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THE MODEL FOR SELECTION OF INNOVATION AND INVESTMENT STRATEGY OF MACHINE-BUILDING ENTERPRISES: PRACTICAL ASPECT

Abstract. The article summarizes the arguments within the scientific challenge in choosing the innovation and investment strategy of machine-building enterprises. The main objective of the research is to develop a model for choosing the optimal strategy for innovation and investment development of machine-building enterprises, taking into account their level of investment attractiveness in the market and the level of innovative capacity as well. Systematization of theoretical and methodological material on the model of choosing the innovation and investment strategy of machine-building enterprises has given grounds to conclude that further research is required regarding the modelling issues based on the indicators of a sophisticated analysis of the investment attractiveness of the enterprise and determining its level of innovation potential in order to increase the efficiency of the domestic machine-building enterprises. The relevance of solving this problem is that it is the right choice of a particular type of innovation and investment strategy will help machine-building enterprises to improve the efficiency of their operation and to establish competitive positions in the market. The methodical tools of the research on the model of choosing the innovation and investment strategy are the matrix and convolution methods based on the fuzzy-set theory. The objects of the research JV «Spheros-Elektron» LLC, LEONI Wiring Systems UA GmbH and PJSC «Drohobych Truck Crane Plant» were chosen, because they reveal peculiarities of the machine-building enterprises' operation in Lviv region. The paper presented the findings of the choice of appropriate innovation and investment strategies, which showed that PJSC «Drohobych Truck Crane Plant» has entered the zone of application of the strategy of innovation changes and is characterized by both low level of investment attractiveness and low level of the innovative potential. JV «Spheros-Elektron» LLC and LEONI Wiring Systems UA GmbH – both have entered the zone of application of the strategy of differentiation, characterized by an average level of investment attractiveness and a satisfactory level of innovation potential. However, according to the first parameter – the level of investment attractiveness of the company on the market, LEONI Wiring Systems UA GmbH has also approached and is close enough to the application of the opportunistic strategy. The research empirically confirms and theoretically proves that in order to remain on the market of PJSC «Drohobych Truck Crane Plant», it is necessary to modernize the products radically. Furthermore, the main tasks of implementing the differentiation strategy for «Spheros-Elektron» and «LEONI» should be: to invest in the activities of research institutions; to conduct consumer preferences analysis; the analysis of its production capacities; installation of new production lines according to the achievements of the technical progress; production output, which is in demand by the population; holding a capable advertising company. The results of the research can be useful for industrial enterprises in general and machine-building enterprises, in particular.

Keywords: fuzzy-set theory, innovation and investment strategies, machine-building enterprise, the model for the selection of the strategy, the strategy of innovation development.

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Introduction. In the context of the modern market environment and the dynamic changes due to the influence of information technologies and the rapid development of scientific and technological progress, domestic machine-building enterprises are becoming increasingly difficult to conduct the production and economic activities. Today, their lion's share is at the stage of decline or survival. However, the current political and economic situation in Ukraine creates new opportunities for the development of machine-building enterprises, focusing the consumer on domestic production. Such an imbalance between the growing demand for machine-building products and the insufficient level of its production creates an urgent need for the search and use of such tools, which would help them to increase the effective functioning and to forge competitive positions in the market. Among such tools, the development of optimal innovation and investment strategy plays an important role. It is important to note that the formula of success of the efficient operation of the enterprise is the right choice of a particular type of innovation and investment strategy, which should be oriented towards the achievement of goals of the enterprise and take into account its real potential. These preconditions increase the relevance of scientific and theoretical research and practical developments in the area of innovation and investment strategies in order to increase the efficiency of domestic machine-building enterprises.

The development and implementation of the innovation and investment strategy will help domestic machine-building enterprises to implement innovative activities and create a favourable investment environment. Accumulation of investments in the development of enterprises will ensure the attraction of new resources, updating the technical and technological basis of the domestic machine-building enterprise, strengthening of financial stability. It will ensure the possibility of activities for the development of the enterprise – restructuring, reengineering, reorganization, etc., which will increase the competitiveness of machine-building products of domestic enterprises both in domestic and in foreign markets.

Literature Review. Discovering the problems of developing a model for the selection of innovation and investment strategy to improve the efficient operation of domestic machine-building enterprises, several scientific achievements of domestic and foreign scientists were worked out. In order to carry out a more detailed analysis of the papers, it is expedient to group them according to the vector of scientific research.

The first group included papers on the issues of innovation and investment strategies. In particular, the formation of innovation and investment strategy of the industrial enterprise in the conditions of competition, the mechanism of its development and the main problems were described in the writings of the following authors: Kandeieva and Brovkova (2014), Nekrasova (2014), Nakonechna (2015), Melnyk et al. (2018). The scientists Haustava (2009) and Rodionova (2011) revealed the theoretical foundations for assessing the investment and innovation potential of the enterprise in the context of a strategic approach. The scientific developments, which highlighted the peculiarities of investment climate formation in Ukraine, and described the methods of assessing the investment attractiveness of enterprises, were published by the scientists, among them: Gaevskaya, (2017), Vakhovych et al. (2014), Sainchuk and Fedkovych (2014), Skalyuk and Loyik (2016). The authors Kağan and Kurtb (2016) conducted an empirical study of the relationship between knowledge management practices and opportunities for strategy formulation. The scientific substantiation of the influence of the strategic information system and strategic design on the competitiveness of the company, conducted by the field research, was discovered by foreign authors, Alyaa Adel Abd Elsalam Ibrahim, Abd El-Hamed Mostafa Abou Naem. The theoretical aspects of the development of innovation strategies and the peculiarities of their practical implementation were highlighted by Augsten et al. (2017), Goffin and Mitchell (2017), Pisano and Gary (2015), Izmailov et al. (2017).

The second group includes the scientific papers aimed at research and analysis of models that can be used for innovation and investment strategies, in particular those based on the fuzzy-set theory. Both

domestic and foreign scientists contributed to the development of scientific aspects of this topic. Among them is Zadeh (1978), who describes fuzzy sets as the basis of probability theory. Fishbern (1981) developed a methodological framework for determining the weight coefficients of the underlying indices that underlie the construction of models using the fuzzy-set theory. Potapov and Yevstafieva (2008) analyze the methods of determining weight coefficients for the assessment of the reliability of commercial banks. The authors Sorochak and Gvozd (2015) scientifically substantiated and proposed a methodology for evaluating the efficiency of business processes of instrument-making enterprises based on the fuzzy-set theory. Nedosekin (2003) discloses the conceptual foundations for the construction of financial analysis on a fuzzy-set theory.

