find (build) such a ranking, the total distance from which to all the specified expert rankings would be minimal:

$$\sum_{j=1}^{m} \left\{ d_j \left(A_j, X \right) \right\} \to \text{min}, \tag{12}$$

where A_j is the ranking of the *j*-th expert; X - Kemeni median; $d_j\left(A_j, X\right)$ - the distance between the ranking of the *j*-th expert A_j and X; *m* - number of experts; *j* - number of the current expert.

The desired ranking will be the Kemeni median. We note that this way we obtain a generalized opinion of experts without rejecting any opinion, since all individual rankings are taken into account in the construction of the median.

2. Calculation of the integral estimate

Calculation of a multi-level integrated estimate of the financial state of enterprises is proposed to be performed according to the following formula:

$$J\left(x^*\right) = \sum_{j=1}^{m} \left[k_j \cdot \sum_{i=1}^{n} \left(G\left(x^*\right) \cdot a_i \right) \right] = \sum_{j=1}^{m} \sum_{i=1}^{n} \left(G\left(x^*\right) \cdot a_i \cdot k_j \right), \quad x^* \in X\ . \tag{13}$$

Where *J* is the integral estimate; $G\left(x^*\right)$ - projection of a non-fuzzy number $x^* \in X$ (quality score) on a hyper-fuzzy number; a_i is the specific weight of the *i*-th index in the *j*-th group; k_j - specific weight of the *j*-th group of indicators; *i* - number of the current indicator in the *j*-th group; *j* - the number of the current group of indicators; *m* - number of groups of indicators; *n* is the number of indicators in group *j*.

The result of calculating the integral estimate is also a fuzzy interval. It should be noted that the maximum width of the resulting interval (the width of the base of the trapezoid) is much larger than the width of any of the intervals characterizing the initial data, i.e. the solution of the problem leads to an increase in uncertainty, however, the use of fuzzy intervals allows us to determine the possible limits of the sought value and determine the most probable range of the value, which gives more real results than with traditional approaches. The theory of fuzzy sets provides for this task a convenient mathematical apparatus that allows the most complete use of information obtained from experts.

The application of the methodology of integrated assessment is not limited to the area of study of the financial and economic state of the enterprise. It can be used both to evaluate specific areas of the company's activities, and to assess the entire economic activity of the company as a whole.

4 CONCLUSION

The mathematical decision-making models proposed in the article can be used to manage industrial enterprises in conditions of instability. The advantage of the model based on the ranking of decision criteria is the identification of priority areas for improving the company's operations. While the advantage of the model based on the construction of an integral indicator is the ability to draw conclusions about the state of the enterprise as a whole and to consider changing this state in time to detect trends.

References

1. Balashov, V.G., Irikov, V.A.: Technologies for improving the financial result: practice and methods. MCFER, Moscow (2009).
2. Balashov, V.G.: IPO and value of Russian companies: fashion and realities. Delo, Moscow (2008).
3. Biryukov, S.Ye., Hainish, S.V.: From the strategy of survival to the strategy of active development (the practice of reforming and financial recovery of JSC "Vladimir Plant" Elektropribor "). From the experience of management consulting. MNIIPU, Moscow (2001).
4. Burkov, V.N., Ageev, I.A., Baranchikov, E.A. and others: Mechanisms of corporate governance. IPU RAN, Moscow (2004).
5. Burkov, V.N., Burkova, I.V., Gubko, M.V.: Mechanisms of management: Management of the organization: planning, organization, stimulation, control. In: Novikov, D.A. (eds.). IPU Lenand, Moscow (2013).
6. Burkov, V.N., Korgin, N.A., Novikov, D.A.: Introduction to the theory of management of organizational systems. In: Novikov, D.A. (eds.). LIBROKOM, Moscow (2009).
7. Bystritsky, V.E., Polyakov, S.V.: Management of industrial enterprise and personnel in the conditions of innovation. UlSTU, Ulyanovsk (2011).
8. Classics of management. In: Warner, M. (eds.). Peter, St. Petersburg (2001).
9. Development of the Russian economy: problems and solutions. In: Osipov, Yu.M., Sinelnikov, S.Yu., Antropov, A.A. (eds.). Faculty of Economics, Lomonosov Moscow State University, Moscow (2016).
10. Dranko, O.I., Irikov, V.A.: The "Cost-effectiveness" method as a tool for selecting priority projects of enterprises. Management Accounting 4, 15–20 (2011).