The academic and methodological material on the model for innovation and investment strategy of industrial enterprises gives grounds to conclude that the problem of developing a model based on indicators of the complex analysis of the investment attractiveness of the industrial enterprise and determining its level of innovation potential for the selection of optimal innovation and investment strategy in order to increase the efficient functioning of domestic machine-building enterprises.

Methodology and research methods. In order to make managerial decisions on stimulating the innovation activity of machine-building enterprises, one should choose the most effective strategy of innovation development for a particular enterprise. In this situation, in our opinion, it is expedient to use a matrix method that involves the construction of a matrix for assessing the financial condition and innovation abilities of the machine-building enterprise. We have proposed two features: the level of investment attractiveness of the enterprise in the market (X) and the level of innovation potential of the enterprise (Y) for the matrix construction.

The general view of such a matrix is shown in Figure 1. The proposed matrix distinguishes twelve types of innovation and investment strategies, among which the machine-building enterprise can choose the optimal one, taking into account its level of innovation potential and investment attractiveness in the market. Thus, below we will reveal the economic essence, the advantages and disadvantages of each of the developed strategies.

The level of innovation potential of the enterprise (Y)	Very good	Market niche strategy	Passive forward strategy	Active forward strategy
	Good	High-tech-oriented strategy	The strategy of «forward strikes»	The strategy of «challenging»
	Satisfactory	Opportunistic strategy	Strategy of differentiation	The strategy of price leadership
	Bad	The strategy of innovative changes	Strategy of expectations	Imitation strategy
		Bad	Good	Very good
		The level of investment attractiveness of the company on the market (X)		

Figure 1. Selection matrix of the strategy for stimulation of innovation and investment activity of enterprises of the machine-building industry

Sources: developed by the authors

The active forward strategy (leadership strategy) – aimed at gaining leadership in the market; while its implementation, the companies seek to become a leading company in a particular area of activity and marketing. As a rule, even large and powerful enterprises do not risk using it in a broad range of

products. Typically, this strategy is applied only to one or more individual products, where there are favourable conditions for its implementation (resources, scientific and technical potential) since it is based on the development of fundamental and drastic innovations. The active forward strategy is hazardous in terms of conquering and maintaining market positions and is associated with significant resource costs. However, the use of this strategy can bring significant results. The active forward strategy is used by attacking companies aimed at eliminating the competitor by taking out unique, innovative products, occupying the dominant positions in the industry, conquering new markets.

The implementation of the strategy of leadership requires a substantiated scientific and research support: a broad field of research in related areas and constant connection with fundamental research; continuous review of the most relevant results of the research works intending to introduce them into production; operational changes in funding the priorities depending on the expected results of marketing. In the area of research and development, a strong base must be created; the most important is the presence of qualified staff, the establishment of constant relations between all the links in the innovation process.

Particular attention is required in the area of licensing and patenting. Maximum early patenting of promising fundamental innovations prolongs the period of preservation of competitive advantages. No less critical is intensive licensing in those markets where the company has no particular advantages and patent protection. Despite the high costs and risks, an active forward strategy continues to be attractive for achieving such goals as ensuring a rapid increase in sales and market share, significant profit on invested capital and the achievement of a stable consumer base.

The passive forward strategy (following the leader) focuses on the rapid expansion of the market niche. The meaning of such a strategy is that the organization focuses on innovations (products) that have already gained recognition in the market. The main objective of such a strategy is a «secure trade policy» when the company tries to avoid significant risk, as well as possible difficulties when developing new products with high innovation characteristics. As a rule, it is used by great enterprises because the implementation of this strategy does not come cheap. It is essential from management since it is necessary to keep the second place in the group of applicants for success, to pursue an active innovation policy, to continually monitor the trends of scientific research and design studies (SRDS) of the technology leader and to seek to create the minimum scientific advancement in these industries in order to reduce the time of scientific and technical preparation of the product before entering the market, following the leader. The companies aligning with this strategy are actively patenting their innovations based on the radical innovations of the technology leader (Krasnokutskaya, 2003).

The companies that have chosen a market niche (focusing) strategy have low investment attractiveness, but the innovation potential is quite high. The enterprise focuses on the innovative potential of the target segment of a particular industry and receives benefit due to the features of this segment that distinguish it from other sectors of the industry. This company has an advantage over competitors with a comprehensive specialization, namely: such a company can choose the direction of optimization - product differentiation or cost reduction.

The goal of the strategy of challenging is to take the place of a leader. An attack on the competitor's strong points can be conducted in any direction: a price reduction; conducting a similar advertising campaign; providing the product with new features (characteristics) that can attract the attention of the competitors; creation of new capacities in the competitor's territory; release of new models of goods that can replace competitors' models (model against model). A classic example, as F. Kotler notes, is the attack by competitors of the company offering a similar quality product and at a lower price (Zakharchenko, 2012).

The strategy of «forward strikes» is aimed at maintaining a favourable position on the market at the expense of: maintaining a geographical area that provides competitive advantages; establishment of

business relations with reliable suppliers of raw materials and supplies; expansion of production facilities and areas in size slightly larger than the market needs at this time; providing benefits to consumers with a high reputation, appropriate style and way of life; creation of a reliable and stable company among consumers, etc. (Koretsky, 2007). Several ways allow to protect the competitive advantages: expansion of the range of products, in order to fill the free market niches of potential competitors; development of models and varieties of products with characteristics that competitors already have or can have; offering models that are closest in their characteristics to competitors' products, at lower prices; signing profitable contracts with the dealers and distributors to push competitors away from their distribution network; guaranteeing dealers and distributors significant discounts to prevent them from getting in touch with other suppliers; offering free or low-cost user training.

The strategy of focusing on high-tech firms is one of the varieties of strategy to conquer market niches. Small high-tech enterprises work in the field of the latest high technologies and are called risky or venture. Many of them are established either by those who are developing a new innovative idea or by their direct involvement. The strategy of venture companies is aimed at developing new technological solutions for implementing the growth strategy in the form of market diversification. The corporations strive to establish internal venture units based on independent innovation and entrepreneurial group, which business is related to commercial risk in the field of SRDS. The internal venture is the most balanced and, at the same time, an effective strategy for penetrating new industries (Zakharchenko, 2012).

The strategy of price leadership involves reducing production costs due to the massive increase in its volume and industrial efficiency of production processes.

The strategy of differentiation is one of the general strategies of the competition, based on the differentiation of goods. Differentiation is the company's desire for uniqueness in any respect necessary to customers. The differentiation strategies become relevant when consumers need to become diverse and cannot be satisfied with standard goods. A successful strategy of differentiation can only be based on the study of consumer needs. In the course of marketing research, the benefits of consumers, their opinions about the value of goods and the quality which they are willing to pay for, are identified. On this basis, the company chooses one or more characteristics of the product. The emergence of competitive advantage can be expected in the case when quite a large number of buyers will be interested in purchasing goods with differentiated (that is, different from that of competitors) characteristics.

In the case of success of differentiation, it allows increasing the price of goods, increases sales in connection with the attraction of additional buyers, increase customer loyalty to the product. The basis for differentiation may be the following properties, such as excellent taste properties of the product, differences in design, service, completeness of the product range, reliability, and safety.

At the same time, the strategy of differentiation, like any strategy, has its risks. The strategy of differentiation will not provide significant competitive advantages if the buyer does not see the value of a unique product since the standard product meets his requirements. The result – a strategy of expenses wins the strategy of differentiation. The strategy of differentiation can be conquered if the competitor has the opportunity to copy the innovations of the company (Gorelov, 2010).

The opportunistic strategy focuses on the product of the market leader, which does not require high costs for scientific development. As a consequence of this strategy – a stable position in the market. At the same time, there is a risk of rapid loss of these benefits due to changes in customer loyalty.

The imitation strategy consists in the fact that the firm buys licenses, concludes licensing agreements, spending the minimum funds on its SRDS. Success, in this case, can be achieved under the condition of high qualifications of the workers and constant support of the achieved level (Gorelov, 2010).

The strategy of expectation is carried out in conditions of uncertain situation and consumer demand. In this case, the company takes a waiting position to clarify the situation on the market and then increases the production and sales of the new product (Sorokolit, 2006).

The strategy of innovation changes is characteristic for enterprises with low innovation potential and investment attractiveness. The main reason for such a situation is obsolete noncompetitive products on the market. To rehabilitate such an enterprise, it is necessary to direct funds to highly qualified personnel, which would provide recommendations for product redesign.

Under the level of investment attractiveness of the enterprise, one should understand the assessment of the state of specific indicators of the financial and economic position of the enterprise (Tyutyunnik, 2013). A competently constructed model of the complex analysis of investment attractiveness of the enterprise should contain a minimum number of indicators that reflect only those data that are of interest to the Head of the enterprise or potential investor. Besides, it is not necessary to include those indicators that duplicate the data in the list of indicators. In our opinion, the number and composition of the indicators proposed by Tyutyunnik (2013) are quite balanced. In particular, we propose to consider the following indicators:

1. The ratio of financial independence (autonomy) shows the share of the private assets in the aggregate. The economically expedient value of this coefficient should be greater than 0.5; that is, the private capital in aggregate should be at least half. It is believed that the investor will be so much more willing to invest in the enterprise, as the share of the personal capital in the aggregate will be higher. Thus, the enterprise is more likely to pay its obligations on its own.

On the other hand, the management should understand that the enterprise will not be able to develop if it does not attract external resources, at least in order to replenish the amount of the working assets.

Besides the rate of autonomy, Tyutyunnik recommends to include in the valuation model the coefficient of financial stability, which characterizes the share of stable sources of financing the activities in their total volume. Nevertheless, in our opinion, its value is quite closely correlated with the value of the coefficient of financial independence.

2. The investment ratio characterizes the sufficiency of the personal assets to cover non-current assets and personal assets in asset formation. The economically expedient value is more than 1. The higher the value of the indicator compared to one, the more stable the financial condition of the enterprise.

3. The manoeuvre ratio. Statutory value: 0.40-0.60. The increase in the value of this rate characterizes positive changes in the financial state of the enterprise because it means that it increases the possibility of manoeuvring with its funds.

4. The current liquidity ratio determines the company's ability to meet its obligations at the expense of its current assets. It is believed that current assets should be 1.5-2.5 times higher than the debt obligations; that is, the statutory value of this indicator is 1.5-2.5. Under this condition, due to the implementation of current assets, the settlement of their obligations is ensured.

A meagre ratio indicates a high probability of a loss of solvency and, above all, ineffective use of debt capital.

The current liquidity ratio shows how short-term liabilities are covered by short-term assets that would have to turn into money for a period equal to the due date of liabilities.

5. The return on assets ratio shows the number of proceeds from the sale of products for 1 UAH of non-current assets. The more the return on assets ratio, the more effective is the use of non-current assets, that is, the investment.

For an investor, the indicator of return on assets ratio is interesting primarily because of its ability to calculate the volume of capital investments in the future. It is not a secret that at almost all machine-building enterprises of Ukraine, the updating of the material and technical base is very slow. Therefore the problem of increasing the efficiency of using fixed assets is very relevant.

6. In addition to the return on assets ratio, it is necessary to analyze the ratio of renewal of fixed assets, which characterizes the level of physical and moral renewal of fixed assets. This indicator should continue to increase, but necessarily inflation-adjusted.

7. The return on personal assets describes the efficiency of the use of personal assets. It is assumed that the personal assets are effectively used when their yield exceeds the yield of long-term investments in the bank.

8. The profitability of the aggregate capital characterizes the operational efficiency of the enterprise.

9. The period of repayment of the creditor indebtedness. It is the average due date of the short-term debt of the enterprise. An increase in the indicator means an increase in debt, but in the presence of this increase, it is necessary to pay attention to the ratios of financial dependence and financial stability.

10. The ratio of short-term receivables and payables shows for which part of the creditor indebtedness the enterprise can pay off its debtors during the year. The statutory value of this indicator is 1. The lower its value from 1, the more the probability of having problems with credits payment.

11. The profitability of production shows the efficiency of production costs. This indicator is the most accurate measurement of the economic efficiency of production since it most closely compares the amount of profit with the size of the costs for which it was received.

12. The profitability of the turnover allows the enterprise to increase its working assets and increase solvency. In order to ensure self-sustainability, the enterprise must provide a profitability level of more than 5% of the turnover.

The analysis of these indicators does not require a broad information base and much time. It can be interpreted as an express analysis. Indeed, for making a final decision on the expediency of investing in the enterprise, the investor may need more information. Nevertheless, in order to orient and make a minimum of conclusions, this is enough.

Under the level of innovation potential of the enterprise we understand the level of development of science and technology in the enterprise, the number of SRDS, which are implemented or can be implemented in order to develop the company or its components, as well as the ability to innovate the development of the enterprise with the use of all necessary resources for this, which is in his disposal (Zakharkin, 2012).

Innovative resources are the production, intellectual and information resources necessary for the innovation activity of the enterprise (Gaevskaya, 2017).

Consequently, in order to evaluate the innovative potential of the enterprise, there is a need to take into account the plurality of factors that are the basis for further calculation of the integral index of its level.