11. Dranko, O.I., Loginovskiy, O.V.: Tasks of industrial development of the Chelyabinsk region. Bulletin of the South Ural State University. Ser. Computer Technologies, Automatic Control, Radio Electronics 3(17), 53–63 (2017).
12. Dranko, O.I., Otarashvili, Z.A., Sushkov, D.V.: Formation of the program of innovative development: cost management. Problems of management 6, 26–31 (2012).
13. Dranko, O.I.: Express model of business valuation. Problems of management 4, 32–37 (2012).
14. Fishburn, P.: Theory of utility for decision-making. Nauka, Moscow (1978).
15. Gelrud, Ya.D., O.V. Loginovskiy, O.V.: Project management. Publishing center of SUSU, Chelyabinsk (2015).
16. Gershun, A., Gorsky, M.: Technologies of balanced management. Olimp-Business, Moscow (2005).
17. Glazyev, S.Yu.: The development of the Russian economy in the context of global technological changes: a scientific report. NIR, Moscow (2007).
18. Gollay, A.V., Loginovskiy, O.V.: Managerial Decision-Making Model Taking into Account Technological Development of the Enterprise. Bulletin of the South Ural State University. Ser. Computer Technologies, Automatic Control, Radio Electronics 4(14), 142–145 (2017).
19. Gollay, A.V., Loginovskiy, O.V.: Method of selecting technologies of a manufacturing enterprise to carry out projects on their improvement on the basis of the theory of fuzzy sets. Bulletin of the South Ural State University. Ser. Computer Technologies, Automatic Control, Radio Electronics 1(18), 117–123 (2018).
20. Kaplan, R.S., Norton, D.P.: Balanced Scorecard. From strategy to action. Olimp-Business, Moscow (2003).
21. Klimanov, V.: State programs for the development of macro-regions of Russia. URSS, Moscow (2016).
22. Kondratiev, V.B.: Branches and sectors of the global economy: features and development trends. International relationships, Moscow (2015).
23. Korennaya, K.A., Loginovsky, O.V., Maksimov, A.A., Shurygin, A.N., Zimin, A.V.: On the directions of innovation for large industrial enterprises (on the example of ferroalloy industries). Bulletin of the South Ural State University. Ser. Computer Technologies, Automatic Control, Radio Electronics 4(14), 107–115 (2014).
24. Korennaya, K.A., Loginovskiy, O.V., Maksimov, A.A., Zimin, A.V.: Global Economic Instability and Management of Industrial Organizations. In: Shestakov, A.L. (eds.). KSU, Kostanay (2014).
25. Korennaya, K.A., Loginovskiy, O.V., Maksimov, A.A.: Information and resource support of management of industrial enterprises on the basis of the forecast-adaptive approach. Information resources of Russia, 16–20 (2012).
26. Korennaya, K.A., Loginovsky, O.V., Maksimov, A.A.: Management of industrial enterprises in conditions of global instability. In: Shestakov, A.L. (eds.). Publishing Center of SUSU, Chelyabinsk (2013).
27. Korennaya, K.A., Loginovskiy, O.V.: Strategy of effective management of a large industrial enterprise. Bulletin of the South Ural State University. Ser. Computer Technologies, Automatic Control, Radio Electronics 3(16), 102–109 (2016).
28. Loginovskiy, O.V., Korennaya, K.A.: Increasing the efficiency of the enterprise on the basis of modern management technologies and information-analytical systems. In: Information Society - 2015: Challenges and Challenges, pp. 4–38. Publishing Center of SUSU, Chelyabinsk (2015).

29. Loginovskiy, O.V., Maksimov, A.A., Burkov, V.N., Burkova, I.V., Gelrud, Ya. D., Korennaya, K.A., Shestakov, A.L.: Management of industrial enterprises: strategies, mechanisms, systems. INFRA-M, Moscow (2018).
30. Loginovskiy, O.V., Maksimov, A.A., Khaldin, K.S.: Management of material resources of an industrial enterprise in modern conditions. Dynamics of complex systems 4, 33–38 (2016).
31. Loginovskiy, O.V., Maksimov, A.A.: Corporate management. T. 2. Mechanical Engineering, Moscow (2007).
32. Loginovskiy, O.V., Maksimov, A.A.: Management of a group of enterprises. Publishing Center of SUSU, Chelyabinsk (2008).
33. Loginovskiy, O.V., Maksimov, A.A.: Management of an industrial enterprise. T. 1. Mechanical Engineering, Moscow (2006).
34. Lutz, R.A.: 7 Chrysler laws. Alpina, Moscow (2003).
35. Maksimov, A.A., Korennaya, K.A., Loginovsky, O.V.: Adaptive management of an industrial corporation in conditions of uncertainty (on the example of ferroalloys industries). Problems of theory and practice of management 9-10, 145–150 (2012).
36. Masaaki, I.: Kaizen: the key to the success of Japanese companies. Alpina Business Books, Moscow (2004).
37. New model of Russia's economic development: the concept of formation and implementation. In: Aksakov, A.G. (eds.). State Duma of Russian Federation, Moscow (2016).
38. Novikov, D.A.: Management methodology. Librocom, Moscow (2011).
39. Novikov, D.A.: Theory of management of organizational systems. Physics and mathematics literature, Moscow (2012).
40. On the strategy for the development of the Russian economy: a scientific report. In: Glazyeva, S.Yu. (eds.). OON RAN, Moscow (2011).
41. Paklin, N.B., Oreshkov, V.I.: Business Intelligence: from data to knowledge. Peter, St. Petersburg (2013).
42. Rogov, S.F.: Mathematical models in decision theory. Company Sputnik +, St. Petersburg (2013).
43. Sterligova, A.N.: Reserve management in supply chains. Infra-M, Moscow (2016).
44. Thompson, A.A., Strickland A.J.: Strategic management: concepts and situations for analysis. Williams, Moscow (2007).
45. Ushvitsky, L.I., Krasnikov, A.V., Dzhavadova, O.M.: Innovational development of the Russian economy: problems and perspectives. SKFU, Moscow (2015).
46. Vissema, H.: Fundamentals of Strategic Management and Entrepreneurship. Infra, Moscow (2008).
47. Womack, J.: Lean production: How to get rid of losses and to achieve prosperity of your company. Alpina Business Books, Moscow (2004).
48. Zadeh, L.A.: Fuzzy Sets as a Basis for a Theory of Possibility Systems: tutorial. North-Holland, Holland (1978).