As indicators of resource provision of the enterprise for the realization of innovation potential (Gaevskaya, 2017) suggests using several rates:

1. The ratio of intellectual property security, calculated as the ratio of the value of rights to commercial designations, to industrial property rights, copyright and related rights to the value of intangible assets of the enterprise.

2. The ratio of the personnel qualification employed in the innovative sphere of the enterprise is the ratio of the number of employees with higher education to the total number of employees of the enterprise engaged in innovation.

3. The ratio of the endowment of the enterprise equipment necessary for the innovation sphere, which is calculated as the ratio of the cost of production equipment associated with technological innovations to the value of all equipment for production purposes.

4. The ratio of mastering of new technologies – the ratio of the value of introduced fixed assets to the average annual cost of the main production assets of the machine-building enterprise.

5. The ratio of mastering of new products – the volume of sales of new products in value terms divided by the total volume of sales of the enterprise for a specified period.

6. The ratio of innovation growth, which is calculated as the ratio of enterprise costs to innovation activity for a certain time to the total volume of expenses of the enterprise for the same period.

The above groups of indicators – on the level of innovation activity of the enterprise and the level of investment attractiveness on the market, give an opportunity to objectively evaluate machine-building enterprises in certain areas and make appropriate conclusions regarding the selection of innovation and investment strategy.

In order to provide the positioning of a particular machine-building enterprise in the matrix presented in Figure 2, it is expedient to use the fuzzy-set theory (Zadeh, 1978), since the integral indicators under which positioning is carried out include a significant number of various primary indicators, both absolute and relative ones.

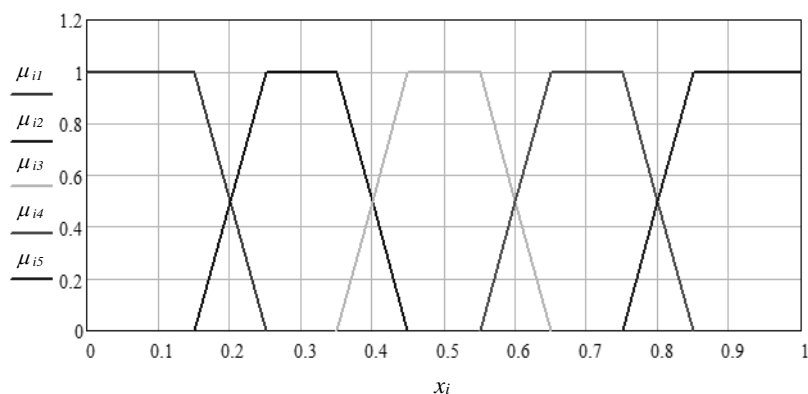


Figure 2. The standard five-level fuzzy 01-classifier is built on trapezoidal membership functions
Sources: Nedosekin (2003)

It is expedient to carry out a quantitative assessment of integral indicators X and Y using double convolution equations:

$$X_n = \sum_{i=1}^n \alpha_i \sum_{j=1}^5 \beta_j \mu_{ij}(x_i) \quad (1)$$

$$Y_m = \sum_{k=1}^m \alpha_k \sum_{j=1}^5 \beta_j \mu_{kj}(y_k) \quad (2)$$

where α_i and α_k – relevance of i and k baseline indicators for convolution; $\mu_{ij}(x_i)$ and $\mu_{kj}(y_k)$ – the value of the membership functions of j quality level relative to the current value of i and k baseline indicators; β_j – nodal points of the standard five-level fuzzy 01-classifier, which value for the indicators, which incremental value corresponds to the improvement of the characteristic, is calculated by the formula:

$$\beta_j^+ = 0,1 + 0,2 \cdot (j - 1), \quad (3)$$

Nevertheless, for the indicators by which the growth of the value of the indicator corresponds to the deterioration of the characteristics – by the formula:

$$\beta_j^- = 0,9 - 0,2 \cdot (j - 1). \quad (4)$$

The standard five-level fuzzy 01-classifier (Figure 2) is based on 01-bearer and allows you to describe five values of the linguistic variable «Indicator level»: «Very low», «Low», «Medium», «High», and «Very high» (Nedosekin, 2003).

The nodal points of the standard five-level fuzzy 01-classifier β_j are, on the one hand, abscissas of the maxima of the corresponding membership functions on the 01-carriers, and, on the other hand, are equitably remote apart from each other on the 01-carriers and symmetric concerning the nodal point 0.5, and particular these points are 0.1; 0.3; 0.5; 0.7; 0.9. These points act as weights when aggregating the system of indicators at the level of their qualitative states. Thus, the nodal points integrate a set of non-standard classifiers (with their asymmetric nodal points) to a single classifier of the standard form, with the simultaneous transition from a set of non-standard carriers of the individual factors to the standard 01-carrier.

The essence of the five-level fuzzy 01-classifier is that if nothing is known about the index, except that it can take any values within the 01-carrier, but it is necessary to establish a link between the qualitative and quantitative estimates of the indicator, the proposed classifier does this is with maximum certainty. Herewith, the sum of all membership functions for any x_i or y_k equal to one, indicating consistency classifier.

Regarding the relevance of fundamental indicators in convolution α_i and α_k , it is appropriate in this case to determine by expertise using Fishburne scale (Fishbern, 1981).

For each primary indicator of the enterprise x_i ($i = \overline{1, n}$) and y_k ($k = \overline{1, m}$), an assessment of its relevance is made, that is, the following relevance system is constructed:

$$\begin{cases} \sum \alpha_i = 1, \\ \alpha_i \geq 0, \\ i = \overline{1, n}. \end{cases} \quad \text{and} \quad \begin{cases} \sum \alpha_k = 1, \\ \alpha_k \geq 0, \\ k = \overline{1, m}. \end{cases} \quad (5)$$

where α_i and α_k – relevance of i and k baseline indicators; i and k – numbers of indicators; n and m are the number of fundamental indicators based on which integral indicators X and Y are determined.

According to the Fishburne principle (Fishbern, 1981), baseline indicators are rated in descending order of importance $x_1 > x_2 > x_3 > \dots > x_i > \dots > x_n$ and $y_1 > y_2 > y_3 > \dots > y_k > \dots > y_m$ (the sign « \sim » means that the expert considers a particular pair of indicators to be equivalent), and their weight after the formulas calculate the ranking:

$$\alpha_i = \frac{2 \cdot (n - i + 1)}{n \cdot (n + 1)} \quad \text{and} \quad \alpha_k = \frac{2 \cdot (m - k + 1)}{m \cdot (m + 1)}. \quad (6)$$

The Fishburne rule reflects the fact that nothing is known about the relevance level of indicators except their hierarchy. Then the assessment (6) corresponds to the maximum entropy of the current information uncertainty about the study subject.

Results. To calculate the complex indicator of determining the level of innovation activity of the enterprise and the level of its investment attractiveness, the resulting weighting factor should be calculated as the average arithmetic weights determined by each of the experts (Potapov, 2008).

All baseline indicators, both quantitative and qualitative, should be ranked in terms of importance. To set up a system of weights, we interviewed seven experts (leading specialists of the investigated machine-building enterprises), which located, respectively, our proposed indicators, each in the following sequence:

- 1) $x_7 > x_{12} > x_8 \sim x_{11} > x_1 \sim x_4 > x_5 > x_6 > x_9 \sim x_{10} > x_2 \sim x_3; y_2 \sim y_3 > y_4 \sim y_5 > y_6 > y_1;$
- 2) $x_1 > x_4 > x_7 \sim x_8 > x_5 > x_6 > x_{10} > x_9 > x_2 \sim x_3 > x_{11} > x_{12}; y_3 \sim y_4 > y_5 > y_6 > y_1 \sim y_2;$
- 3) $x_5 > x_1 > x_8 \sim x_7 > x_9 > x_2 > x_{11} > x_{12} > x_6 > x_{10} > x_3 \sim x_4; y_6 > y_3 \sim y_4 \sim y_5 > y_2 > y_1;$
- 4) $x_8 > x_7 > x_{11} \sim x_{12} > x_1 > x_4 > x_5 \sim x_6 > x_2 > x_3 > x_9 \sim x_{10}; y_2 > y_3 > y_6 \sim y_4 > y_1 > y_5;$
- 5) $x_4 > x_1 > x_2 \sim x_8 > x_5 \sim x_6 > x_7 > x_{12} > x_{11} \sim x_9 > x_{10} > x_3; y_3 > y_2 > y_4 > y_5 > y_6 > y_1;$
- 6) $x_7 > x_8 > x_2 \sim x_1 > x_{11} > x_{12} > x_4 > x_5 > x_9 \sim x_{10} > x_6 > x_3; y_6 \sim y_4 > y_5 \sim y_1 > y_2 \sim y_3;$
- 7) $x_8 > x_{12} > x_1 \sim x_4 > x_7 \sim x_{11} > x_5 \sim x_6 > x_2 > x_9 > x_{10} \sim x_3; y_6 > y_3 > y_1 > y_2 > y_4 > y_5.$

The weight of all the baseline indicators according to their ranking by experts are calculated by the formulas (6) presented in Table 1 and 2.

Table 1. The calculation of the values of the baseline indicators that characterize the investment attractiveness of the enterprise, according to their ranking by experts

Experts	The relevance of baseline indicators that characterize the investment attractiveness of the enterprise											
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
1	0.096	0.019	0.019	0.090	0.077	0.064	0.154	0.121	0.045	0.045	0.121	0.142
2	0.154	0.045	0.045	0.141	0.103	0.090	0.121	0.121	0.064	0.077	0.026	0.013
3	0.141	0.090	0.019	0.019	0.154	0.051	0.122	0.122	0.103	0.038	0.077	0.064
4	0.103	0.051	0.038	0.090	0.071	0.141	0.141	0.154	0.019	0.019	0.122	0.122
5	0.141	0.122	0.013	0.154	0.096	0.096	0.077	0.122	0.045	0.025	0.045	0.064
6	0.122	0.122	0.013	0.077	0.064	0.026	0.154	0.141	0.044	0.044	0.103	0.090
7	0.122	0.051	0.019	0.122	0.071	0.071	0.096	0.154	0.038	0.019	0.096	0.141
Medium	0.126	0.071	0.024	0.100	0.091	0.067	0.124	0.134	0.051	0.038	0.084	0.090

Sources: developed by the authors

Table 2. The calculation of the values of the baseline indicators that characterize the level of innovation potential of the enterprise, according to their ranking by experts

Experts	Relevance of baseline indicators that characterize the level of innovation potential of the enterprise					
	y_1	y_2	y_3	y_4	y_5	y_6
1	0.048	0.262	0.262	0.167	0.167	0.094
2	0.071	0.071	0.262	0.262	0.191	0.143
3	0.049	0.095	0.190	0.190	0.190	0.286
4	0.095	0.286	0.238	0.166	0.049	0.166
5	0.048	0.238	0.286	0.190	0.145	0.095
6	0.167	0.071	0.071	0.262	0.167	0.262
7	0.190	0.143	0.238	0.095	0.048	0.286
Medium	0.095	0.167	0.221	0.190	0.137	0.190

Sources: developed by the authors

We will analyze following the given method the activity of the following machine-building enterprises: JVJV «Spheros-Elektron» LLC, LEONI Wiring Systems UA GmbH and PJSC «Drohobych Truck Crane Plant». The baseline indicators for positioning these enterprises in the selection matrix of the strategy for stimulating innovation activity are listed in Table 3.

Table 3. Baseline indicators for positioning enterprises in the selection matrix of the strategy for stimulating innovation activity

Indicator	Method of calculation	JV «Spheros-Electron» LLC	LEONI Wiring Systems UA GmbH	PJSC «Drohobych Truck Crane Plant»
1.1. The ratio of financial independence	personal assets/total assets	0.667	0.266	0.312
1.2. Investment ratio	(personal assets + long-term liabilities)/non-current assets	2.542	0.254	0.718
1.3. Manoeuvre ratio	personal working assets/personal assets	0.738	0.232	0.002
1.4. Current liquidity ratio	working assets/current liabilities	2.214	1.000	0.812
1.5. The return on assets ratio	net sales revenue/average annual residual value of fixed assets	5.71	28.23	9.56
1.6. The fixed asset renewal ratio	increase in the initial cost of fixed assets/initial cost of fixed assets	0.129	0.244	0.035
1.7. The return on personal assets	net profit/personal assets	0.239	0.327	-
1.8. The return on total capital	financial result before taxation/fixed assets	0.194	0.176	-
1.9. The payable period	360 × payables/production cost	68.0	15.7	235.2
1.10. The ratio of receivables and payables	receivables/payables	1.36	14.60	0.31
1.11. The production profitability	financial result before taxation/(average annual cost of fixed assets + value of standardized working capital)	0.339	0.184	-
1.12. The profitability of turnover	operating profit - paid interest/sales turnover	0.267	0.119	-
2.1. The intellectual property ratio	the value of rights to commercial labels, rights to industrial property rights, copyright and related rights/intangible assets	0.247	0.123	0.054
2.2. The proficiency ratio	number of employees with higher education/total number of employees of the enterprise	0.44	0.45	0.24
2.3. The ratio of the innovative equipment of the enterprise	the cost of production equipment related to technological innovations/cost of equipment for production purposes	0.264	0.351	0.103
2.4. The ratio of mastering new technologies	the value of the introduced fixed assets/average annual cost of fixed assets	0.195	0.287	0.094
2.5. The ratio of mastering new products	the volume of sales of new products/total sales	0.123	0.155	0.035
2.6. The ratio of innovation growth	expenses of the enterprise for innovation activity/total expenses of the enterprise	0.032	0.071	0.021

Sources: developed by the authors based on data for enterprises in 2018

The trapezoidal five-level membership functions (see an example of such a membership function for the values of the ratio of financial independence in Figure 3) for all the baseline indicators given in Table 3.

The calculation of integral indicators of the level of investment attractiveness of the enterprise in the market (X_n) and the level of innovation potential of the enterprise (Y_m) for positioning enterprises in the matrix of selection a strategy for stimulating innovation and investment activity was carried out in the environment of the application software package MathCAD. In order to illustrate the sequence of their calculation, we give an example of the calculation of the integral indicators of the matrix of selection a strategy for stimulating innovation for JV «Spheros-Electron» LLC in the table form (see Table 4 and 5).

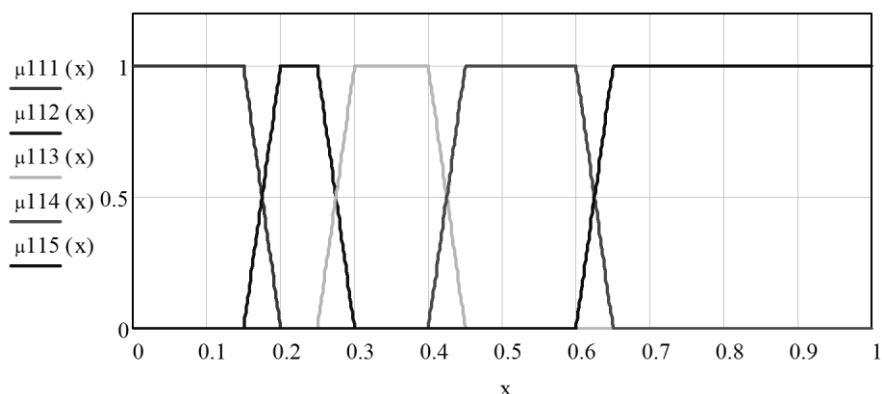


Figure 3. The five-level fuzzy classifier is constructed on trapezoidal membership functions for the linguistic evaluation of the values of the ratio of financial independence

Sources: developed by the authors

Table 4. Data for assessment of the integral index X_n (JV «Spheros-Electron» LLC)

Specified values of the baseline indicators	By weight of baseline indicators	Functions of belonging to the values of the baseline indicators by the standard five-level fuzzy 01-classifier				
		«Very low»	«Low»	«Medium»	«High»	«Very high»
		$\mu_{11}(x_i)$	$\mu_{12}(x_i)$	$\mu_{13}(x_i)$	$\mu_{14}(x_i)$	$\mu_{15}(x_i)$
$x_1 = 0.90$	$\alpha_1 = 0.126$	0	0	0	0	1
$x_2 = 0.90$	$\alpha_2 = 0.071$	0	0	0	0	1
$x_3 = 0.78$	$\alpha_3 = 0.024$	0	0	0	0.62	0.38
$x_4 = 0.67$	$\alpha_4 = 0.100$	0	0	0.14	0.86	0
$x_5 = 0.37$	$\alpha_5 = 0.091$	0	0.64	0.36	0	0
$x_6 = 0.27$	$\alpha_6 = 0.067$	0.18	0.82	0	0	0
$x_7 = 0.28$	$\alpha_7 = 0.124$	0.11	0.89	0	0	0
$x_8 = 0.30$	$\alpha_8 = 0.134$	0	1	0	0	0
$x_{10} = 0.70$	$\alpha_{10} = 0.038$	0	0	0	1	0
$x_{11} = 0.30$	$\alpha_{11} = 0.084$	0	1	0	0	0
$x_{12} = 0.57$	$\alpha_{12} = 0.090$	0	0	0.66	0.34	0
Node points (β_j^+)		0.1	0.3	0.5	0.7	0.9
$x_9 = 0.52$	$\alpha_9 = 0.051$	0	0.1	0.9	0	0
Node points (β_j^-)		0.9	0.7	0.5	0.3	0.1

Sources: developed by the authors

The calculation based on the data of the tables by formulas (1) and (2) gives the following coordinates for the positioning of JV «Spheros-Electron» LLC in the selection matrix of the strategy for stimulating innovation activity (Table 5).

If the quantification of the integral indexes X_n and Y_m can be carried out according to formulas (1) and (2), the three-level and four-level 01-classifiers with subsets should not be used for the recognition of the linguistic levels of these indicators, rather than the standard five-level 01-classifier. «Bad», «Good», «Very good» of the linguistic variable «Level of the indicator» in the three-level classifier and «Bad», «Satisfactory», «Good», «Very good» – at the four-level classifier.

Table 5. Data for assessment of the integral index Y_m (JV «Spheros-Electron» LLC)

Specified values of the baseline indicators	By weight of baseline indicators	Functions of belonging to the values of the baseline indicators by the standard five-level fuzzy 01-classifier				
		«Very low»	«Low»	«Medium»	«High»	«Very high»
		$\mu_{k1}(y_k)$	$\mu_{k2}(y_k)$	$\mu_{k3}(y_k)$	$\mu_{k4}(y_k)$	$\mu_{k5}(y_k)$
$y_1 = 0.46$	$\alpha_1 = 0.095$	0	0.21	0.79	0	0
$y_2 = 0.50$	$\alpha_2 = 0.167$	0	0	1	0	0
$y_3 = 0.30$	$\alpha_3 = 0.221$	0	1	0	0	0
$y_4 = 0.48$	$\alpha_4 = 0.190$	0	0.1	0.9	0	0
$y_5 = 0.25$	$\alpha_5 = 0.137$	0.27	0.73	0	0	0
$y_6 = 0.13$	$\alpha_6 = 0.190$	0.86	0.14	0	0	0
Node points (β_j^+)		0.1	0.3	0.5	0.7	0.9

Sources: developed by the authors

$$X_n = 0.126 \times 0.9 + 0.071 \times 0.9 + 0.024 \times 0.78 + 0.1 \times 0.67 + 0.091 \times 0.37 + 0.067 \times 0.27 + 0.124 \times 0.28 + 0.134 \times 0.3 + 0.051 \times 0.52 + 0.038 \times 0.7 + 0.084 \times 0.3 + 0.09 \times 0.57 = 0.519; \quad (7)$$

$$Y_m = 0.095 \times 0.46 + 0.167 \times 0.5 + 0.221 \times 0.3 + 0.19 \times 0.48 + 0.137 \times 0.25 + 0.19 \times 0.13 = 0.343 \quad (8)$$

The transition from five levels to three and four because the matrix of the selection of a strategy for stimulating innovation and investment activity of enterprises has a dimension of 4'3 (only 12 items).

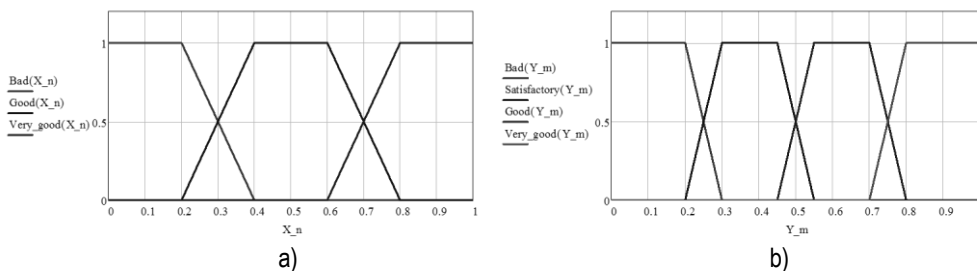


Figure 4. Three- (a) and four-level (b) fuzzy classifiers are based on trapezoidal membership functions for the linguistic evaluation of the integral indexes X_n and Y_m

Sources: developed by the authors

The rule for recognizing the linguistic values of integral indicators X_n and Y_m , calculated by formulas (1) and (2), are presented in Table 6 and 7. When recognizing these rules of the linguistic values of integral indicators X_n and Y_m , calculated for JV «Spheros-Electron» LLC, it is possible to position the level of the index X_n of this enterprise as «Good», and the level of the indicator Y_m as «Satisfactory». Similarly, the assessment of integral indicators and positioning in the matrix of the selection of a strategy for stimulating innovation and investment activity for the remaining enterprises has been carried out. In particular, for LEONI Wiring Systems UA GmbH, the calculated values are: $X_n = 0.392$, and $Y_m = 0.364$. Recognizing these values with the rules in Table 6 and 7 indicates that the level of investment attractiveness of this enterprise on the market is 96% «Good» and 4% «Bad», and the level of innovation potential is 100% «Satisfactory». With respect to PJSC «Drohobych Truck Crane Plant», the values of integral indicators here for are $X_n = 0.221$, $Y_m = 0.167$. Recognizing the linguistic values of these integral indicators, can position the level of X_n by 90% as «Bad» and 10% as «Good» and the level of the Y_m as 100% «Bad».

Table 6. The recognition rule of linguistic values of the integral index X_n – the level of investment attractiveness of the enterprise on the market

Value interval X_n	The classification of levels of investment attractiveness of the enterprise on the market	Degree of assessment confidence (membership function)
$0 \leq X_n < 0.2$	Bad	$\mu_1 = 1$
$0.2 \leq X_n < 0.4$	Bad	$\mu_1 = 5 \times (0.4 - X_n)$
	Good	$\mu_2 = 1 - \mu_1$
$0.4 \leq X_n < 0.6$	Good	$\mu_2 = 1$
$0.6 \leq X_n < 0.8$	Good	$\mu_2 = 5 \times (0.8 - X_n)$
	Very good	$\mu_3 = 1 - \mu_2$
$0.8 \leq X_n \leq 1.0$	Very good	$\mu_3 = 1$

Sources: developed by the authors

Table 7. The recognition rule of linguistic values of the integral index Y_m – the level of innovation potential of the enterprise

Value interval Y_m	The classification of levels of innovative potential of the enterprise	Degree of assessment confidence (membership function)
$0 \leq Y_m < 0.2$	Bad	$\mu_1 = 1$
$0.2 \leq Y_m < 0.3$	Bad	$\mu_1 = 10 \times (0.3 - Y_m)$
	Satisfactory	$\mu_2 = 1 - \mu_1$
$0.3 \leq Y_m < 0.45$	Satisfactory	$\mu_2 = 1$
$0.45 \leq Y_m < 0.55$	Satisfactory	$\mu_2 = 10 \times (0.55 - Y_m)$
	Good	$\mu_3 = 1 - \mu_2$
$0.55 \leq Y_m < 0.7$	Good	$\mu_3 = 1$
$0.7 \leq Y_m < 0.8$	Good	$\mu_3 = 10 \times (0.8 - Y_m)$
	Very good	$\mu_4 = 1 - \mu_3$
$0.8 \leq Y_m \leq 1.0$	Very good	$\mu_4 = 1$

Sources: developed by the authors

Based on the calculations, the positioning of the explored machine-building enterprises in the selection matrix of the strategy for stimulating innovation activity has been performed (see Figure 5).

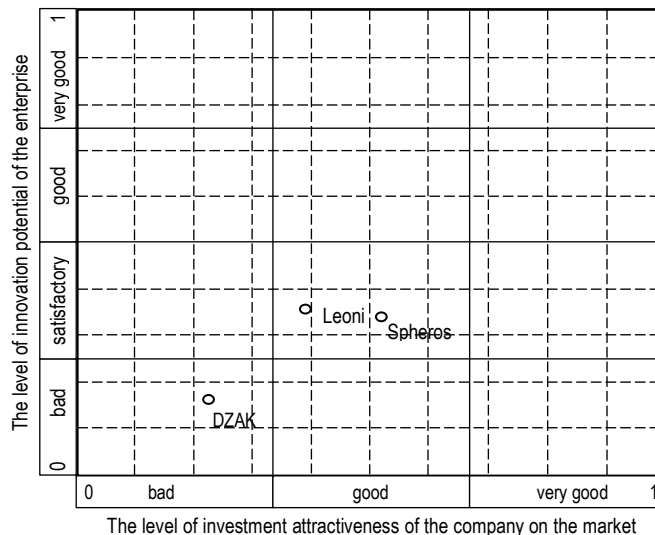


Figure 5. The positioning of machine-building enterprises in the selection matrix of the strategy for stimulating innovation activity

Sources: developed by the authors.

The high positioning of the three machine-building enterprises allows us to draw the following conclusions:

- PJSC «Drohobych Truck Crane Plant» – the enterprise has entered the zone of application of the strategy of innovation changes and is characterized by both low level of investment attractiveness and low level of the innovative potential;
- JV «Spheros-Elektron» LLC and LEONI Wiring Systems UA GmbH – both companies have entered the zone of application of the strategy of differentiation, characterized by an average level of investment attractiveness and a satisfactory level of innovation potential. However, according to the first parameter, that is, the level of investment attractiveness of the company on the market, LEONI Wiring Systems UA GmbH has also approached and is close enough to the application of the opportunistic strategy.

Conclusions. In order to increase the efficient functioning of domestic machine-building enterprises, the article proposes a matrix model for the selection of the strategy for stimulating their innovation and investment activity. The indicators have been systematized, which provides for comprehensive assessment and sophisticated analysis of their investment attractiveness on the market and the level of innovation potential, as well as to select the most effective innovation and investment strategy for the enterprise, focusing on the value of a complex indicator, and to propose specific strategic measures for the business development of enterprises within the selected strategy. Having tested the proposed model, based on the researches and calculations, it is possible to offer for each of the considered in the activity of the machine-building enterprises the following strategies of stimulation of innovation activity: PJSC «Drohobych Truck Crane Plant». It is necessary to apply a strategy of innovation changes for JV «Spheros-Elektron» LLC and LEONI Wiring Systems UA GmbH the most expedient is the application of a differentiation strategy that is more competitive than the innovation one. Therefore, in order to remain on the market of PJSC «Drohobych Truck Crane Plant», it is necessary to modernize the products radically. Furthermore, the main tasks of implementing the differentiation strategy for «Spheros-Electron» and «LEONI» should be: to invest in the activities of research institutions; to conduct consumer preferences analysis; the analysis of its production capacities; installation of new production lines according to the achievements of the technical progress; production output, which is in demand by the population; holding a capable advertising company. Subject to the successful implementation of the strategy of differentiation, «LEONI» and «Spheros-Electron» can move to a strategy of price leadership according to our matrix, which involves reducing production costs due to massive increase in the volume of innovative products and efficiency of the production processes. At this stage, the main task for enterprises should be to enter the markets of the leading world countries, seizing gradually up to 5% of the share of its industrial market.

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Модель вибору інноваційно-інвестиційної стратегії машинобудівних підприємств: практичний аспект

Стаття узагальнює аргументи в межах наукової проблематики з питання вибору інноваційно-інвестиційної стратегії машинобудівних підприємств. Основною метою проведеного дослідження є розроблення моделі вибору оптимальної стратегії інноваційно-інвестиційного розвитку машинобудівних підприємств, враховуючи рівень їх інвестиційної привабливості на ринку та рівень їх інноваційного потенціалу. Систематизація науково-теоретичного та методичного матеріалу щодо моделі вибору інноваційно-інвестиційної стратегії машинобудівних підприємств дала підстави зробити висновки про те, що недостатньо вивченими залишаються питання розроблення моделі, що ґрунтується на показниках комплексного аналізу інвестиційної привабливості підприємства та визначення його рівня інноваційного потенціалу, для вибору оптимальної інноваційно-інвестиційної стратегії з метою підвищення ефективності функціонування вітчизняних машинобудівних підприємств. Актуальність вирішення даної проблеми полягає в тому, що саме правильний вибір конкретного виду інноваційно-інвестиційної стратегії, яка повинна бути орієнтована на досягнення поставлених цілей підприємства та враховувати його наявний потенціал, є тим інструментарієм, який допоможе машинобудівним підприємствам підвищити ефективність їх функціонування та сформувати конкурентні позиції на ринку, адже сьогодні в країні гостро стоїть питання дисбалансу між зростаючими потребами споживання машинобудівної продукції та недостатнім рівнем її виробництва вітчизняними підприємствами. Методичним інструментарієм проведеного дослідження щодо моделі вибору інноваційно-інвестиційної стратегії стали матричний метод та метод згортки на основі теорії нечітких множин. Об'єктами дослідження обрано: СП ТзОВ «Сферос-Електрон», ЛЕОНІ Ваєрінг Системс УА ГмБХ та ПАТ «Дрогобицький завод автомобільних кранів», оскільки саме вони розкривають особливості функціонування машинобудівних підприємств Львівщини та є різними за своїм фінансово-господарським станом функціонування, що сприятиме ґрунтовнішому дослідженню щодо вибору відповідних інноваційно-інвестиційних стратегій. У статті представлено результати емпіричного аналізу вибору відповідних інноваційно-інвестиційних стратегій, який засвідчує, що ПАТ «Дрогобицький завод автомобільних кранів» – підприємство потрапило в зону застосування стратегії інноваційних змін та характеризується як низьким рівнем інвестиційної привабливості так і низьким рівнем інноваційного потенціалу; СП ТзОВ «Сферос-Електрон» та ЛЕОНІ Ваєрінг Системс УА ГмБХ – обидва підприємства потрапили в зону застосування стратегії диференціації, що характеризується середнім рівнем інвестиційної привабливості та задовільним рівнем інноваційного потенціалу. Проте за першим параметром, тобто рівнем інвестиційної привабливості підприємства на ринку, ЛЕОНІ Ваєрінг Системс УА ГмБХ наблизились ще й досить близько до зони застосування опортуністичної стратегії. Дослідження емпірично підтверджує та теоретично доводить, що для того, щоб залишитись на ринку ПАТ «Дрогобицький завод автомобільних кранів» повинен докорінно модернізувати продукцію. А основними завданнями реалізації стратегії диференціації для «Сферос-Електрон» та для «ЛЕОНІ» повинні бути: інвестувати кошти у діяльність науково-дослідних установ; проводити аналіз влгодобань споживачів; аналіз власних виробничих потужностей; монтаж нових ліній виробництва згідно досягнень НТП; випуск продукції, яка користується попитом на ринку; проведення ефективної рекламної кампанії. За умови успішного проведення стратегії диференціації фірми ЛЕОНІ та «Сферос-Електрон» згідно нашої матриці можуть переходити до стратегії цінного лідерства, що передбачає зниження витрат виробництва за рахунок масового збільшення обсягів інноваційної продукції і раціоналізації виробничих процесів. На даному етапі основним завданням для підприємств повинен стати вихід на ринки збуту провідних світових країн, захопивши поступово до 5% частки свого галузевого ринку. Результати проведеного дослідження можуть бути корисними для промислових підприємств загалом та для машинобудівних підприємств, зокрема.

Ключові слова: інноваційно-інвестиційні стратегії, машинобудівне підприємство, модель вибору стратегії, стратегія інноваційного розвитку, теорія нечітких множин.

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